An investigation of cognitive functioning and personality traits in obsessive-compulsive disorder, panic disorder, healthy controls and sub-clinical obsessive-compulsives

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ABSTRACT

Obsessive-compulsive disorder (OCD) is a common psychiatric illness characterised by recurrent, intrusive thoughts and repetitive, stereotyped behaviours. There is converging evidence that OCD is associated with a specific cognitive deficit related to organising and manipulating information in working memory. There is also evidence that OCD is associated with certain pre-morbid personality traits. However, further research is needed to elucidate whether these cognitive deficits and personality traits are specific to OCD or are present in other anxiety disorders and/or individuals with sub-clinical levels of obsessive-compulsive (OC) symptoms. In this thesis, 20 OCD patients were compared to 20 patients with panic disorder, 20 subjects with sub-clinical OC symptoms and 20 healthy control subjects on tests of working memory and the Five-Factor Model of personality. To measure different aspects of working memory, participants completed three delayed matching-to-sample (DMS) tasks and two continuous performance working memory tasks (n-back tasks). The DMS tasks assessed the ability to actively maintain different types of information in working memory (irregular objects; geometric objects; spatial locations). The n-back tasks assessed the ability to update and temporally order verbal and spatial stimuli in working memory. The OCD patients were less accurate than the healthy control subjects on the memory trials of the spatial DMS task, the 3-back trials of the spatial n-back task, and the 2-back and 3-back trials of the verbal n-back task. The OCD patients were also less accurate than patients with panic disorder and sub-clinical OC subjects on the verbal 3-back task. The results indicated that OCD patients were impaired on cognitive tasks requiring the maintenance of spatial stimuli and the updating and temporal ordering of verbal and spatial stimuli in working memory. The OCD patients were not impaired on tasks requiring the maintenance of object information in working memory. To measure normal personality traits, subjects completed the Revised NEO Personality Inventory (NEO PI-R). Compared to healthy controls, OCD patients reported being highly emotional and introverted, less open to new experiences, and lacking confidence in their own abilities. The OCD patients were similar to the panic disorder patients on most of the domains and facets of the NEO PI-R, however, they were distinguished by their lower openness to experiencing new activities, and being less diligent and purposeful. Compared to the sub-clinical OC subjects, OCD patients reported being more prone to feelings of depression, more vulnerable to stress, less likely to experience positive emotions, more humble and sincere and less able to carry tasks through to completion. Overall, the thesis provided further evidence that OCD patients are impaired on cognitive tasks requiring the organisation and manipulation of information in working memory. However, it is still unclear whether this deficit arises due to capacity constraints being exceeded in working memory systems, or some other executive dysfunction such as excessive error monitoring. Future research, combining neuropsychological testing with neuroimaging techniques, is required to better understand the neural mechanisms underlying the impaired performance of OCD patients on tests of working memory. The present thesis also found that normal personality traits – as measured by the NEO PI-R – were able to

distinguish OCD patients from healthy controls, patients with panic disorder and individuals with sub-clinical levels of OC symptoms. The results have implications for sub-clinical OC research and the clinical management of OCD.

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SIGNED DECLARATION

I declare that this thesis does not incorporate without written acknowledgment any material previously submitted for a degree in any University, College of Advanced Education, or other educational institution; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

I further declare that the ethical principles and procedures specified in the National Health and Medical Research Council (NH&MRC) document on human research and experimentation have been adhered to in the presentation of this thesis.

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Signed:

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ACC	Anterior cingulate cortex
ADTP	Anxiety Day Treatment Program
ANOVA	Analysis of variance
APA	American Psychiatric Association
AVLT	Auditory Verbal Learning Test
BDI-II	Beck Depression Inventory - version 2
BVRT	Benton Visual Retention Test
CANTAB	Cambridge Neuropsychological Test Automated Battery
CAT	Category Alternation Test
CIDI-Auto	Composite International Diagnostic Inventory - version 2
CLPT	Competing Language Processing Task
CPT	Continuous Performance Test
CPT-IP	Continuous Performance Test - Identical Pairs version
CVLT	California Verbal Learning Test
DART	Depression and Anxiety Research and Treatment Program
DAT	Delayed Alternation Test
DFT	Design Fluency Task
DIS	Diagnostic Interview Schedule
DMS	Delayed-matching-to-sample
DSM-III	Diagnostic and Statistical Manual of Mental Disorders - third Edition
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders - fourth Edition
ECA	Epidemiological catchment area
EPQ	Eysenck Personality Questionnaire
EPS	Early Parkinson's symptoms
FFM	Five Factor Model
fMRI	Functional magnetic resonance imaging
FSIQ-2	Full Scale IQ - 2 subtest version
FSIQ-4	Full Scale IQ - 4 subtest version
GPQ	Goldberg Personality Questionnaire
HVOT	Hooper's Visual Organisation Test
IGT	Iowa Gambling Task
IQ	Intelligence quotient
LOT	Line Orientation Test
MANOVA	Multivariate analysis of variance
MD	Major depression
MDD	Major depressive disorder
MMPI	Minnesota Multiphasic Personality Inventory
MRT	Mental Rotation Test

NEO PI-R	Revised NEO Personality Inventory
OAT	Object Alternation Test
OC	Obsessive-compulsive
OCADF	Obsessive-Compulsive and Anxiety Disorders Foundation
OCD	Obsessive-compulsive disorder
OCPD	Obsessive-compulsive personality disorder
OMO	Odd-man-out Test
PET	Positron Emission Tomography
PI	Padua Inventory
PIQ	Non-verbal Intelligence
RAS	Responsibility Attitude Scale
rCBF	Regional cerebral blood flow
RCFT	Rey Complex Figure Test
rCMRglc	Regional cerebral glucose
RFT	Recurring Figures Test
SNRI	Selective norepinephrine reuptake inhibitor
SPECT	Single positron emission computed tomography
SSRI	Selective serotonin reuptake inhibitor
STAI	State Trait Anxiety Inventory
STAI-S	State Trait Anxiety Inventory - State form
STAI-T	State Trait Anxiety Inventory - Trait form
TCI	Temperament and Character Inventory
TEA	Test of Everyday Attention
TMT	Trail Making Test
TOH	Tower of Hanoi
TOL	Tower of London
TPQ	Tridimensional Personality Questionnaire
TPT	Tactual Performance Test
VIQ	Verbal Intelligence Quotient
VVT	Visual-verbal Test
WAIS	Wechsler Adult Intelligence Scale
WASI	Wechsler Abbreviated Scale of Intelligence
WCST	Wisconsin Card Sorting Test
WHO	World Health Organisation
WMS	Wechsler Memory Scale
Y-BOCS	Yale Brown Obsessive-Compulsive Scale
Y-BOCS CL	Yale Brown Obsessive-Compulsive Symptom Checklist

CHAPTER 1: OVERVIEW

Obsessive-compulsive disorder (OCD) is an anxiety disorder that ranks as the fourth most common psychiatric disorder behind major depression, the phobias and substance abuse (Aouizerate et al., 2004). OCD is a severe and disabling disorder that is frequently associated with other serious conditions such as depression and other anxiety disorders. Research on this illness is vital because of the large number of patients that it affects, the severity of their symptoms and the degree of impairment that these symptoms cause (Ownby, 1998).

The purpose of the present thesis is to investigate the specificity of the cognitive impairment and personality traits of patients with OCD in comparison to clinical and healthy controls and individuals with sub-clinical levels of obsessive-compulsive (OC) symptoms.

In recent years there has been a great deal of research examining the neuropsychological deficits associated with OCD. Evidence is accumulating that OCD patients are impaired on tasks requiring the organisation or manipulation of information in working memory. For example, OCD patients have demonstrated impairment on tests of spatial working memory (Purcell, Maruff, Kyrios, & Pantelis, 1998a, 1998b; van der Wee et al., 2003), mental rotation of spatial stimuli (Savage et al., 1999), temporal ordering (Jurado, Junque, Vallejo, Salgado, & Grafman, 2002), memory for frequency (Jurado, Junque, Vallejo, & Salgado, 2001) and semantic integration (Savage et al., 2000; Cabrera, McNally, & Savage, 2001; Deckersbach et al., 2004). However, further research is required to establish whether the deficits are specific to OCD or are also present in individuals with other anxiety disorders or with sub-clinical OC symptoms.

Compared to the neuropsychology of OCD there has been substantially less research conducted into the normal personality traits associated with OCD. Specifically, there have been few studies investigating the Five-Factor Model of personality (FFM) in OCD or in other anxiety disorders. There is preliminary evidence that OCD is associated with certain normal personality traits such as high Neuroticism, low Extraversion and low sensation-seeking (Samuels et al., 2000; Rector, Hood, Richter, & Bagby, 2002; Leong, 2003; Bienvenu et al., 2004). However, few studies have examined the personality traits of OCD patients in comparison to other anxiety disorders or individuals with sub-clinical OC symptoms.

To better understand the pathophysiology of OCD and to design effective treatment programs, uncovering the specificity of the cognitive deficits and premorbid personality traits of individuals with OCD is an important part of research into this disorder. To investigate the specificity of the deficits associated with OCD, comparison with other anxiety disorders is important. This thesis will include a control group with another anxiety disorder (panic disorder) to investigate whether

observed deficits are related to the core symptoms of OCD or are associated with anxiety in general.

Studies investigating questions about the cognitive deficits and personality traits associated with OCD have utilised both clinical and sub-clinical cohorts. The problem with using sub-clinical OC samples is that it is unclear whether the findings from these studies can be generalised to clinical OCD patients. There is evidence that sub-clinical OC subjects have personality and clinical features (Mataix-Cols, Vallejo, & Sanchez-Turet, 2000; Fullana et al., 2004) and cognitive deficits (Mataix-Cols et al., 1997; Mataix-Cols, Barrios, Sanchez-Turet, Vallejo, & Junque, 1999a; Mataix-Cols et al., 1999b; Spitznagel & Suhr, 2002) that resemble those of OCD patients. However, direct comparison of the two groups is rare. For this reason, this thesis will include a sub-clinical OC sample to allow direct comparison with the OCD patients on neuropsychological tests and personality measures.

This thesis aims to answer a number of questions regarding the cognitive impairment observed in OCD. Firstly, is there a distinction in the ability of OCD patients to maintain representations of pattern versus spatial material in working memory? Secondly, are patients with OCD impaired on working memory tasks that involve executive processes such as updating and temporal coding of information? Finally, does the performance of OCD patients decrease as the task load increases? To investigate these questions the OCD patients in this thesis completed a series of delayed-matching-to-sample tasks (DMS) and continuous performance working memory tasks. These tasks were comprised of different types of stimuli (objects, spatial locations and letters), had varying levels of difficulty, and required different types of processing (maintenance of stimuli versus continual updating of stimuli). The tasks used in this thesis have been used extensively in lesion and neuroimaging studies of working memory (Smith et al., 1995; Smith & Jonides, 1997; Smith & Jonides, 1998; Smith & Jonides, 1999). The performance of the OCD patients was compared to an anxiety disorder control group (panic disorder), a healthy control group and a sub-clinical OC group.

This thesis also aimed to investigate the normal personality traits associated with OCD and how they compared to healthy control subjects, patients with panic disorder and sub-clinical OC subjects. The Revised NEO Personality Inventory (NEO PI-R; Costa & McCrae, 1992) was used to measure the higher-order and lower-order personality traits associated with OCD.

The thesis begins with an overview of OCD in Chapter 2. This chapter includes a description of the development of OCD as a diagnosis, the current diagnostic criteria for OCD, prevalence statistics, subtypes of OCD, the clinical features of OCD and a description of cognitive models of OCD. Chapter 2 also includes a discussion of the findings from genetic studies, neurological examinations, neurosurgery, and brain imaging studies regarding the possibility of an underlying biological deficit in OCD. Chapter 3 discusses the results from the neuropsychological literature

regarding the cognitive deficits associated with OCD. Included are the findings from recent studies proposing the importance of strategic memory processes in OCD – such as manipulating information in working memory. Chapter 4 discusses the personality features associated with OCD. This chapter includes a discussion of recent studies utilising the FFM to better understand the personality traits associated with OCD. The use of non-clinical OC samples in OCD research is discussed in Chapter 5. This chapter discusses the features of OCD that are shared by individuals with sub-clinical OC symptoms and evidence that the cognitive deficits observed in OCD may also be present in individuals with sub-clinical OC symptoms. The motivation for the thesis, aims and hypotheses are presented in Chapter 6. The selection and description of the thesis participants is outlined in Chapter 7. Chapter 8 describes the materials used in the thesis as well as the experimental procedure employed. The results from the statistical analyses are provided in Chapters 9, 10 and 11. The final chapter is a discussion of the results, the limitations of the thesis, suggestions for future research and concluding remarks (Chapter 12).

CHAPTER 2: OBSESSIVE-COMPULSIVE DISORDER

2.1 Introduction

This chapter will give an overview of Obsessive-compulsive disorder (OCD) including its conceptual history, current definition, prevalence and clinical features. Evidence suggesting an underlying biological deficit in OCD will also be presented.

2.2 Conceptual history

Reports of OCD-like phenomena have been observed as early as medieval times (Berrios, 1989). Individuals with obsessive thoughts, particularly blasphemous or sexual, were generally considered to be possessed and exorcism was typically the treatment of choice. The religious explanation for the cause of obsessions and compulsions was eventually relaced by a medical one (Jenike, 2001). The modern concept of OCD evolved in the 19th century as a result of two important developments. Firstly, theorists argued that the presence of insight distinguished obsessions from delusions and separated OCD from psychosis (Jenike, 2001). Secondly, compulsions were distinguished from stereotyped, irresistible behaviours which were instead classified as impulsions (Tallis, 1995). Throughout the 19th century, authors variously attributed the symptoms of OCD to volitional, intellectual, emotional or organic impairment (Spitzer & Sigmund, 1997).

One of the first authors to describe the features of OCD was Esquirol (1772–1840) who considered OCD to be a form of partial insanity. Esquirol believed that obsessions were a disorder of will or volition, however, the volitional view of OCD declined by the middle of the 19th century (Berrios, 1989). Westphal (1833–1890) considered OCD to be a disorder of the intellect and conceptualised obsessions as ideas that enter a persons' consciousness against their will, cannot easily be dismissed and are regarded as abnormal. Westphal observed that OCD patients suffer from anxiety as a reaction to their obsessions and also noted a link between obsessions and compulsive behaviour (Spitzer & Sigmund, 1997). Morel (1809–1873) described OCD as a disease of the emotions and recognised the presence of insight as fundamental to the disorder. Morel also noted the relationship between OCD and anxiety. Alternatively, Magnan (1835–1916) considered OCD to be a psychosis of degeneration arising from cerebral pathology (Berrios, 1989).

Psychological theories of OCD were consolidated at the beginning of the 20th century through the writings of Pierre Janet (1859–1947) and Sigmund Freud (1856–1939) (Jenike, 2001). According to Janet, obsessional illness progressed through a three-stage process. The first stage was described as the 'psychasthenic state'. This was characterised by feelings of incompleteness and imperfection, doubt, a need for order, excessive cleanliness, poor thought control, and a fondness for collecting things (Tallis, 1995). The second stage was characterised by 'forced agitations' which generally occurred under demanding circumstances (Kolada, Bland,

& Newman, 1994). Forced agitations would generally take the form of either order and symmetry rituals, compulsive checking or mental ruminations. The third and final stage of the illness was that of 'obsessions and compulsions'. In this stage, thoughts and impulses that were easily evoked dominated the patients' life. Obsessions were typically concerned with blasphemous, violent or sexual themes, and attempts to resist impulses increased anxiety. Implicit in Janet's stages was the existence of an obsessional continuum, ranging from normal obsessional behaviour, through obsessive personality, to symptomatic obsessional neurosis (Tallis, 1995).

Janet's description of an obsessional continuum was later reflected in the writings of Sigmund Freud who distinguished the 'anal erotic character' from obsessive-compulsive neurosis (Tallis, 1995). The central features of the anal erotic character were obstinacy, parsimony and orderliness (Tallis, 1995). As a result of the theories of Janet and Freud, treatment of OCD shifted from attempts to modify the obsessional behaviour towards the treatment of the unconscious conflicts that were assumed to underlie the symptoms (Jenike, 2001).

By the middle of the 20th century, learning theories that had proven useful in dealing with phobic disorders were being applied to OCD (Jenike, 2001). The growth of behaviour research in the 1950s led to the development of exposure and response prevention for reducing compulsions. Behaviour therapy is still considered one of the most effective treatments for reducing the severity of obsessive-compulsive behaviours (Jenike, 2001).

In recent years, investigations have focused on the biology of OCD through studies of the disorder's pharmacology, neurosurgery, brain imaging, genetics, neuropsychology, and the relationship between OCD symptoms and neurological disorders such as Sydenham's chorea and Tourette's syndrome (Jenike, 2001). These investigations have led to the development of theories of basal ganglia and frontal lobe dysfunction as the underlying pathophysiology of OCD (Saxena, Brody, Schwartz, & Baxter, 1998; Aouizerate et al., 2004).

In summary, the contemporary diagnosis of OCD has a long history with many of the symptoms of OCD having been recognised for over a hundred years (Tallis, 1995). By the end of the 20th century, advances in pharmacology, neuroanatomy, neurophysiology and learning theories had combined to provide a therapeutically useful conceptualisation of OCD (Spitzer & Sigmund, 1997).

2.3 Prevalence

For many years OCD was considered a rare disorder in the general population with estimates as low as 0.9% (Ingram, 1961) and 0.05% (Woodruff & Pitts, 1964). This perception was mainly based on the low reported rates of the disorder in psychiatric clinics. However, many individuals with OCD are embarrassed about their symptoms or fear that their symptoms are a

sign of madness. As a result of this fear and embarrassment, many people with OCD are reluctant to admit to their symptoms or to present for treatment (Parkin, 1997). Recent epidemiological surveys suggest that OCD is more common than previously thought and that OCD is among the most common of mental disorders (Micallef & Blin, 2001).

The Epidemiologic Catchment Area (ECA) surveys conducted in the United States in the early 1980s used the Diagnostic Interview Schedule (DIS; Robins, Helzer, Croughan, & Ratcliff, 1981) to estimate the prevalence of OCD according to the criteria of the *Diagnostic and Statistical Manual of Mental Disorders*, third edition (*DSM-III*; American Psychiatric Association (APA), 1980). These surveys reported that OCD was relatively common with the estimated lifetime prevalence of OCD in adults ranging from 1.9% to 3.3% across the five ECA sites (Karno, Golding, Sorenson, & Burnam, 1988). The same study estimated that the past-month prevalence of OCD was 1.3% (Karno et al., 1988). A similar survey in Canada also used DIS/DSM-III criteria and reported a lifetime prevalence of 2.9% in adults (Kolada et al., 1994). A cross-national study by Weissman et al. (1994), used DIS/DSM-III criteria to estimate the prevalence of OCD in seven countries: United States, Canada, Puerto Rico, Germany, Taiwan, Korea and New Zealand. Most of the lifetime prevalence rates fell between 1.9% and 2.5% with the exception of Taiwan which had a rate of 0.7%.

A more recent Canadian study, using criteria from the *DSM*, fourth edition (*DSM-IV*; APA, 1994), estimated that the past-month prevalence rate of OCD was 0.6% (Stein, Forde, Anderson, & Walker, 1997). A study using a Zurich community cohort also used *DMS-IV* criteria to estimate that the lifetime prevalence of OCD was 3.5% (Angst et al., 2004). Mohammadi et al. (2004) used *DSM-IV* criteria and reported that the life-time prevalence of OCD in Iran was 1.8%. In terms of Australian statistics, the *Mental Health and Wellbeing Survey* conducted in 1997 used *DSM-IV* criteria and estimated the past-year prevalence of OCD in Australia to be 0.4% (Australian Bureau of Statistics, 1997).

In a review of nine epidemiological studies employing standardised interview methods Bebbington (1998) estimated that the prevalence of OCD was approximately 1%. This estimate would make OCD less prevalent than depression but about twice as common as schizophrenia and bipolar disorder (Bebbington, 1998).

2.4 Current definition

To receive a diagnosis of OCD according to the *DSM-IV* (APA, 1994) an individual must present with either obsessions or compulsions, however, the majority present with both (Samuels & Nestadt, 1997).

Obsessions are defined as recurrent and persistent thoughts, impulses or images that are experienced as intrusive and inappropriate at some time during the disturbance. The

obsessions are not simply excessive worries about everyday problems and cause significant distress. The individual tries to ignore or suppress such obsessions, or to neutralise them with some other thought or action, and recognises that the obsessions are a product of his or her own mind (APA, 1994).

Compulsions are defined as repetitive behaviours or mental acts that the person feels driven to perform in response to an obsession, or according to rules that must be applied rigidly. The compulsions are aimed at preventing or reducing distress or preventing some dreaded event or situation; however, the compulsions either are not connected in a realistic way with what they are designed to neutralise or prevent, or are clearly excessive (APA, 1994).

DSM-IV criteria also requires that at some point during the course of the disorder the individual recognises that the obsessions or compulsions are excessive or unreasonable. The obsessions or compulsions must also cause marked distress, be time-consuming (take more than one hour a day), or significantly interfere with the person's normal routine, occupational (or academic) functioning, or usual social activities or relationships (APA, 1994). The diagnosis of OCD should not be made if the symptoms can be attributed to another disorder (e.g. preoccupation with food in the presence of an eating disorder; hair pulling in the presence or trichotillomania) or are the consequence of substance abuse (Jenike, 2001).

2.5 Subtypes of OCD

The empirical structure of OCD symptoms has received a great deal of attention given the heterogenous nature of the disorder. Various methods have been used to identify subtypes of OCD including demographic and clinical characteristics (age of onset; gender; comorbidity with other conditions) and phenomenological consistencies. The dichotomy between obsessions and compulsions has also been a popular approach to symptom classification (Summerfeldt, Richter, Antony & Swinson, 1999). More recently, research to identify specific subtypes of OCD has focused primarily on symptom presentation. The symptoms used to define OCD are diverse and include a range of obsessions and compulsions (Lochner & Stein, 2003). The most common obsessions relate to concerns about contamination, obsessive doubt, need for symmetry and aggression or harm. The most common compulsions involve checking, washing and counting (Samuels & Nestadt, 1997).

Sub-typing according to clinical phenotype has typically utilised factor analytical methods to evaluate responses on various measures of obsessive-compulsive symptomatology. The inventories that have been subject to factor analyses most frequently are the Padua Inventory (PI; Sanavio, 1988) and the Yale-Brown Obsessive Compulsive Symptom Checklist (Y-BOCS CL; Goodman et al., 1989b).

The PI is a 60-item self-report measure that describes common obsessional and compulsive behaviour. Each item is rated on a 0 to 4 scale regarding degree of disturbance. Studies that have factor analysed the PI have typically identified four to five symptom clusters. Some of the factors identified in these studies include impaired control over mental activities, contamination, checking, urges and worries of losing control, impulses, rumination, precision, obsessions about harm, and dressing and grooming compulsions (van Oppen Pet al., 1995; Kyrios et al., 1996; Sanavio, 1988; Sternberger & Burns, 1990).

The Y-BOCS CL is a comprehensive list of obsessions and compulsions divided into 15 categories. Studies that have factor analysed the Y-BOCS CL have typically identified three to five symptom clusters. Some of the factors identified in these studies include symmetry and hoarding, contamination and checking, pure obsessions, obsessions and checking, symmetry and ordering, cleanliness and washing, hoarding, contamination and cleaning, harming, contamination, and certainty (Baer, 1994; Leckman et al., 1997; Calamari et al., 1999; Summerfeldt et al., 1999).

There are some symptom themes that are consistently identified in factor analytic studies (contamination/washing, checking, hoarding, symmetry/ordering). These factors are likely to represent reliable and valid symptom subtypes of OCD. However, some symptom themes have mixed empirical support (pure obsessionals, sexual/religious obsessions, harming obsessions) and are likely to represent dimensions of OCD rather than specific subtypes (McKay et al., 2004).

Studies examining the structure of obsessions and compulsions have contributed substantially to the understanding of heterogeneity in OCD (McKay et al., 2004). Ongoing investigation of specific subtypes of OCD is considered important for elucidating etiological processes of the disorder and improving treatment outcomes (Calamari et al., 2004).

2.6 Clinical features of OCD

In addition to the core symptoms of obsessions and compulsions, OCD is characterised by a number of other clinical features including intolerance for uncertainty, an exaggerated sense of responsibility, over-estimation of threat or harm, guilt and perfectionism.

Intolerance for uncertainty is a central feature of OCD (Steketee, Frost, & Cohen, 1998). Individuals with OCD often describe a feeling of uncertainty regarding their own behaviour which manifests itself as repetitive behaviours or actions (Greisberg & McKay, 2003). Repetitive behaviours are typically maintained to reduce discomfort and anxiety but they also satisfy the need for certainty before completing an activity (Steketee et al., 1998).

It has been suggested that the difference between normal intrusive thoughts and clinical obsessions is not related to the content or the frequency of the thoughts but in the way they are interpreted (Salkovskis, 1985, 1989). Normal intrusions become obsessions when they are interpreted as indicating personal responsibility for causing harm. This inflated sense of responsibility is thought to be the cause of various types of obsessional problems and compulsive behaviours (Pleva & Wade, 2002).

OCD is also characterised by an exaggerated estimation of threat or harm (Anholt et al., 2004). As a result of their inflated sense of responsibility, individuals with OCD overestimate the importance of their thoughts and actions, believing that their actions will be responsible for the occurrence of an undesirable outcome (Greisberg & McKay, 2003). Steketee et al. (1998) reported that OCD patients score higher on measures of the estimation of threat as well as measures of responsibility, tolerance of uncertainty, control, beliefs about the consequences of anxiety and the capacity to cope.

OCD is also associated with a need for perfection, a feature of OCD described as early as Janet and Freud's work (Hill, McIntire, & Bacharach, 1997; Coles, Frost, Heimberg, & Rheaume, 2003). Repeating an action multiple times until it feels 'just right' is reported as one of the central features of OCD (Greisberg & McKay, 2003). A number of authors have noted a link between obsessive-compulsive behaviour, perfectionism and the perception of inflated responsibility (Rheaume, Freeston, Dugas, Letarte, & Ladouceur, 1995; Bouchard, Rheaume, & Ladouceur, 1999)

Individuals with OCD also experience a sense of guilt that arises from assigning blame to themselves for experiencing unacceptable obsessive thoughts (Salkovskis, 1985, 1989; Rachman, 1993). Savoie (1996) suggests that guilt may precede and motivate as well as be the consequence of obsessive-compulsive symptoms.

Based on these clinical observations a number of authors have developed comprehensive models to explain the cognitive dysfunction present in OCD.

2.7 Cognitive theories of OCD

Cognitive models of OCD emphasize the role of dysfunctional beliefs and the associated appraisal of threat. The most comprehensive cognitive models of OCD are described by Salkovskis (1985, 1989) and Rachman (1997, 1998).

Salkovskis (1985, 1989) proposed that an important factor in the development of obsessions is the evaluation made by the patient regarding the content or the frequency of the intrusive thought. Individuals vulnerable to developing obsessions believe that they are personally responsible for the possible consequences of the intrusion. This faulty appraisal leads to

depressed mood and increased discomfort. In addition, there is an increase in the accessibility of the intrusive thought into consciousness and an attentional bias towards stimuli that are related to the thought.

As individuals with OCD feel personally responsible for the consequences of the obsessive thought, they usually take action to prevent the event from happening. Typically these actions consist of either neutralising behaviours (compulsive acts) or counterproductive strategies such as thought suppression and avoidance. These actions then lead to maintenance of the faulty beliefs and an increase in the frequency of the intrusive thoughts (Salkovskis, 1985, 1989).

Salkovskis (1985) argues that rather than modifying the intrusive thoughts, therapy should concentrate on the automatic thoughts consequent on the intrusions and the beliefs that give rise to them. The aim of cognitive-behavioural treatment for OCD is to help the patient understand that obsessional thoughts are irrelevant to further action. In addition, it is important to teach patients that intrusive thoughts are partially under their own control and therefore of no special significance (Salkovskis, 1989).

Rachman (1997, 1998) proposes that obsessional problems arise when an individual believes that their intrusive thoughts reveal something meaningful about themselves, that it is a warning sign that a negative event will come true, or that it is an indication that the individual is in danger of losing control. In this model the obsessions will persist as long as the thought is interpreted as being catastrophic, and will only diminish when the misinterpretations are weakened. Once an intrusive thought is interpreted as having personal significance it gives rise to active resistance to the obsession, avoidance and neutralising behaviours. These acts then serve to preserve the catastrophic misinterpretation of the obsession (Rachman, 1998).

A number of factors may cause some individuals to misinterpret the personal significance of particular intrusive thoughts. Firstly, vulnerable individuals may possess pre-existing beliefs about the significance and dangerousness of certain types of thoughts. Secondly, internal and external sources of provocation (stress, bodily sensations, reduction in discomfort) experienced in conjunction with the intrusive thought can enhance the appraisals of significance and even the occurrence of the intrusive thought (Rachman, 1998).

Rachman's theory implies a shift in treatment emphasis to the core catastrophic misinterpretation of personal significance of the obsession. The focus is shifted from the neutralising behaviour to the obsession itself (Rachman, 1997).

Cognitive models such as those proposed by Salkovskis and Rachman have advanced the understanding of OCD and resulted in a shift in treatment from pure exposure to restructuring the problematic responsibility beliefs (Purdon & Clark, 1999).

2.8 Biological theories of OCD

In addition to cognitive dysfunction, there is also emerging evidence that OCD is associated with distinct patterns of brain dysfunction. This observation has led several authors to develop biological models of OCD. The majority of these biological models hypothesise the involvement of the prefrontal cortex, basal ganglia and/or the limbic system in the pathogenesis of OCD (Hoehn-Saric & Greenberg, 1997). Evidence to support these biological models derives from several sources including genetics, neurological examinations, neurosurgery, biochemical studies and brain imaging.

2.8.1 Genetics

Evidence for a possible genetic component in OCD derives mainly from family and twin studies (Aouizerate et al., 2004). There have been several reports of monozygotic twins concordant for obsessive-compulsive symptoms (Woodruff & Pitts, 1964; Marks, Crowe, Drewe, Young, & Dewhurst, 1969; McGuffin & Mawson, 1980; Cryan, Butcher, & Webb, 1992). Twin studies have also suggested that monozygotic twins are more likely to be concordant for OCD than dizygotic twins (Kolada et al., 1994).

Early family studies reported obsessional illness in 0.4–7.5% of parents and siblings of patients with obsessional neurosis (Brown, 1942); (Rosenberg, 1967). Later studies variously reported rates of OCD in first degree relatives of adult patients with OCD of 0%, 2.5%, 3.4%, 5% and 11.7% (Insel, Hoover, & Murphy, 1983; Hoover & Insel, 1984; Rasmussen & Tsuang, 1986; Bellodi, Sciuto, Diaferia, Ronchi, & Smeraldi, 1992; Black, Noyes Jr, Goldstein, & Blum, 1992; Nestadt et al., 2000).

The evidence for a genetic component in OCD is still scarce (Aouizerate et al., 2004). The findings from genetic studies suggest that monozygotic twins may share determinants for OCD, however, it is still to be established whether these determinants are genetic, environmental, or both (Samuels & Nestadt, 1997). Additionally, the results from family studies suggest that overall, less than 10% of relatives suffer from OCD (Kolada et al., 1994). Although a genetic predisposition for OCD may be present in some individuals, it would appear that non-genetic factors are also important (Evans, Lewis, & Iobst, 2004).

2.8.2 Neurology

Several lines of evidence suggest an underlying neurophysiological abnormality in OCD. For example, there are numerous reports of associations between OCD and neurological disorders involving the basal ganglia and/or orbitofrontal cortex (Rapoport & Fiske, 1998). These include OCD following encephalitis lethargica, a disease causing basal ganglia injury, to cases of OCD following other damage to the basal ganglia due to things such as carbon monoxide poisoning, anoxia or infections (Schilder, 1938; Laplane et al., 1989; Cheyette & Cummings, 1995).

Symptoms of OCD have also been reported in movement disorders such as Huntington's disease (Cummings & Cunningham, 1992), Sydenham's chorea (Swedo et al., 1989) and Tourette's syndrome (Shapiro & Shapiro, 1992). These observations provide further evidence that the basal ganglia plays a role in the mediation of OCD as movement disorders are typically associated with basal ganglia pathology (Rapoport & Fiske. 1998).

2.8.3 Neurosurgery

Further evidence to support an underlying neurophysiological abnormality in OCD derives from the neurosurgery literature. Neurosurgical treatments are sometimes considered for the management of chronic and disabling forms of OCD that have proven to be resistant to other forms of treatment (Aouizerate et al., 2004). Stereotactic neurosurgical procedures such as cingulotomy, capsulotomy, limbic leucotomy, and subcaudate tractotomy are often effective in reducing symptoms in patients with intractable OCD (Jenike et al., 1991; Baer et al., 1995; Sachdev et al., 2001; Dougherty et al., 2002; Kim et al., 2003). As these neurosurgical procedures involve lesions of the pathways between the basal ganglia, the limbic system and the frontal lobes, the efficacy of these operations in reducing OCD symptoms suggests some involvement of these overlapping brain areas in the production of OCD symptoms (Aouizerate et al., 2004).

2.8.4 Biochemistry

Biochemical theories of OCD have developed as a result of observations of apparent abnormalities in serotonin function in patients with OCD (Barr, Goodman, Price, McDougle, & Charney, 1992). Additionally, selective serotonin reuptake inhibitors (SSRIs) and the serotonergic tricyclic antidepressant clomipramine have been shown to have antiobsessional effects (Insel, 1990a, 1990b; Winslow & Insel, 1990).

A number of investigations have demonstrated that serotonergic agents such as clomipramine, fluoxetine and fluvoxamine are often effective in treating OCD symptoms (Thoren, Asberg, Cronholm, Jornestedt, & Traskman, 1980; Goodman, Price, & Charney, 1989a; Goodman & McDougle, 1990; Jenike, 1990; Jenike, Baer, & Greist, 1990; Barr et al., 1992; Goodman, McDougle, & Price, 1992a; Stein, Hollander, Mullen, DeCaria, & Liebowitz, 1992).

In addition, there is evidence that dopaminergic systems may also be involved in OCD (Hale, 1996). Dopaminergic systems have been implicated in Tourette's syndrome, a disorder which has an increased incidence of OCD among its sufferers (Goodman et al., 1990; Goodman, McDougle, & Price, 1992b). Augmenting SSRI treatment with a dopamine agonist has also been shown to be effective in selected OCD patients (Goodman, McDougle, Barr, Aronson, & Price, 1993; McDougle, Goodman, Leckman, & Price, 1993; McDougle, Goodman, & Price, 1993).

2.8.5 Brain imaging

The development of biological theories of OCD has been advanced by neuroimaging studies that describe structural and functional abnormalities in the brains of individuals with OCD.

Early studies focused on investigating structural abnormalities that may differentiate OCD from control subjects using magnetic resonance imaging and computed tomography procedures (Wilson, 1998). The results of structural imaging studies have been inconsistent with some - but not all - scans showing abnormalities in the structures that have been implicated in biological theories of OCD (Hoehn-Saric & Greenberg, 1997). When compared to controls, OCD patients have exhibited decreased caudate nucleus volumes (Luxenberg et al., 1988; Robinson et al., 1995), significantly less retrocallosal white matter (Jenike et al., 1996), reduced orbitofrontal and amygdala volumes (Szeszko et al., 1999), smaller left orbitofrontal volumes (Kang et al., 2004), reduced gray matter volumes in the medial frontal gyrus, medial orbitofrontal cortex and left insuloopercular region (Pujol et al., 2004) and increased gray matter volume bilaterally in the ventral part of the putamen and the anterior cerebellum (Pujol et al., 2004). However, other studies have failed to find any structural abnormalities in OCD patients (Aylward et al., 1996).

To investigate the functional activity of brain structures in individuals with OCD, functional imaging studies have been undertaken using single photon emission computerised tomography (SPECT), positron emission tomography (PET) and functional magnetic resonance imaging (fMRI). Functional imaging studies have typically investigated differences in regional brain activity between OCD and control subjects using three different paradigms: resting state, symptom provocation, or in conjunction with certain treatments (Wilson, 1998).

Resting scans utilising functional imaging techniques have typically found increased prefrontal activity although there has been some variation in the precise location and laterality of differences. For example, studies have reported increased activity in the orbital gyri and caudate nucleus (Baxter et al., 1987), increased activity in the medial-frontal cortex (Machlin et al., 1991), increased activity in the parietal and frontal cortex and decreased activity in the caudate nucleus (Rubin, Villanueva-Meyer, Ananth, Trajmar, & Mena, 1992), and increased activity in the orbitofrontal, premotor and mid-frontal cortex (Sawle, Hymas, Lees, & Frackowiak, 1991). A more recent study compared nine drug-free OCD patients without depression to six control subjects using TC-99m HMPAO brain perfusion SPECT imaging. Quantitative regional analysis revealed that the OCD patients had significantly increased regional brain perfusion in the right thalamus, left frontotemporal cortex and bilateral orbitofrontal cortex in comparison with controls (Alptekin et al., 2001).

As obsessive-compulsive symptoms are not present continuously, provocation studies were designed to detect changes in brain function during times when symptoms actually occur

(Hoehn-Saric & Greenberg, 1997). Zohar et al. (1989) scanned OCD patients with contamination obsessions under three conditions: relaxation, imaginal flooding, and during a provocation stimulus. Compared to the relaxation state, imaginal flooding slightly increased regional cerebral blood flow (rCBF) in temporal and left regions while provocation lowered rCBF in several cortical regions. However, given the limitations of the imaging technique the changes observed may have represented changes in anxiety rather than changes specific to OCD (Hoehn-Saric & Greenberg, 1997).

Rauch et al. (1994) used a more sophisticated scanning method (PET) to measure changes in brain function in OCD patients under various conditions: rest, exposure to a control stimulus and exposure to a provocative stimulus. When compared to resting conditions, the provocation stimulus induced increased rCBF bilaterally in the orbitofrontal cortex, in the right caudate nucleus and the left anterior cingulate, with a trend toward an increase in the left thalamus. Using a similar provocation stimulus, Breiter and Rauch (1996) used fMRI to investigate brain changes in OCD patients. This study found changes consistent with the PET study except that paralimbic (medial orbital gyrus, anterior cingulate, temporal cortex and insular cortex) and limbic (amygdala) activation were more prominent.

Using a similar technique to Breiter and Rauch (1996), Adler et al. (2000) examined symptom provocation in non-medicated OCD patients. The results were consistent with previous studies using medicated patients and suggested that the symptoms of OCD are mediated by a number of brain regions including the anterior cingulate as well as frontal and temporal regions.

Neuroimaging studies of OCD have also been undertaken in conjunction with certain treatment interventions. For example, Hansen, Hasselbalch, Law, and Bolwig (2002) studied patients before and after SSRI treatment. Regional cerebral glucose metabolic rates (rCMRglc) were measured using 18-fluoro-deoxyglucose PET scanning. The authors found that after the treatment there was a significant decrease in rCMRglc in the right caudate nucleus which also had a significant positive correlation with symptom severity. Perani et al. (1995) also found that, after treatment, improvement in obsessive-compulsive symptoms was associated with a decrease in rCMRglc in the cingulate cortex.

The results from neuroimaging studies provide further evidence that the pathophysiology of OCD involves abnormal functioning along specific frontal sub-cortical brain circuits. Specifically, the evidence points to increased activity in the orbitofrontal cortex, caudate nucleus, thalamus and anterior cingulate gyrus (Saxena et al., 1998). However, there are limitations associated with imaging studies. For example, unlike neuropsychological and lesion techniques, neuroimaging can make associations between brain regions and cognitive processes, but cannot demonstrate the necessity of a brain region for a specific cognitive process (D'Esposito, Postle, & Rypma, 2000).

2.8.6 Biological models of Obsessive-compulsive disorder

By integrating observations from genetic, neurological, neurosurgical and neuroimaging studies of patients with OCD, several authors have formulated comprehensive neuroanatomical models of OCD (Modell, Mountz, Curtis, & Greden, 1989; Insel & Winslow, 1992; Insel, 1992; Saxena et al., 1998; Aouizerate et al., 2004). These models have generally implicated dysfunction in the circuits connecting the limbic areas of the prefrontal cortex and the basal ganglia through the thalamus (Aouizerate et al., 2004).

Modell et al. (1989) provided an early model of OCD based on results from neurochemical, neuroimaging, pharmacological treatment studies and neurosurgery studies. This model proposed that OCD symptoms arise due to dysfunction in the connections linking the orbitofrontal cortex, the striatum and the thalamus. In normal individuals, the activity of the connections is controlled by inhibitory dopaminergic and serotonergic inputs to the striatum. In OCD these connections are inadequately modulated which results in a runaway positive feedback loop.

A more recent model by Saxena et al. (1998) proposed that the symptoms of OCD are mediated by hyperactivity in the circuits connecting the orbitofrontal cortex and the basal ganglia. The authors suggest an imbalance in the 'tone' of the direct and indirect orbitofrontal-subcortical pathways produces a hyperactive circuit that mediates the repetitive, fixed behaviours observed in OCD. Aouizerate et al. (2004) also suggests that the symptoms of OCD result from a disruption in information processing within the circuits connecting the prefrontal cortex to the basal ganglia.

2.9 Summary

The common conclusion of biological theories of OCD is that the disorder is characterised by increased rates of metabolism in the frontal lobe and the basal ganglia (Aouizerate et al., 2004). The strongest evidence of a biological substrate in OCD derives from the neuroimaging data. However, given the limitations associated with neuroimaging techniques, an important aspect of the ongoing investigations regarding the biological basis of OCD is to better understand the neuropsychological correlates and the personality traits associated with the disorder. The next two chapters will discuss the specificity of the neuropsychological deficits observed in OCD and the personality traits associated with the disorder.

CHAPTER 3: OBSESSIVE-COMPULSIVE DISORDER AND NEUROPSYCHOLOGY

3.1 Introduction

Increasing interest in the biological substrates of OCD has been complemented in recent years by the publication of several studies assessing the neuropsychological correlates of the disorder (Tallis, 1995). Neuropsychology is considered a useful tool for assessing the potential role of different brain regions in the genesis of OCD processes (Aouizerate et al., 2004). This chapter examines the results from neuropsychological studies that have examined the performance of OCD patients on tasks assessing the cognitive functions of attention, executive function, visuospatial function, nonverbal memory and verbal memory.

3.2 Attention

Attention refers to the cognitive process of orienting to and perceiving stimuli (Lezak, 1995). The over-focused attention of OCD patients concerning their symptoms have led researchers to experimentally investigate the attentional mechanisms involved in OCD (Towey et al., 1990). Studies assessing attention in OCD have generally employed tasks to assess attention span, speed of information processing, selective attention and sustained attention (Kuelz, Hohagen, & Voderholzer, 2004).

3.2.1 Attention span

Attention span is a measure of the capacity of a persons' attentional system (Lezak, 1995). The Digit Span test (Wechsler, 1981) is commonly used to assess attention span in OCD research and consists of two parts. In Digit Span forwards, the subject is required to repeat sequences of three to nine digits. In Digit Span backwards, the sequences are two to eight numbers long and the subject must say them in reverse order (Spreen & Strauss, 1998). A number of studies have found that OCD patients perform as well as control subjects on the Digit Span test (Hollander et al., 1993; Cohen et al., 1996; Tallis, Pratt, & Jamani, 1999; Deckersbach, Otto, Savage, Baer, & Jenike, 2000; Okasha et al., 2000; Jurado et al., 2001; Singh, Mukundan, & Khanna, 2003; Boldrini et al., 2004). While Flor-Henry, Yeudall, Koles, and Howarth (1979) reported poorer performance by OCD patients on the Digit Span test, their study included OCD patients with significantly lower IQs than the control subjects, which may have influenced the result.

3.2.2 Speed of information processing

Studies investigating speed of information processing in OCD have yielded inconsistent results. A common task employed to assess information processing speed in OCD is the Trail Making Test (TMT; Reitan, 1958). The TMT consists of two parts. Part A involves connecting consecutively numbered circles with a continuous line, while part B involves alternately connecting digits and letters (Lezak, 1995). The TMT tests for speed of attention, sequencing, mental flexibility and visual search and motor function (Spreen & Strauss, 1998). A number of

studies have reported that OCD patients perform as well as controls on this test (Berthier, Kulisevsky, Gironell, & Heras, 1996; Cohen et al., 1996; Jurado et al., 2001; Kivircik, Yener, Alptekin, & Aydin, 2003; Roth, Baribeau, Milovan, & O'Connor, 2004). However, other authors have reported slower performance by OCD patients (Martinot et al., 1990; Schmidtke, Schorb, Winkelmann, & Hohagen, 1998; Moritz et al., 2001a, 2002; Borkowska, Pilaczynska, & Rybakowski, 2003; Kwon et al., 2003). Choi et al. (2004) also found that OCD patients performed more poorly than controls on Trails B, although the OCD patients in their study had significantly lower IQs than the control subjects. Kuelz et al. (2004) have suggested that inconsistencies in these results may be due to the inclusion of medicated subjects in some studies. However, in the study by Kwon et al. (2003) participants were medication free in the four weeks prior to testing. Kim, Park, Shin, and Kwon (2002) also found that OCD patients performed more poorly on Trails A at initial testing but not at four-month follow-up after pharmacological treatment.

3.2.3 Selective attention

There is also mixed evidence in the OCD literature for impairment on tests of selective attention. The Stroop task (Stroop, 1935) is frequently used as a measure of selective attention in OCD research. In the traditional Stroop colour-naming task, the subject is required to name the ink colour in which the stimulus words are written and ignore the word content. It takes longer for the subject to name the ink colour in cases where the ink colour and word colour are incongruent than in the control condition in which they are consistent. The Stroop task measures the ability of a subject to shift perceptual set in order to conform to changing demands and to suppress a habitual response in favour of an unusual one (Spreen & Strauss, 1998). The results from studies examining Stroop performance in OCD have yielded mixed results. Hartston and Swerdlow (1999) reported that OCD patients performed as well as control subjects on the word and colour conditions of the Stroop but performed more poorly on the interference condition (colour ink mismatched to word). Harris and Dinn (2003) found that compared to controls, OCD patients were impaired on the congruent and incongruent colour-naming trials but not the word-naming trials. Martinot et al. (1990) also reported poorer performance by OCD patients on the Stroop task, however, there have been many studies that find no difference between OCD patients and controls (Boone, Ananth, Philpott, & Kaur, 1991; Hollander et al., 1993; Schmidtke et al., 1998; Gehring, Himle, & Nisenson, 2000; Moritz et al., 2002; Borkowska et al., 2003; Kivircik et al., 2003; Nielen & Den Boer, 2003). Cohen, Rasic Lachenmeyer and Springer (2003) have suggested that deficits in selective attention may be the consequence of situational anxiety rather than being specifically related to the symptomatology of OCD.

Some studies have suggested that there is an attentional bias for threat-related stimuli in OCD (Foa, Ilai, McCarthy, Shoyer, & Murdock, 1993; Unoki, Kasuga, Matsushima, & Ohta, 1999). For example, Foa et al. (1993) examined the performance of OCD washers and non-washers to

normal controls on a modified Stroop task using contamination, general threat, neutral and non-words. OCD washers showed longer response latencies to contamination words than to neutral words, and their latencies to contamination words were longer than the latencies of OCD non-washers and of normal controls. OCD non-washers showed longer latencies to general threat words than to non-words. Normal controls were slower in colour-naming neutral words than either contamination or general threat words. However, an attentional bias for threat-related stimuli has also been observed in other anxiety disorders (Williams, Mathews, & MacLeod, 1996).

3.2.4 The Test of Everyday Attention

One study that did demonstrate attentional deficits in OCD was conducted by Clayton, Richards, & Edwards (1999). In this study, OCD patients were compared to clinical (panic disorder) and healthy control subjects on a battery of psychometric attention tasks know as the Test of Everyday Attention (TEA; Robertson, Ward, Ridgeway, & Nimmo-Simth, 1994). The TEA is comprised of eight subtests which load on four attention factors (selective attention, attentional switching, sustained attention and auditory-verbal working memory). In this study, OCD patients performed more poorly than the clinical and healthy controls on measures of selective attention, auditory-verbal working memory and attentional switching. These measures assessed the ability to pick out targets in complex visual arrays, manipulate information in auditory-verbal memory and the ability to shift train of thought (cognitive flexibility). The OCD patients performed as well as the control subjects on the factor of sustained attention which measures the ability to maintain attention on a relatively unchanging task (Clayton et al., 1999).

3.2.5 Sustained attention

Zielinski, Taylor and Juzwin (1991) also found that OCD patients were not impaired on a test of sustained attention. Twenty-one OCD patients were compared to 21 matched controls on a version of the Continuous Performance Task (CPT; Cornblatt & Erlenmeyer-Kimling, 1985). The CPT is used to assess lapses in attention or vigilance, and impulsivity (Spreen & Strauss, 1998). The results showed no significant differences between the OCD patients and the controls on any of the CPT subscales. No differences between OCD and controls on other versions of the CPT have also been reported by Milliery, Bouvard, Aupetit and Cottraux (2000) and Ursa, Stenger, Shear, Jones and Carter (2003).

3.2.6 Summary

Overall, the evidence for a deficit in attention in OCD is weak. There is little evidence of a deficit in attention span or sustained attention, and mixed evidence for a deficit in selective attention and speed of information processing.

3.3 Executive function

Given the association between OCD and a proposed frontal-striatal dysfunction, executive functions have received a great deal of attention in research on OCD. Executive functions typically refer to higher-order cognitive functions which depend on frontal cortex integrity (Lezak, 1995). Different methods of assessing executive functions include set-shifting, alternation learning, verbal fluency, decision-making, planning and problem solving.

3.3.1 Set-shifting

A number of studies have used the Wisconsin Card Sorting Task (WCST; Berg, 1948) to assess set-shifting ability in OCD. In the WCST the subject must determine the criterion for sorting stimulus cards into four piles. After each sort, the subject is given feedback about whether the pile was correct or not. Once the subject has successfully sorted a number of cards (typically six to ten), the sorting criterion is changed. The purpose of the WCST is to assess the ability to form abstract concepts, to shift and maintain set and to utilise feedback (Spreen & Strauss, 1998). Some studies have found impaired performance by OCD patients on the WCST (Head, Bolton, & Hymas, 1989; Boone et al., 1991; Hymas, Lees, Bolton, Epps, & Head, 1991; Okasha et al., 2000), however, the majority of studies have reported no difference in the performance of OCD patients compared to controls (Zielinski et al., 1991; Abbruzzese, Ferri, & Scarone, 1995b; Abbruzzese, Bellodi, Ferri, & Scarone, 1995a; Gross-Isseroff et al., 1996; Abbruzzese, Ferri, & Scarone, 1997; Cavedini, Ferri, Scarone, & Bellodi, 1998; Deckersbach et al., 2000; Moritz et al., 2001a; Sanz, Molina, Calcedo, Martin-Loeches, & Rubia, 2001; Kim et al., 2002; Moritz et al., 2002; Cavallaro et al., 2003; Kwon et al., 2003; Boldrini et al., 2004; Roth et al., 2004). Lucey et al. (1997) and Choi et al. (2004) also reported poorer performance by OCD patients on the WCST but, in both studies, the OCD patients had significantly lower IQs than the control subjects.

Veale, Sahakian, Owen and Marks (1996) observed a set-shifting deficit in OCD in comparison to control subjects on a set-shifting task from the Cambridge Neuropsychological Test Automated Battery (CANTAB). In this task, subjects were required to learn a series of visual discriminations based on feedback provided after each trial. The subjects were required to maintain attention on the reinforced stimulus but are required to shift attention to a previously irrelevant stimulus in the latter stages of the task. Veale et al. (1996) reported a cumulative increase in the number of OCD patients who failed at each stage of the task. The impaired performance of the OCD patients on the set-shifting task suggested that they had difficulty in selectively attending to relevant stimuli when competing stimuli was introduced. However, this result was not replicated by Purcell et al. (1998a, 1998b) or Nielen and Den Boer (2003) using the same battery of tasks.

The ability to initiate and shift mental set and the ability to maintain mental set in OCD was also investigated by Savage et al. (1999). Twenty OCD patients were compared to 20 matched

controls on the visual-verbal test (VVT) and the odd-man-out test (OMO). The VVT assesses the ability to initiate and shift mental set while the OMO test assesses the ability to maintain mental set. The OCD patients did not differ from controls on either of these tests. Schmidtke et al. (1998) also failed to find evidence of a set-shifting deficit in OCD on a choice reaction time task with set-shifting to an internal cue.

3.3.2 Alternation learning

In contrast to the negative findings associated with OCD and set-shifting tasks, a number of studies have found impaired performance by OCD patients on tasks that assess alternation learning. In alternation learning tasks, subjects are required to select one of two objects or locations on each trial with the correct response corresponding to the object or location that the subject did not choose on the previous trial. These tasks require subjects to hold information 'on line' and to update information on a trial-by-trial basis (Zald, Curtis, Folley, & Pardo, 2002). Tasks used to assess alternation learning in OCD include the Object Alternation Task (OAT) and the Delayed Alternation Task (DAT). A number of studies have reported impaired performance by OCD patients on the OAT and the DAT (Abbruzzese et al., 1995a; Gross-Isseroff et al., 1996; Abbruzzese et al., 1997; Cavedini et al., 1998; Moritz, Fricke, Wagner, & Hand, 2001b; Harris & Dinn, 2003). Given the evidence that the OAT and DAT are sensitive to orbitofrontal cortex (OFC) impairment, the results from these studies support theories of impaired OFC functioning in OCD (Zald et al., 2002).

3.3.3 Verbal fluency

In OCD research the assessment of verbal fluency has mostly utilised tests of letter or category fluency. In these tests, subjects are required to produce as many words as possible starting with a specified letter or belonging to a specified category in a given period of time (Spreen & Strauss, 1998). Studies investigating verbal fluency performance in OCD have yielded conflicting results. A number of studies have reported that OCD patients perform more poorly on tests of verbal fluency when compared to healthy controls (Head et al., 1989; Hymas et al., 1991; Christensen, Kim, Dysken, & Hoover, 1992; Thienemann & Koran, 1995; Berthier et al., 1996; Schmidtke et al., 1998; Deckersbach et al., 2000; Moritz et al., 2001a; Kim et al., 2002; Moritz et al., 2002; Borkowska et al., 2003; Harris & Dinn, 2003; Kwon et al., 2003; Choi et al., 2004). However, there are also a number of studies that have reported unimpaired performance in OCD patients (Martinot et al., 1990; Zielinski et al., 1991; Boone et al., 1991; Abbruzzese et al., 1995a; Cavedini et al., 1998; Pujol et al., 1999; Deckersbach et al., 2000; Basso, Bornstein, Carona, & Morton, 2001; Jurado et al., 2001; Kivircik et al., 2003; Boldrini et al., 2004). Interpretation of these results is difficult given that the methodology varied between each study. For example, the time spans assigned for the word production varied substantially between studies (Kuelz et al., 2004).

3.3.4 Planning and problem-solving

In assessing planning and problem-solving ability the tasks most commonly used in OCD research are the Tower of Hanoi (TOH; Simon, 1975) and the Tower of London (TOL; Shallice, 1982) tasks. The TOH is a test of higher-order executive function (Spreen & Strauss, 1998). In this task the subject is required to figure out a sequence of spatially controlled moves so that the stimulus rings end up in a particular goal configuration (Kuelz et al., 2004). The number of trials, number of rings, destination, break between trials, maximum moves and feedback on success can all be manipulated by the examiner (Spreen & Strauss, 1998). The TOL is a simpler version of the TOH. In this test the subject is required to move coloured beads from their initial position on upright sticks to achieve a new predetermined arrangement in as few moves as possible (Spreen & Strauss, 1998).

Results from studies using the computerised CANTAB version of the TOL have yielded conflicting results. Some studies have reported that OCD patients demonstrate no differences compared with control subjects in terms of their accuracy on this task (Veale et al., 1996; Purcell et al., 1998a, 1998b). However, Purcell et al. (1998a, 1998b) did report deficits related to motor speed in their comparison of OCD and healthy control subjects. Veale et al. (1996) also reported that when OCD patients made an error they took longer to devise an alternative solution. In contrast, Nielen and Den Boer (2003) found that OCD patients were less accurate on the CANTAB version of the TOL compared to healthy controls. In this study, the OCD patients needed more moves, and more time, to solve the problems.

Results from studies using the TOH task have also produced conflicting results. For example, Schmidtke et al. (1998) used a five-disk version of the TOH to compare problem-solving ability between OCD patients and healthy controls. There were no differences between the groups on the number of moves required to complete the task. Cavedini, Cisima, Riboldi, D'Annucci and Bellodi (2001) used a difficult four-ring version of the TOH, demonstrated to be sensitive to striatal dysfunction (Cavedini et al., 2001). Sixty-four OCD patients were compared to 58 control subjects on three different trials of the TOH task. The trials assessed rule recognition, procedural learning and declarative learning. In this study, the OCD patients performed significantly worse than the control subjects on all three trials. The authors suggested that the results point to the involvement of the basal ganglia in the pathophysiology of OCD. Impairment on the four-ring version of the TOH has also been reported by Cavallaro et al. (2003). OCD patients were compared to schizophrenia and healthy control subjects on the four-disk version of the TOH as well as the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994) and the WCST. The OCD patients performed as well as the controls on the WCST but were worse on the TOH and the IGT.

3.3.5 Decision-making

Cavedini et al. (2002) also investigated executive impairment in OCD using the IGT. This task measures decision-making impairment and was originally designed to study patients with damage to the ventromedial section of the prefrontal cortex (Bechara et al., 1994). The IGT assesses a subject's capacity to acquire a preference through reward and punishment as represented by gains and losses of play money. Cavedini et al. (2002) compared OCD, panic disorder and healthy control subjects on the IGT. The OCD patients performed more poorly than healthy controls and panic disorder patients by preferring the 'disadvantageous' deck. In contrast, the healthy controls and panic disorder patients made significantly more selections from the 'advantageous' decks. The authors suggest that the OCD patients preferred the 'disadvantageous' decks because they were encouraged by the prospect of immediate reward, and insensitive to the future consequences. This study also found that poor neuropsychological task performance predicted poor outcome of pharmacological treatment. A study by Nielen, Veltman, de jong, Mulder and den Boer (2002) also examined performance on the IGT in OCD patients and healthy controls. In this study there was no difference in performance between the OCD and control subjects. However, the authors did report that performance on the IGT decreased as a function of symptom severity in the OCD patients. The results suggest that the role of decision-making in OCD may be more complex than previously thought (Nielen et al., 2002)

3.3.6 Summary

The evidence for an executive dysfunction in OCD is mixed. Some functions within this cognitive domain appear to be compromised (alternation learning, decision-making) while others appear to be intact (set-shifting). The results for other functions are contradictory (planning and verbal fluency).

3.4 Visuospatial function

Visuospatial ability refers to the capacity to perceive and manipulate objects in space (Kuelz et al., 2004). OCD patients have demonstrated impairment on some tasks that assess visuospatial ability including the Hooper's Visual Organisation Test (HVOT; Hooper, 1958) and the Block Design test (Wechsler, 1981). They show intact performance on other tasks such as the copy trials of the Rey Complex Figure Test (RCFT; Osterrieth, 1944).

The HVOT assesses the ability to conceptually rearrange pictures that have been disarranged (Spreen & Strauss, 1998). Boone et al. (1991) found that a sample of non-depressed OCD patients performed more poorly on HVOT in comparison to matched healthy control subjects.

Hollander et al. (1993) also reported deficits in visuospatial function in OCD patients. Compared to healthy control subjects, OCD patients performed more poorly on the Block Design test. The Block Design test involves using red and white blocks to construct replicas of

constructions made by an examiner of designs printed in smaller scale (Spreen & Strauss, 1998). A number of other studies have also reported poorer performance by OCD patients on the Block Design test compared to controls (Head et al., 1989; Hymas et al., 1991; Christensen et al., 1992; Moritz, Kloss, Jahn, Schick, & Hand, 2003).

Other evidence for visuospatial impairment in OCD was reported by Moritz et al. (2003) and Savage et al. (1999). Moritz et al. (2003) compared OCD patients on a measure of visuospatial transformation. In this task, subjects are required to match the sides and edges of a ground-plan to points of a completed body. Subjects have four minutes to complete as many as possible. Moritz et al. (2003) found that OCD patients performed significantly worse than control subjects on this task. Savage et al. (1999) compared OCD patients to healthy controls on a mental rotations task (MRT). The MRT measures spatial skill and the ability to perform spatial rotations. Savage et al. (1999) found that OCD patients recorded significantly lower scores on the MRT compared to healthy control subjects.

As with other cognitive domains, OCD patients do not perform poorly on all measure of visuospatial functioning. For example, Head et al. (1989) found that OCD patients were not impaired on the Line Orientation Test (LOT; Benton, Varney, & Hamsher, 1978). The LOT involves making spatial judgements about the orientation of stimulus lines. Hymas et al. (1991) also found that OCD patients were not impaired on this test.

OCD patients also tend to perform as well as control subjects on the copy trials of the RCFT. The RCFT copy trial involves copying a complex geometric figure and assesses visuospatial constructional ability (Spreen & Strauss, 1998). The majority of studies have found that OCD patients perform as well as controls on the copy trial of the RCFT and other figure recall tests (Martinot et al., 1990; Savage et al., 1999; Tallis et al., 1999; Savage et al., 2000; Kim et al., 2002; Moritz et al., 2003). While Choi et al. (2004) found poorer performance by OCD patients on RCFT copy trials, this study included control subjects with significantly higher IQs than the OCD patients.

While OCD patients tend to perform as accurately as control subjects on the copy trial of the RCFT, a number of studies have reported that OCD patients generally score poorly on a measure of organisational copy strategy (Savage et al., 1999; Savage et al., 2000; Mataix-Cols et al., 2003; Boldrini et al., 2004). Behar et al. (1984) also reported that OCD patients were as accurate as controls on the copy trial of the RCFT but that the OCD patients adopted an 'immature' approach to copying the task. Deckersbach et al. (2000) reported that OCD patients showed adequate copy accuracy in comparison to normative group performance but adopted a fragmented approach to drawing the geometric figure. Roth et al. (2004) also found that OCD patients performed as well as controls on the copy version of the RCFT but they took longer to complete it.

3.4.1 Summary

Overall, the evidence for a visuospatial deficit in OCD is mixed. While subjects perform more poorly than control subjects on some tasks within this domain (i.e. block design, MRT, HVOT) they show intact performance on others (i.e. RCFT, LOT).

3.5 Nonverbal memory

A number of different tasks have been used to assess nonverbal memory in OCD. These include the Benton Visual Retention Task (BVRT; Benton, 1974), the Recurring Figures Test (RFT; Kimura, 1963), the Corsi Block-tapping Test (Milner, 1971) and the immediate and delayed recall trials of the RCFT.

Cohen et al. (1996) compared OCD patients to normal controls and subjects with social phobia on the BVRT. The BVRT measures visual memory and visuocontructional ability and involves reproducing increasingly complex designs after a 10-second exposure (Lezak, 1995). Compared to controls, OCD patients showed poorer performance on the BVRT. Deficiencies in nonverbal memory were also reported by Zielinski et al. (1991) and Tallis et al. (1999) who found that, compared to controls, OCD patients were impaired on the RFT. The RFT involves viewing 20 stimulus cards containing drawings of geometric or irregular nonsense figures. The subject is then shown 140 cards and must indicate which of the cards was seen previously (Lezak, 1995). Zielinski et al. (1991) also found that the OCD patients made more errors on the nonsense figures than on the geometric designs on both the immediate and delayed recognition trials of the RFT.

Zielinski et al. (1991), Boldrini et al. (2004) and Moritz et al. (2003) all reported impaired performance by OCD patients on the Corsi Block-tapping Test when compared to controls. In the Corsi Block-tapping Test, an examiner taps stimulus blocks in a prearranged sequence and the subject attempts to copy the tapping pattern (Lezak, 1995). However, other authors have noted no deficits in OCD patients on tasks of block tapping (Purcell et al., 1998a, 1998b) or spatial span (Tallis et al., 1999).

Other evidence for a nonverbal memory deficit in OCD derive from studies reporting impairment on immediate recall of a visual set, delayed recall of a visual set and visual delayed recognition (Dirson, Bouvard, Cottraux, & Martin, 1995), and impairment on the visual reproduction subtest of the Wechsler Memory Scale (WMS; Wechsler, 1997) (Christensen et al., 1992). Singh et al. (2003) also found that OCD patients were impaired on a cube test requiring the sequential organisation of spatial stimuli.

A consistent finding in the assessment of neuropsychological deficits in OCD is impairment on the recall trials of the RCFT and similar figure recall tests. The recall trials of the RCFT and

other figure recall tests assess nonverbal memory and consist of an immediate recall trial (usually three minutes later) and a delayed recall trial (usually 15 to 60 minutes later) of a previously presented complex geometric figure (Spreen & Strauss, 1998). While Moritz et al. (2003) found that OCD patients were not impaired on this test, numerous other authors have reported this deficit (Martinot et al., 1990; Savage et al., 1999; Tallis et al., 1999; Deckersbach et al., 2000; Savage et al., 2000; Kim et al., 2002; Kwon et al., 2003; Mataix-Cols et al., 2003; Boldrini et al., 2004; Choi et al., 2004).

While there have been a number of studies that report nonverbal memory deficits in OCD there are reports that demonstrate that OCD patients perform as well as controls on some measures of nonverbal memory. For example, Boldrini et al. (2004) found that OCD patients performed as well as controls on the Benton Facial Recognition task (Benton, 1983). Martin, Wiggs, Altemus, Rubenstein and Murphy (1995) found that OCD patients performed as well as control subjects on a task that tested working memory for line drawings of animals and nonsense objects. Singh et al. (2003) compared OCD and healthy controls on a Card Position test. The Card Position test is based on the principle of memory for position and processing. Five cards with figures of sequentially varying spatial positions are presented in an array. Subjects are shown only the first and last card for 10 seconds. A series of cards are then presented randomly to the subject and they are required to pick three of these cards which display the in-between positions to complete the series. Singh et al. (2003) found that OCD patients were not impaired on this task compared to controls. The authors proposed that performance on the Card Position test was facilitated by clues - in the form of choice cards - which made manipulation of the task stimuli simpler.

In an attempt to clarify the nature and specificity of the cognitive deficits present in OCD, Purcell et al. (1998b) compared patients with OCD to healthy controls and patients with unipolar depression and panic disorder. All participants - matched for age, gender and pre-morbid IQ - completed seven subtests from the CANTAB. The subtests assessed the cognitive functions of planning, delayed matching-to-sample (DMS), spatial working memory, spatial recognition, pattern recognition, spatial span and attentional set-shifting. Measures of cognitive and motor speed were also recorded.

Purcell et al. (1998b) found that patients with OCD were impaired on measures of spatial working memory, spatial recognition and speed of motor initiation and execution. Patients with panic disorder and depression did not differ from normal controls on these tasks (Purcell et al., 1998b). Thus, while selective deficits in some executive and visual memory processes were observed, other functions within each of these cognitive domains were preserved. The results suggested that the OCD patients did not exhibit generalised cognitive dysfunction (Purcell et al., 1998b).

For example, Purcell et al. (1998b) observed that OCD patients were able to organise and execute a series of goal-directed moves on the Tower of London planning task but were significantly impaired in the organisation and execution of a series of selections on the spatial working memory task. The authors suggested that executive processes related to the organising of response sequences and the monitoring of their execution were facilitated by the presence of external cues and that these executive processes were compromised when the OCD patients had to rely on internal visual representations to guide their selections (Purcell et al., 1998b). Savage et al. (2000) has also suggested that external organisation benefits performance in OCD.

Purcell et al. (1998b) also suggested that there was a distinction in visual memory processing in OCD. OCD patients showed intact recognition and recall of pattern material but impaired recognition of spatial locations. Purcell et al. (1998b) suggested that the differences may have been a reflection of the effect of verbal mediation. For the pattern recognition and DMS tasks, subjects were able to easily apply verbal labels to the stimuli according to their shape and colour. However, on the spatial memory tasks, verbal labels were less easy to apply. On the spatial memory tasks, more reliance was placed on generating visual representations of the stimulus location suggesting that verbal representations may facilitate memory processes in OCD while the use of visual representations presents more of a problem (Purcell et al., 1998b). A study by Nielen and Den Boer (2003) supports this finding. In this study, OCD patients were impaired on the CANTAB measure of spatial recognition but not pattern recognition when compared to control subjects. The notion that OCD patients are impaired on tasks which do not permit verbal mediation has also been proposed by Zielinski et al. (1991).

An earlier study by Purcell and colleagues also suggested a dissociation between memory for spatial and pattern information (Purcell et al., 1998a). This study found significant differences between 23 OCD patients and matched control subjects on the CANTAB measures of spatial working memory and spatial recognition, but not on the DMS or pattern recognition tasks (Purcell et al., 1998a). Purcell et al. (1998a) also compared the results from their study with other studies that had used the CANTAB with different patient groups. Compared to the results of studies using frontal lobe patients, patients with Parkinson's disease, temporal lobe patients and individuals with progressive supranuclear palsy, the results suggested a syndrome of frontal-subcortical dysfunction in OCD in which executive function impairments are prominent (Purcell et al., 1998a). Purcell et al. (1998a) also examined working memory in OCD as a function of task difficulty and established that deficits only emerged as task demand increased.

To further investigate the idea that OCD is associated with a spatial working memory deficit, particularly when task difficulty is high, van der Wee et al. (2003) conducted a functional magnetic resonance imaging (fMRI) study comparing 11 OCD patients to matched controls on a parametric spatial n-back task. The spatial n-back task involves comparing the spatial location

of letters presented 0, 1, 2 and 3 trials previously. The behavioural results indicated that the OCD patients performed more poorly than controls at the highest level of task difficulty (spatial 3-back). Analysis of the fMRI data showed that patients engaged the same set of brain regions during the working memory task as the control subjects. There was, however, elevated activity in the anterior cingulate cortex (ACC) in the OCD patients. The enhanced activity in the ACC, and the normal activity in other working memory areas, was observed at all load levels even when performance deteriorated at the highest load level. van der Wee et al. (2003) suggested that the capacity of the working memory system was not affected in OCD as the system did not disengage with excessive demand.

van der Wee et al. (2003) proposed that the deficit in spatial working memory may be secondary to another disturbed aspect of executive dysfunction in OCD. The lateral prefrontal and the parietal regions have been implicated in the maintenance and manipulation of spatial material. These regions were not affected in the OCD patients, suggesting that the capacity to maintain and manipulate spatial information was not affected in OCD. Previous research has also suggested that the ACC is not involved in storing and manipulating information in the working memory process. The two main hypotheses regarding the function of the ACC propose that it plays a role in the implementation of a strategy or that it is involved in evaluating the effects of a strategy through the monitoring of performance. The ACC is particularly active in situations where there is a high likelihood of making an error (Aouizerate et al., 2004). van der Wee et al. (2003) suggest that the hyperactivity observed in the ACC when OCD patients performed the spatial n-back task may reflect an effort to develop or maintain a strategy, an increase in error monitoring, or may be the result of a compensatory mechanism required to perform certain cognitive tasks in the presence of OCD. However, as this was the first study to use the parametric n-back task with OCD subjects, replication is necessary to confirm the findings of van der Wee et al. (2003).

3.5.1 Summary

Nonverbal memory impairment in OCD patients is one of the more consistent findings in neuropsychological research. OCD patients have demonstrated impairment on a number of tests of nonverbal memory including the BVRT, RFT, the recall trials of the RCFT, CANTAB spatial recognition and working memory and the spatial n-back task. Impairment would appear to be most prominent on tasks requiring the ability to update, sequence, manipulate or organise information ‘on line’. Savage et al. (1999) has suggested that OCD patients may perform more poorly on tests of nonverbal memory because these tests are more susceptible to executive impairment due to their more abstract nature and the greater demands placed on organisational capacity.

3.6 Verbal memory

Verbal memory has been studied in OCD using a variety of instruments including the Auditory Verbal Learning Test (AVLT; Taylor, 1959) and subtests from the WMS (Wechsler, 1997).

OCD patients are generally not impaired on the AVLT (Jurado et al., 2001; Jurado et al., 2002) or the logical memory scale of the WMS (Boone et al., 1991; Christensen et al., 1992; Radomsky & Rachman, 1999). Other studies have also reported that OCD patients are not impaired on tasks of verbal memory (Dirson et al., 1995), episodic and recognition verbal memory (MacDonald, Antony, Macleod, & Richter, 1997) or working memory for abstract words (Martin et al., 1995).

While it was generally thought that verbal memory was intact in OCD, more recent studies have suggested that on verbal tasks that require strategic or executive processing such as semantic clustering and temporal ordering, OCD patients are impaired when compared to control subjects. For example, Savage et al. (2000) evaluated the mediating effects of organisational strategy on measures of both verbal and nonverbal memory in OCD. Thirty-three OCD patients and 30 matched controls completed the RCFT and the California Verbal Learning Task (CVLT; (Delis, Kramer, Kaplan, & Ober, 1987). The CVLT involves recalling items from a shopping list that are derived from four semantic categories. The test assesses the strategies and processes involved in learning and remembering verbal material (Spreen & Strauss, 1998). Compared to control subjects, the OCD patients demonstrated impaired free recall on both the verbal (CVLT) and nonverbal (RCFT) memory tests. Savage et al. (2000) suggested that strategic processes not only underlie abnormalities in nonverbal memory but also underlie verbal episodic memory in OCD. A number of other studies support this idea (Deckersbach et al., 2000; Cabrera et al., 2001; Jurado et al., 2001; Jurado et al., 2002; Singh et al., 2003; Deckersbach et al., 2004).

For example, Deckersbach et al. (2000) found that OCD patients scored below expectation for overall items recalled on the CVLT. Compared to a normative sample, OCD patients were poorer on both long-delayed and short-delayed free recall. Deckersbach et al. (2004) also found that OCD patients were impaired on the CVLT compared to healthy controls on both the long-delayed free recall measure and a measure of verbal organisation. Cabrera et al. (2001) compared 21 OCD patients to 21 control subjects and found that OCD patients were impaired in their ability to integrate semantic information.

Jurado et al. (2001) examined temporal memory in patients with OCD. In this study, 27 OCD patients were compared to 27 control subjects on the AVLT, the digit span test and on a task designed to test incidental memory for frequency. The frequency occurrence task is a measure of temporal memory and depends on frontal lobe integrity (Jurado et al., 2001). Compared to control subjects, OCD patients were impaired on the frequency occurrence task but not the AVLT or the digit span test.

Support for impairment in temporal memory in OCD was also provided by Jurado et al. (2002). Compared to controls, OCD patients were impaired on a task that required temporal ordering. The temporal ordering task consisted of three 15-word lists that had high, medium or no semantic interrelatedness. Subjects were required to read and make a pleasantness rating of each word. A recognition task was then presented that included the 15 original words and 15 new words. After three minutes of interference the subjects were required to reproduce the sequential order of the previously presented list. A recognition score was calculated as the number of hits minus the false positives. Temporal ordering performance was calculated as the sum of the distance between the actual position of the word in the list and the estimated position. Temporal ordering hits were the number of words placed in the correct position. Jurado et al. (2002) found that OCD patients were impaired in their ability to sequentially order words but not impaired on the measure of recognition memory.

Singh et al. (2003) also reported poorer performance by OCD patients on a Competing Language Processing Task (CLPT) in comparison to control subjects. The CLPT is comprised of sets of five-worded sentences. Subjects are required to decide if each sentence is true or false and also recall the last word of each sentence at the end of each set. The OCD patients performed more poorly on this test compared to healthy control subjects.

3.6.1 Summary

The evidence for a verbal memory impairment in OCD is mixed. As with most other cognitive domains, OCD patients show impairments on some measures of verbal memory but not all. It would appear that OCD patients are more likely to be impaired on measures of verbal memory that involve some kind of strategic or organisational processing (Greisberg & McKay, 2003). The evidence from recent studies of verbal memory in OCD suggest that a deficit in manipulating information in working memory may not be restricted to nonverbal information.

3.7 Interpretation of neuropsychological findings

The results from neuropsychological research in OCD suggest that individuals with this disorder do not exhibit generalised cognitive impairment. While some functions within certain cognitive domains such as executive, visuospatial, nonverbal memory and verbal memory appear to be compromised, there are other functions within these domains that are intact. Examination of the tests that OCD patients perform poorly on – rather than the cognitive domains that these tests measure – may provide more insight into subjects' impairment. Since the majority of neuropsychological tests involve a combination of several elementary cognitive functions and cannot be reduced to a single cognitive function, research may be better off focusing on the requirements of each task rather than the global cognitive domain being assessed (Kuelz et al 2004).

Examination of the requirements of the tasks that OCD patients perform poorly on may provide support for the theories of Purcell et al. (1998a, 1998b) and Zielinski et al. (1991) regarding the use of verbal mediation as an aid to OCD patients in performing cognitive tasks; the theory of Purcell et al. (1998b) that relying on visual representations of stimuli results in poorer performance in individuals with OCD; and the theory of Savage et al. (1999) that tasks involving the strategic aspects of memory – manipulating, updating, temporal ordering – are performed more poorly by patients with OCD.

Table 1 is a summary of the performance of OCD patients on neuropsychological tasks that permit verbal rehearsal of task stimuli. OCD patients tend to perform as well as control subjects on tasks that permit verbal rehearsal such as the Digit Span test, CANTAB pattern recognition, CANTAB DMS, the AVLT, the WMS logical memory test, working memory for line drawings, and working memory for abstract words.

Table 1
Summary of the performance of OCD patients on tasks that permit verbal rehearsal of task stimuli

Task	Requirements of task	Result	Author
Digit Span	Repeat sequences of digits	OCD = controls	Hollander et al. (1993) Cohen et al. (1996) Tallis et al. (1999) Deckersbach et al. (2000) Okasha et al. (2000) Jurado et al. (2001) Singh et al. (2003) Boldrini et al. (2004)
		OCD ↓ controls	Flor-Henry et al. (1979)
CANTAB - Pattern recognition	Recognise abstract line patterns	OCD = controls	Purcell et al. (1998a,b) Nielen and Den Boer (2003)
CANTAB - Delayed-matching-to-sample	Remember target stimuli (rectangular shapes with different arrangements of shape and colour)	OCD = controls	Purcell et al. (1998a,b)
AVLT	Recall list of 15 words	OCD = controls	Jurado et al. (2001) Jurado et al. (2002)
WMS – logical memory	Recall verbally presented story	OCD = controls	Boone et al. (1991) Christensen et al. (1992) Radomsky & Rachman (1999)
Working memory for line drawings	Pick different drawings from 16 successively presented pages of drawings	OCD = controls	Martin et al. (1995)
Working memory for abstract words	Pick a different word from 16 successively presented pages	OCD = controls	Martin et al. (1995)

Alternatively, OCD patients tend to perform more poorly than control subjects on neuropsychological tasks that do not permit verbal rehearsal, but rely more on visual representations of the task stimulus. For example, OCD patients perform poorly on tasks such

as the OAT and the DAT, the Block Design test, visuospatial transformation, mental rotation, the cube test, CANTAB spatial recognition, CANTAB spatial working memory and the spatial n-back task. Table 2 is a summary of the performance of OCD patients on tasks that do not permit verbal rehearsal of stimuli.

Table 2

Summary of the performance of OCD patients on tasks that do not permit verbal rehearsal of task stimuli

Task	Requirements of task	Result	Author
Object alternation and Delayed alternation tasks	Select one of two objects or locations, correct response corresponds to object or location not chosen on previous trial	OCD ↓ controls	Abbruzzese et al. (1995a) Abbruzzese et al. (1997) Cavedini et al. (1998) Gross-Isseroff et al. (1996) Moritz et al. (2001b)
Block design	Use red and white blocks to construct replicas of test constructions	OCD ↓ controls	Hollander et al. (1993) Head et al. (1989) Hymas et al. (1991) Christensen et al. (1992) Moritz et al. (2003)
Visuospatial transformation	Match sides and edges of a ground plan to points of a completed body	OCD ↓ controls	Moritz et al. (2003)
Mental rotation	Perform spatial rotations on task stimuli	OCD ↓ controls	Savage et al. (1999)
Cube test	Sequentially organise spatial stimuli	OCD ↓controls	Singh et al. (2003)
CANTAB - Spatial working memory	Search through boxes on computer screen to locate tokens	OCD ↓ controls	Purcell et al. (1998a,b)
CANTAB – spatial recognition	Recognise the spatial locations task stimuli	OCD ↓ controls	Purcell et al. (1998a,b) Nielen and Den Boer (2003)
Spatial n-back task	Compare spatial locations of letters presented 0, 1, 2 and 3 trials previously	OCD = controls (0, 1, 2-back trials) OCD ↓ controls (3-back trials)	Van der Wee et al. (2003)

OCD patients also tend to perform poorly on tasks that require strategic processing, such as manipulating, updating and organising information. For example, OCD patients perform more poorly than controls on the TEA auditory-verbal working memory task, the OAT and the DAT, the 4-ring version of the Tower of Hanoi, HVOT, mental rotation, the cube test, CANTAB spatial working memory, spatial n-back, RCFT recall trials, CVLT, tests of semantic integration, temporal ordering tasks and the CLPT. Table 3 displays a summary of the performance of OCD patients on tasks that require strategic processing.

Table 3

Summary of the performance of OCD patients on tasks requiring the strategic processing of task stimuli

Task	Requirements of task	Result	Author
Object alternation and Delayed alternation tasks	Select one of two objects or locations, correct response corresponds to object or location not chosen on previous trial	OCD ↓ controls	Abbruzzese et al. (1995a) Abbruzzese et al. (1997) Cavedini et al. (1998) Gross-Isseroff et al. (1996) Moritz et al. (2001b)
Tower of Hanoi (4-ring version)	Figure out sequence of spatially controlled moves to rebuild tower configuration in as few moves as possible	OCD ↓ controls	Cavedini et al. (2001) Cavallaro et al. (2003)
Hooper's visual organisation test	Conceptually rearrange pictures that have been disarranged	OCD ↓ controls	Boone et al. (1991)
Mental rotation	Perform spatial rotations on task stimuli	OCD ↓ controls	Savage et al. (1999)
Cube test	Sequentially organise spatial stimuli	OCD ↓controls	Singh et al. (2003)
CANTAB - Spatial working memory	Search through boxes on computer screen to locate tokens	OCD ↓ controls	Purcell et al. (1998a,b)
CANTAB - spatial recognition	Recognise the spatial locations of task stimuli	OCD ↓ controls	Purcell et al. (1998a,b) Nielen and Den Boer (2003)
Spatial n-back task	Compare spatial locations of letters presented 0, 1, 2 and 3 trials previously	OCD = controls (0, 1, 2-back trials) OCD ↓ controls (3-back trials)	Van der Wee et al. (2003)
RCFT - recall trials	Recall complex geometric figure from memory	OCD ↓ controls	Martinot et al. (1990) Savage et al. (1999) Tallis et al. (1999) Deckersbach et al. (2000) Savage et al. (2000) Kim et al. (2002) Kwon et al. (2003) Mataix-Cols et al. (2003) Boldrini et al. (2004) Choi et al. (2004)
		OCD = controls	Moritz et al. (2003)
CVLT	Memorise shopping list of words from different semantic categories	OCD ↓ controls	Savage et al. (2000) Deckersbach et al. (2004)
Semantic integration	Extract gist from complex linguistic material	OCD ↓ controls	Cabrera et al. (2001)
Frequency of occurrence task	Estimate the frequency of the appearance of orally presented words	OCD ↓ controls	Jurado et al. (2001)
Temporal ordering	Reproduce sequential order of word list	OCD ↓ controls	Jurado et al. (2002)
Competing Language Processing task	Listen to series of five worded sentences, decide if true or false and recall last word of each sentence	OCD ↓ controls	Singh et al. (2003)

Overall, OCD patients tend to perform more poorly on tasks that require strategic processing, like the organisation and manipulation of information in working memory. In addition, OCD

patients appear to perform well on tasks permitting verbal rehearsal, but more poorly on task requiring the use of visual representations of stimuli.

3.8 Summary

The results from studies assessing cognitive functioning in OCD do not present a clear and specific neuropsychological profile. Studies assessing fluency, set-shifting, planning and problem solving are contradictory, selective attention may be related to situational anxiety (Cohen et al., 2003), while speed of information processing may be affected by medication (Kuelz et al., 2004). Methodological issues such as small sample sizes, questionable matching of control subjects to patients and the inclusion of patients with significant levels of depression are also thought to have compromised early neuropsychological studies (Gibbs, 1996). Additionally, only a few studies have employed clinical control groups, comprising patients with other anxiety disorders, to investigate the specificity of the performance of the OCD patients (Cohen et al., 1996; Clayton et al., 1999; Purcell et al., 1998b; Boldrini et al., 2004). Results from neuropsychological assessments are important as they may provide clinical researchers with important clues in their efforts to better understand OCD. For example, extracting a characteristic profile of OCD may allow for a better understanding of the aetiology of the disorder, and assist with predicting treatment response and optimising therapeutic strategies (Kuelz et al., 2004).

Examination of the requirements of the tests that OCD patients perform poorly on suggests a deficit in the ability to maintain visual representations of stimuli, and to organise and manipulate information in working memory. This type of deficit would support the fronto-striatal hypothesis of OCD. As working memory involves executive processes important for higher cognitive processes, damage to working memory can result in difficulties with higher-order tasks such as applying strategies to appropriately retain information and deficits in problem solving and reasoning (Hinkin et al., 2002). Studies of patients with lesions of the frontal lobes or with disorders affecting frontal-striatal system function (Parkinson's disease and Huntington's disease) have demonstrated impairment of planning and organisational processes crucial for efficient encoding and retrieval of information - the 'executive' or 'strategic' aspects of memory. This pattern of memory impairment differs from problems associated with medial temporal system dysfunction in which subjects have difficulty storing and consolidating new memories (Savage et al., 1999). A deficit in the strategic aspects of memory may explain the impairment observed in patients with OCD on complex verbal and nonverbal tasks requiring the manipulation of information in working memory.

Organising and manipulating information in working memory may constitute a basic deficit in OCD. However, it has been suggested that the evidence for a working memory deficit in OCD is inconclusive and requires further investigation (Evans et al., 2004). Therefore, investigation of the ability of OCD patients to perform tasks that permit verbal mediation and those that

require the maintenance of internal representations of stimuli is required. Additionally, investigation of the ability of OCD patients to perform tasks that require 'executive' memory processes such as manipulating, updating and organising information in working memory are also required. These investigations may help clarify the nature of the cognitive impairment in OCD.

CHAPTER 4: OBSESSIVE-COMPULSIVE DISORDER AND PERSONALITY

4.1 Introduction

This chapter discusses the relationship between OCD and normal personality traits. There are a number of reasons for examining the personality traits associated with OCD. Firstly, uncovering the temperamental features of individuals with OCD has important clinical relevance. For example, there is evidence that normal models of personality can provide important information during clinical assessment (Trull & Sher, 1994). There is also evidence that dimensional personality traits can be useful in predicting treatment response and guiding treatment strategies (Miller, 1991). Determining the nature of the relationship between normal personality traits and OCD is also important in terms of understanding the aetiology of the disorder (Bejerot, Ekselius, & von Knorring, 1998; Bienvenu et al., 2004). In this chapter, early observations regarding OCD and obsessional personality will be presented, along with more recent investigations utilising the dimensional approach to personality assessment. A description of the Five-Factor Model of personality (FFM) is also included along with recent studies utilising the FFM in the assessment of normal personality traits in OCD and other clinical disorders.

4.2 Obsessive-Compulsive Disorder and obsessional personality

Early theories regarding the personality characteristics of individuals with OCD were generally based on clinical impressions (Black & Noyes Jr., 1997). Pierre Janet and Sigmund Freud were both instrumental in describing personality traits thought to be representative of a predisposition to obsessional illness. These early conceptualisations of personality vulnerability still figure prominently in the current conceptualisation of obsessive-compulsive personality disorder (OCPD) (Rector et al., 2002). OCPD is characterised by a pattern of preoccupation with orderliness, perfectionism and interpersonal control, at the expense of flexibility and openness (APA, 1994).

While it was generally thought that OCPD represented a predisposing vulnerability to the development of OCD the empirical research estimates co-morbidity rates as low as 2% (Rector et al., 2002). Recent studies using standardised assessment have shown that while 33% to 88% of patients with OCD meet criteria for a personality disorder and many patients have obsessive-compulsive personality traits, very few actually meet criteria for OCPD (Black & Noyes Jr., 1997). A number of studies have found that OCD is frequently associated with other personality disorders, including histrionic and avoidant personality disorder, rather than OCPD (Mavissakalian, Hamann, & Jones, 1990, 1993; Sciuto et al., 1991).

After reviewing the literature, Baer and Jenike (1992) concluded that the majority of patients with OCD had at least one personality disorder, however, OCPD was in the minority. The

defining characteristics of OCPD do not appear to be specifically related to the personality characteristics of OCD (Rector et al., 2002).

4.3 Dimensional assessment of personality in Obsessive-Compulsive Disorder

Recent investigations have utilised more standardised approaches in the assessment of personality in OCD. Normal personality traits are typically viewed as being dimensional and continuous in nature (Black & Noyes Jr., 1997). The dimensional assessment of personality typically involves the use of scales or questionnaires in which participants indicate how strongly various statements characterise them (Gray & Braver, 2002). The traits measured by these scales include higher-order personality domains from comprehensive models of personality. Extreme scores, in combination with personal distress and/or social impairment, tend to reflect personality pathology (Rector et al., 2002).

Carey et al. (1986), for example, administered the Minnesota Multiphasic Personality Inventory (MMPI; Hathaway & McKinley, 1943) to 32 outpatients with OCD. The mean MMPI profile showed elevations on a number of scales including, depression (scale 2), psychopathic deviance (scale 4), psychasthenia (scale 7), and schizophrenia (scale 8). The authors considered this result to be compatible with clinical observations of OCD since patients tend to experience both depression and anxiety (scales 2 and 7), tend to endorse fears of losing control in socially unacceptable ways (scale 4) and tend to endorse obsessions and superstitions (scale 8).

Pfohl, Black, Noyes Jr., Kelley and Blum (1990) compared 25 OCD patients with 35 healthy controls on the Tridimensional Personality Questionnaire (TPQ: Cloninger, 1987). The TPQ measures three dimensions of personality: novelty seeking, harm avoidance and reward dependence. Compared to healthy control subjects, OCD patients scored significantly higher on the measures of harm avoidance and reward dependence. The OCD patients also scored lower than the controls on novelty seeking, although the difference did not reach significance.

The Temperament and Character Inventory (TCI: Cloninger, Svrakic, & Przybeck, 1993) is a revised version of the TPQ which measures four dimensions of temperament (novelty-seeking, harm-avoidance, reward-dependence, persistence) and three dimensions of character (self-directedness, cooperativeness, self-transcendence). Lyoo, Lee, Kim, Kong and Kwon (2001) used the TCI to compare 40 OCD outpatients with 40 matched control subjects. The OCD patients were significantly higher on the temperament measure of harm-avoidance and significantly lower on the temperament measure of novelty-seeking. The OCD patients were also significantly lower on the character measure of self-directedness. The results, compatible with the clinical description of OCD, suggested that individuals with OCD are anxious and avoid dangerous situations. The low self-directedness suggested that when individuals with OCD initiate goal-directed behaviours, they are hindered by invasive obsessions and compulsions.

Lyoo et al. (2001) also found that after controlling for depression and anxiety, harm avoidance and self-directedness significantly predicted the severity of obsessive-compulsive symptoms in the OCD patients. Cruz-Fuentes, Blas, Gonzalez, Camarena and Nicolini (2004) also found that compared to control subjects, OCD patients score higher on harm-avoidance and lower on self-directedness and cooperativeness on the TCI.

Kusunoki et al. (2000) directly compared OCD patients to patients with major depression (MD) and healthy controls on the TCI. Compared to the control subjects, OCD and MD patients scored significantly higher on harm-avoidance and significantly lower on self-directedness and co-operativeness. The OCD patients scored significantly lower on novelty-seeking than the MD patients and the controls. Therefore, while OCD and MD patients shared similar personality characteristics on harm-avoidance, self-directedness and co-operativeness, OCD was distinguished from MD in terms of low novelty-seeking. The authors suggested that low novelty-seeking may have a significant relationship to the specific aetiology of OCD (Kusunoki et al., 2000).

Fullana et al. (2004) compared 56 individuals with OCD to 40 healthy control subjects on the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (Torrubia, Avila, Molto, & Caseras, 2001), the Spanish version of the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1975) and measures of depression and anxiety. The OCD patients scored significantly higher on the measures of Neuroticism, sensitivity to punishment and Psychoticism compared to the control subjects. The OCD patients were also significantly lower on the measure of Extraversion but no different to the controls on the measure of sensitivity to reward. Regression analysis indicated that for the comparison of OCD patients and healthy control subjects, Psychoticism scores were the best predictor of the severity of obsessive-compulsive symptoms.

While a number of differences between OCD patients and healthy control subjects have emerged on measures of normal personality, a unique relationship between higher-order personality traits and OCD when compared to other clinical disorders is still to be demonstrated conclusively (Rector et al., 2002). As a result, further exploration of personality assessment in OCD is required. In addition, the early work investigating personality in OCD utilised measures of personality that did not resolve the lower-order dimensions of personality. There is emerging evidence that lower-order dimensions of personality are important in understanding certain clinical disorders (Bienvenu et al., 2001; Bienvenu et al., 2004).

4.4 The Five-Factor Model of personality

The FFM is a representation of the structure of personality traits which have been developed and elaborated over a number of years (Digman, 1990). The five factors represent basic dimensions underlying personality traits, identified as a result of factor analytic studies of both

natural language and personality questionnaires. The FFM allows investigation of the five broad domains of personality as well as the lower-order facets that comprise each domain. The five broad personality factors or domains consist of: Neuroticism, Extraversion, Openness-to-experience, Agreeableness and Conscientiousness. Neuroticism measures the general tendency to experience negative affects such as fear, sadness, embarrassment, anger guilt and disgust. The Extraversion domain assesses how "energetic" a person is. People who score high on this factor like to work in cooperation with others, are talkative, enthusiastic and seek excitement. Openness-to-experience measures things such as imagination, aesthetic sensitivity, preference for varity, intellectual curiosity and independence of judgment. The Agreeableness domain is primarily a dimension of interpersonal tendencies. The agreeable person is sympathetic to others, eager to help and believes that others will be helpful in return. The basis of the Conscientiousness domain is the active process of planning, organizing and carrying out tasks. The five factors are defined by groups of intercorrelated traits referred to as facets (Costa & McCrae, 1992). There is a growing body of theoretical and empirical evidence linking normal personality traits represented by the FFM to psychiatric disturbances (Quirk, Christiansen, Wagner, & McNulty, 2003).

For example, low Conscientiousness has been linked to greater levels of depression in adults (Soldz & Vaillant, 1999). Higher scores on the domain of Openness (Trull & Sher, 1994; Huprich, 2000) and the Openness facets of fantasy, feelings and aesthetics (Bagby, Joffe, Parker, Kalemba, & Harkness, 1995) have also been linked to depression. Differences on the Openness domain and its facets have also been observed in schizophrenia and bipolar disorder (Bagby et al., 1996; Bagby et al., 1997). Neuroticism and Extraversion are also frequently associated with anxiety and depressive disorders (Trull & Sher, 1994; Huprich, 2000).

In a comprehensive study of the FFM in anxiety and depression, Bienvenu et al. (2001) used the Revised NEO Personality Inventory (NEO PI-R; Costa & McCrae, 1992) to compare individuals with depressive and anxiety disorders (major depression, simple phobia, social phobia, agoraphobia and panic disorder) to a control group without any of these disorders. Compared to the control group, subjects with simple phobia, social phobia, agoraphobia, panic disorder and depression reported higher levels of Neuroticism. Subjects with social phobia, agoraphobia and panic disorder reported significantly lower Extraversion compared to the control group. There were no differences between the subjects with anxiety or depressive disorders and the control group on the domains of Openness, Agreeableness or Conscientiousness.

Bienvenu et al. (2001) also observed a number of differences between the experimental groups on the facets of the NEO PI-R. The depressed subjects were significantly higher than the control group on all facets of Neuroticism. Subjects with simple phobia, social phobia, agoraphobia and panic disorder were also significantly higher than the control group on all of

the Neuroticism facets except impulsiveness. On the Extraversion facets, the simple phobia subjects were lower than controls on the measures of warmth and gregariousness. The subjects with social phobia were significantly lower than the controls on warmth, gregariousness, assertiveness, excitement seeking, and positive emotions. Subjects in the agoraphobia group were significantly lower than the controls on the facets of warmth, gregariousness, excitement seeking and positive emotions. Compared to the control group, the panic disorder patients were significantly lower on the facets of warmth, assertiveness, and positive emotions while the major depression group were significantly lower than controls on the facet of assertiveness. The simple phobia subjects were also lower than controls on the Agreeableness facet of compliance and the Conscientiousness facets of self-discipline. Subjects with social phobia were significantly lower than controls on the Agreeableness facet of trust and the Conscientiousness facets of competence, achievement striving, self-discipline, and deliberation. The subjects with agoraphobia were significantly lower than the control group on the Agreeableness facets of trust and compliance and the Conscientiousness facet of self-discipline. The panic disorder group were also significantly lower on the Agreeableness facets of trust and compliance and lower on the Conscientiousness facet of competence. The subjects with major depression were significantly higher than the control group on the Openness facet of feelings and significantly lower on the Conscientiousness facet of self-discipline.

Overall, the results suggested that Neuroticism, Extraversion, and facets of Agreeableness and Conscientiousness were important constructs in understanding the relationships between personality and anxiety and depressive disorders (Bienvenu et al., 2001). Few studies, however, have examined the FFM specifically in OCD.

A follow up study by Bienvenu et al. (2004) included OCD patients in an investigation of the FFM in anxiety and depressive disorders. Bienvenu et al. (2004) used the NEO PI-R to compare personality traits in subjects with each of the disorders of interest (simple phobia; social phobia; agoraphobia; panic disorder; OCD; generalised anxiety disorder [GAD]; major depressive disorder [MDD]; dysthymia) to those in subjects with none of the disorders of interest. All of the disorders of interest were associated with higher Neuroticism scores. The three phobias and dysthymia were also associated with lower Extraversion scores and OCD was associated with higher mean Openness-to-experience compared to the control subjects (Bienvenu et al., 2004).

At the facet level, the agoraphobia and OCD patients were higher on some facets of Neuroticism compared to subjects without any of the disorders of interest. Specifically, the OCD patients were higher on measures of anxiety, depression, self-consciousness and vulnerability. The agoraphobia subjects were higher on all Neuroticism facets except impulsiveness. Subjects with simple phobia and GAD were higher on some facets of Neuroticism (simple phobia: anxiety, angry hostility, depression, self-consciousness and vulnerability; GAD: anxiety,

depression, self-consciousness and vulnerability) and lower on the Conscientiousness facet of self-discipline. The panic disorder and dysthymia subjects were also higher on some facets of Neuroticism (panic disorder: anxiety, angry hostility, depression and vulnerability; dysthymia: depression, self-consciousness and vulnerability) than the comparison subjects and were also lower on some facets of Extraversion (panic disorder: positive emotions; dysthymia: warmth, gregariousness, excitement seeking and positive emotions). Social phobia was associated with higher scores on all but one facet of Neuroticism (impulsiveness), lower scores on all facets of Extraversion, lower on the Agreeableness facet of trust and lower on the Conscientiousness facets of competence, achievement striving and self-discipline. Finally, the MDD subjects were higher on all facets of Neuroticism, lower on the Extraversion facets of assertiveness, higher on the Openness facet of feelings and lower on the Conscientiousness facet of self-discipline.

Overall, this study provided further evidence that examining both higher- and lower-order personality traits is important in better understanding personality traits in clinical disorders. However, this study did not compare the clinical disorders to each other and used a control group comprising individuals with other clinical disorders. A number of other studies have examined the FFM in OCD in comparison to healthy controls and other clinical disorders.

For example, Samuels et al. (2000) used the NEO PI-R to investigate differences between OCD patients and healthy controls on specific features of normal personality. Compared to the healthy control subjects, OCD patients scored significantly higher on the Neuroticism domain and all of its facets. The OCD patients were also higher on two Openness facets (fantasy and feelings) and lower on two Conscientiousness facets (competence and self-discipline). The OCD patients were also significantly lower on the domain of Extraversion, the Extraversion facet of assertiveness and the Openness facet of actions, and significantly higher on the Agreeableness facets of straightforwardness, modesty and tendermindedness - although the OCD patients were still in the ‘average’ range for each of these domains and facets. Samuels et al. (2000) suggested that the profile of the OCD patients was characteristic of highly neurotic, tender minded people who lack the ability to carry tasks to completion. The low Conscientiousness reported by the OCD patients suggested that individuals with OCD judge that they are not performing at the level required by their own high standards. Alternatively, worry and doubt may interfere with their productivity. The higher scores by patients with OCD on the facets of impulsivity and fantasy may also reflect a difficulty in resisting intrusive thoughts (Samuels et al., 2000).

Rector et al. (2002) also investigated the FFM in OCD. This study compared 98 OCD patients to 98 subjects with Major Depressive Disorder (MDD) on the domains and facets of the NEO PI-R. The OCD patients scored significantly higher than the subjects with MDD on the domains of Extraversion, Agreeableness and Conscientiousness and significantly lower on the domain of Neuroticism. On the facets of Neuroticism, the OCD patients were significantly higher on

anxiety but lower on depression. The OCD patients were also significantly higher on the Extraversion facets of warmth, activity and positive emotions and higher on the Agreeableness facet of altruism. On the Conscientiousness facets, the OCD patients were significantly higher than the MDD subjects on the measures of competence and order. Overall, the significant differences at the domain and facet level between the OCD and MDD subjects suggested that there may be disorder-specific associations with personality traits (Rector et al., 2002). Rector et al. (2002) also investigated the influence of current levels of depression on personality differences between the OCD and MDD subjects. The results suggested that the ability to experience positive emotions and Conscientiousness were moderated by the presence of secondary depression. However, differences between the groups on the domains of Extraversion and Agreeableness, and the facets of warmth, anxiety and depression were not influenced by secondary depression. Rector et al. (2002) also noted the low self-discipline score of the OCD patients. The authors suggested that despite the desire for order and organisation, individuals with OCD are unable to achieve these tasks to their satisfaction (Rector et al., 2002).

Leong (2003) compared OCD patients to other obsessive-compulsive (OC) spectrum disorders (anorexia nervosa, bulimia nervosa), psychiatric controls (major depression) and healthy controls on the NEO PI-R. The OCD patients reported significantly higher Neuroticism than healthy controls but not clinical controls. The OCD patients were significantly higher on all but one facet of Neuroticism (impulsiveness) compared to the healthy controls and were significantly higher than the clinical control group on the facet of anxiety. The OCD patients did not differ from the control groups on the Extraversion domain or its facets, except for being lower than the healthy controls on the facet of activity. There were no differences between the OCD patients and the clinical or healthy control subjects on the Openness domain and its facets, or the Agreeableness domain and its facets. The OCD patients were also no different to the control groups on the domain of Conscientiousness, however, they were significantly lower on the facet of self-discipline compared to the healthy control group. The OCD subjects did not differ from the OC spectrum subjects on any of the NEO PI-R measures.

4.5 Summary

There are few studies that have utilised the dimensional assessment of personality in OCD. In particular, studies examining the FFM in OCD are only recently emerging in the OCD literature. A summary of studies assessing normal personality traits in OCD is included as Table 4. While there are some similarities in the results of these studies, further investigation is required to clarify the normal personality features of individuals with OCD.

Table 4

Summary of studies assessing normal personality traits in OCD patients

Author	Measure	Subjects	Result	
Carey et al. (1986)	MMPI	32 OCD	OCD elevated on	depression scale psychopathic deviance psychasthenia schizophrenia
Pfohl et al. (1990)	TPQ	25 OCD 35 controls	OCD ↑ controls	reward dependence harm avoidance
Lyoo et al. (2001)	TCI	40 OCD 40 controls	OCD ↑ controls OCD ↓ controls	harm avoidance novelty seeking self-directedness
Cruz-Fuentes et al. (2004)	TCI	54 OCD 54 Control	OCD ↑ controls OCD ↓ controls	harm avoidance cooperativeness self-directedness
Kusunoki et al. (2000)	TCI	43 OCD 43 Major Depression 43 Controls	OCD and MD ↑ Controls OCD and MD ↓ Controls	harm avoidance self-directedness cooperativeness novelty-seeking
Fullana et al. (2004)	SPSRQ EPQ	56 OCD 40 controls	OCD ↑ controls OCD ↓ controls	Neuroticism Punishment Psychoticism Extraversion
Bienvenu et al. (2004)	NEO PI-R	14 OCD 173 Simple phobia 89 Social phobia 46 Agoraphobia 43 Panic Disorder 31 GAD 132 Major depression 18 Dysthymia 295 Controls	All disorders ↑ controls OCD ↑ controls	Neuroticism Openness Anxiety Depression Self-consciousness Vulnerability
Samuels et al. (2000)	NEO PI-R	65 OCD 72 Controls	OCD ↑ controls OCD ↓ controls	Neuroticism Neuroticism facets Fantasy and feelings Straightforwardness Modesty Tendermindedness Competence Self-discipline Extraversion Assertiveness Actions
Rector et al. (2002)	NEO PI-R	98 OCD 98 Major Depression	OCD ↑ Major depression OCD ↓ Major depression	Extraversion Agreeableness Conscientiousness Anxiety Warmth Activity Positive emotions Altruism Competence Order Neuroticism Depression
Leong (2003)	NEO PI-R	40 OCD 81 OC spectrum 37 Depression 42 Controls	OCD ↑ controls OCD ↑ Depression OCD ↓ controls	Neuroticism Neuroticism facets (except impulsiveness) Anxiety Activity Self-discipline

CHAPTER 5: OBSESSIVE-COMPULSIVE DISORDER AND ANALOGUE RESEARCH

5.1 Introduction

So far, the present thesis has discussed research that has used clinical samples to examine the cognitive deficits and personality traits of individuals with OCD. However, there is accumulating evidence that OCD can also be productively examined by conducting analogue studies with individuals who score highly on self-report measures of OCD (Burns, Formea, Keortge, & Sternberger, 1995). This chapter discusses the utility of using sub-clinical obsessive-compulsive (OC) samples in OCD research. The features of individuals with sub-clinical OC are discussed including the prevalence of OC symptoms in non-patient samples. A discussion of the cognitive deficits and personality traits of individuals with sub-clinical OC symptoms is also included.

5.2 The use of analogue samples in OCD research

Analogue research in anxiety disorders can be traced back to an early investigation by Lang and Lazovik (1963). In this seminal study, snake-fearful college students were recruited to investigate the efficacy of using systematic desensitisation in the reduction of fear. This study provided a template for future analogue studies which became increasingly attractive to clinical researchers due to the greater experimental control and more objective assessment of therapeutic outcomes (Gibbs, 1996).

Employing sub-clinical samples in clinical research has a number of advantages. Firstly, recruitment of clinical samples is difficult, particularly in an academic setting (Gibbs, 1996). Sub-clinical OC samples also tend to have fewer competing factors (i.e. medication, co-morbid conditions) that can influence the outcome of experimental research (Kazdin, 1978). Also, given that the decision to seek psychiatric treatment may be influenced by a number of factors (social, attitudinal, economic) irrelevant to the disorder, a clinical sample will not necessarily be representative of all occurrences of the disorder in the general population (Borkovec & Rachman, 1979; Shapiro et al., 1984). Therefore, it is important to supplement clinical research with work on sub-clinical subjects who exhibit similar psychological disturbances (Gibbs, 1996).

5.3 Prevalence of obsessions and compulsions in non-patient samples

The exact frequency of sub-clinical OC is unknown due to a wide discrepancy in prevalence rates across studies (Gibbs, 1996). However, there appears to be a high prevalence of obsessions and compulsions in non-patient samples (Rachman & de Silva, 1978; Salkovskis & Harrison, 1984). One recent epidemiologic study reported that 22 to 26% of 2,200 respondents had obsessions or compulsion, yet only 0.6% received a diagnosis of OCD after clinical reappraisal (Stein et al., 1997). Degonda, Wyss and Angst (1993) reported a lifetime prevalence of 5.7% for obsessive-compulsive syndromes which they defined as OCD symptoms accompanied by distress and social impairment but not severe enough to lead to symptom

suppression. A study by Angst et al. (2004) estimated that the one-year prevalence rate for obsessive-compulsive symptoms was 3.9% and the lifetime prevalence of obsessive-compulsive symptoms was 8.7%.

5.4 Cognitive deficits in sub-clinical obsessive compulsives

An important question for OCD research is whether observed neuropsychological deficits are exclusive to patients with OCD, or if they are also present in subjects who have a degree of obsessive-compulsive symptomatology but do not meet diagnostic criteria for the disorder (Mataix-Cols, 2003). Early studies using analogue samples in OCD research focused on uncovering deficits in memory functioning in sub-clinical checkers. More recently, studies have focused on tests sensitive to frontal lobe dysfunction in psychometrically defined sub-clinical OC samples.

5.4.1 Memory deficits

Given the evidence for a nonverbal memory deficit in OCD, Sher and colleagues conducted a series of studies designed to test a similar hypothesis in a sub-clinical OC population (Sher, Frost, & Otto, 1983; Sher, Mann, & Frost, 1984; Sher, Frost, Kushner, Crews, & Alexander, 1989).

Sub-clinical checkers were selected on the basis of self-reported checking behaviours on the Maudsley Obsessive-Compulsive Inventory (Hodgson & Rachman, 1977) and compared to non-clinical subjects on various dimensions of memory. Using this selection method, Sher and colleagues found significant differences between checkers and non-checkers on various measures of memory functioning. For example, checkers produced lower Wechsler Memory Scale memory quotients in comparison to non-checkers (Sher et al., 1984; Sher et al., 1989). Checkers also scored higher on the Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982), a self-report inventory that assesses impairment in memory, perception and motor functioning in natural settings (Sher et al., 1989).

Sher and colleagues also found that checkers recalled fewer actions in which they engaged over the course of an experimental session (Sher et al., 1983; Sher et al., 1984; Sher et al., 1989; Sheffler Rubenstein, Peynircioglu, Chambless, & Pigott, 1993). For example, compared with normal controls, checkers remembered fewer actions than controls and were also more likely to report an action that was not assessed in the experiment. Consistent with previous research in clinical OCD samples, there was no impairment in the ability of checkers to recall verbal material (Sheffler Rubenstein et al., 1993). Compulsive checkers were also found to have a poorer memory for prior actions than controls, and also underestimated their ability to distinguish memories of real and imagined events (Sher et al., 1983).

5.4.2 Frontal lobe dysfunction

Executive functions have received a great deal of attention in OCD neuropsychology research given the association between OCD and a proposed frontal-striatal dysfunction. In recent years, attention has turned to sub-clinical OC subjects to establish whether a similar deficit exists in these individuals. There have only been a few studies that have investigated the performance of sub-clinical OC subjects on tests sensitive to fronto-striatal functioning.

Evidence that sub-clinical OC subjects show a deficit in the ability to manipulate information in visual working memory was reported by Mataix-Cols et al. (1997). Sub-clinical OC subjects were impaired on a computerised version of the identical pairs version of the continuous performance test (CPT-IP; Obiols, Garcia-Domingo, de Trincheria, & Domenech, 1993) compared to non-clinical controls. The CPT-IP is a complex attentional task that focuses on cognitive (as opposed to perceptual) processing, and on working memory. Mataix-Cols et al. (1997) found that compared to control subjects, sub-clinical OC subjects performed more poorly on the 'numbers' subtest but better on the 'shapes' subtest of the CPT-IP.

Mataix-Cols et al. (1999a) examined the performance of sub-clinical OC subjects on tests of verbal and design fluency. Subjects completed two verbal fluency tests (FAS test and the category alternation test [CAT]) and a design fluency test (DFT). The sub-clinical OC subjects did not differ from the control subjects on the FAS test, and differences on the CAT disappeared after controlling for state anxiety. The sub-clinical OC subjects did perform more poorly than the controls on the DFT, even after controlling for current mood. The result suggests that there is a deficit in the ability of sub-clinical OC subjects to organise non-structured material (Mataix-Cols et al., 1999a).

Mataix-Cols et al. (1999b) compared 35 sub-clinical OC subjects with 36 control subjects on the Tower of Hanoi test (TOH), Wisconsin Card Sorting Test (WCST), Auditory Verbal Learning Task (AVLT), Tactual Performance Test (TPT), Trail Making Test – part B (TMT-B), verbal fluency and the Stroop test. While the sub-clinical OC subjects performed more poorly on the TOH, there were no differences compared to the non-clinical controls on the WCST, AVLT, TPT, TMT, verbal fluency or Stroop task. The results suggested that sub-clinical OC subjects have difficulty on tasks that require maintaining and sequencing spatially-controlled motor moves. Given that the impaired performance of the sub-clinical OC was not related to confounding factors such as clinical state or medication status, the authors suggested that a deficit in manipulating spatial information may constitute a basic deficit or a trait marker of OCD.

Mataix-Cols (2003) provided support for this result by comparing 25 sub-clinical OC subjects to 28 control subjects on the TOH and the AVLT. The sub-clinical OC subjects performed more poorly than controls on the 3-disk version of the TOH but not on the AVLT. The author suggests

that the result is indicative of a deficit in spatial problem-solving strategies in sub-clinical OC subjects.

A number of other studies have reported neuropsychological deficits in sub-clinical OC subjects that have also been observed in clinical OCD samples. For example, Spitznagel and Suhr (2002) found that sub-clinical OC subjects were impaired on tests of delayed alternation and object alternation but not on a measure of letter fluency. Pleva and Wade (2002) compared 30 high-OC and 30 low-OC subjects on the subtests of the Test of Everyday Attention (TEA). In this study, the high-OC subjects performed more poorly on the TEA compared to the low-OC subjects. As with OCD patients, sub-clinical OC subjects have also demonstrated equivalent performance to normal controls on the Stroop task (Hajcak & Simons, 2002).

5.5 Personality and clinical features of sub-clinical obsessive-compulsives

Personality and clinical features associated with OCD have also been reported in sub-clinical OC samples. These characteristics include inflated responsibility, guilt, obsessive-compulsive personality traits, neuroticism, risk-aversion and negative affect.

5.5.1 Responsibility and guilt

Clinical observations of OCD patients indicate that they are often consumed by an exaggerated sense of responsibility surrounding their obsessional symptoms. Accompanying this is a sense of guilt which arises from assigning blame to themselves for experiencing unacceptable obsessive thoughts (Salkovskis, 1985; Rachman, 1993). A number of investigations have used sub-clinical OC samples to investigate the relationship between responsibility, guilt and obsessive-compulsive behaviour (Gibbs, 1996). For example, a number of studies employing sub-clinical OC samples have found that both guilt, and perceived responsibility, predict obsessive thinking and compulsive behaviour (Freeston, Ladouceur, Thibodeau, & Gagnon, 1992; Mancini, D'Olimpio, & D'Ercole, 2001; Mancini, D'Olimpio, & Cieri, 2004). Pleva and Wade (2002) also found that high-OC subjects reported significantly higher levels of responsibility on the Responsibility Attitude Scale (RAS; Salkovskis et al., 2000) compared to low OC subjects. Other research has investigated differences in the level of guilt experienced between sub-clinical OC subjects and normal controls. A number of studies have found that, in comparison to non-clinical subjects, sub-clinical OC subjects report experiencing significantly higher levels of guilt (Sher et al., 1983; Frost, Sher, & Geen, 1986; Frost, Steketee, Cohn, & Griess, 1994).

5.5.2 Obsessive-compulsive personality traits

It has been suggested that perfectionism lies at the core of several behavioural and psychological disturbances including obsessive-compulsive symptoms (Gibbs, 1996). For example, Mataix-Cols et al. (2000) found that sub-clinical OC subjects scored higher on a measure of obsessional personality compared to non-clinical subjects. Associations between

sub-clinical obsessive-compulsive symptoms and several obsessive-compulsive personality traits including perfectionism, moral rigidity, indecisiveness and hoarding behaviour have also been reported by a number of studies (Frost & Gross, 1993; Frost & Sher, 1989; Frost & Shows, 1993; Frost et al., 1994). Wade, Kyrios and Jackson (1998) also found that perfectionist tendencies predicted compulsive checking and cleaning behaviours in a non-clinical student sample.

5.5.3 Neuroticism and risk-avoidance

Personality studies suggest that sub-clinical OC subjects are neurotic and introverted individuals who dislike spontaneity and prefer safety and predictability in order to satisfy their need for control over their environment (Gibbs, 1996). High levels of risk-avoidance and low novelty-seeking have been identified in OCD patients who present for treatment (Pfohl et al., 1990; Lyoo et al., 2001; Kusunoki et al., 2000). Decreased risk-taking and low sensation-seeking also appear to be associated with sub-clinical OC symptoms as demonstrated in an investigation that compared sub-clinical OC subjects to control subjects on measures of these traits (Frost et al., 1994). Mataix-Cols et al. (2000) found that sub-clinical OC subjects scored higher on the Neuroticism scale of the Eysenck Personality Questionnaire (EPQ) compared to non-clinical controls. Fullana et al. (2004) compared sub-clinical OC subjects to matched controls on the EPQ and found that the sub-clinical OC subjects were higher on Neuroticism compared to the controls subjects. In the same study, regression analysis indicated that Neuroticism was the best predictor of scores on a measure of obsessive-compulsive behaviour. Wade et al. (1998) also found that neuroticism, mediated by a negative mood state, predicted obsessions and compulsions in a sub-clinical OC sample. The same study found that unwanted intrusive thoughts, doubts and ruminations were related to neuroticism, independent of mood state.

5.5.4 Negative affect

Several studies have investigated the role of negative affect in the genesis and maintenance of OCD. For example, Reynolds and Salkovskis (1992) found that induced depressed mood leads to an increase in the frequency of intrusive cognitions. Freeston et al. (1992) also found evidence for a positive association between negative affect and OC symptoms. The presence or absence of negative affect may also be partially responsible for the fluctuating course of OCD (Ristvedt, Mackenzie, & Christenson, 1993). A number of studies have also reported that sub-clinical OC subjects score higher on measures of depression and anxiety compared to non-clinical controls (Mataix-Cols et al., 2000; Pleva & Wade, 2002).

5.5.5 The Five-Factor Model of personality

There have been few studies of the FFM in sub-clinical OC subjects. Gershuny, Sher, Rossy and Bishop (2000) compared sub-clinical compulsive checkers to non-checking anxious individuals and controls on the Goldberg Personality Questionnaire (GPQ; Goldberg, 1992). The GPQ measures five personality dimensions: emotional stability (Neuroticism), Extraversion,

Agreeableness, Conscientiousness and intellect. Gershunny et al. (2000) found that compulsive checkers were less emotionally stable (more neurotic) and more conscientious than non-checking, non-anxious controls.

5.6 Summary

The use of sub-clinical OC samples to investigate OC phenomena is justified in terms of the number of dimensions on which sub-clinical OC samples and OCD patients are similar. These include symptom profile, personality and psychological characteristics, and cognitive dysfunction (Gibbs, 1996). The main limitation of using sub-clinical OC subjects in OCD research is that it is unknown whether the findings of studies using sub-clinical OC subjects can be generalised to clinical populations (Mataix-Cols, 2003).

A number of studies have suggested that deficits in manipulating visual information may be basic in OCD and are congruent with the involvement of the fronto-striatal circuits. Studies using sub-clinical OC samples have also found similar deficits. However, further experimental examination, with both sub-clinical OC and clinical OCD samples, is required to test the hypothesis that OC subjects have difficulty holding a plan or sequence of action in memory - that is working memory deficits (Mataix-Cols et al., 1999).

More research is also required into the personality traits of individuals with sub-clinical OC symptoms and how they compare to clinical OCD patients. While there is some evidence that the personality traits of sub-clinical OC subjects resemble OCD patients, few studies have directly compared the two groups on measures of normal personality. Direct comparison of OCD and sub-clinical OC subjects may provide information on personality traits that represent a vulnerability to OCD, and also provide information regarding personality traits that may distinguish clinical and sub-clinical OC symptoms.

The present study may be the first ever to directly compare OCD and subclinical OC subjects on measures of working memory and normal personality traits.

CHAPTER 6: AIMS AND HYPOTHESES

6.1 Motivation for the present thesis

To date, no study has directly compared OCD patients to healthy controls, clinical controls and sub-clinical OC subjects on measures of cognitive function and personality traits. The motivation for this thesis was to further investigate the idea that OCD patients have a specific deficit related to the executive processes of organising and manipulating information in working memory, and to examine the specificity of the personality traits of OCD patients on a measure of the Five-Factor Model of normal personality (FFM).

To investigate the specificity of the working memory deficits associated with OCD, comparison with other psychiatric disorders is important. Identifying whether the pattern of impairment is related to the core symptoms of OCD (obsessions and compulsions) or associated with anxiety in general, requires the comparison of OCD patients with subjects affected by another anxiety disorder. Panic disorder is considered a good control group for OCD because it has the anxiety symptoms and the avoidance (of phobic objects or situations), but does not present the core symptoms of OCD (obsessions and compulsions) (Boldrini et al., 2004). There have been few studies that have examined neuropsychological impairment in panic disorder. An early study by Lucas, Telch and Bigler (1991) found that patients with panic disorder had poorer visual learning and recall and poorer verbal recall than healthy control subjects. Asmundson, Stein, Larsen and Walker (1994) failed to replicate the finding of impaired visual memory instead finding deficits in verbal learning and verbal recall. More recently, Gladsjo et al. (1998) and Purcell et al. (1998b) failed to find any significant differences between panic disorder patients and controls on a battery of neuropsychological tasks. Other studies have also reported intact neuropsychological performance by panic disorder patients compared to OCD and healthy control subjects (Clayton et al., 1999; Cavedini et al., 2002). This thesis will directly compare the working memory performance of OCD patients with individuals with another anxiety disorder, specifically panic disorder.

There have been numerous studies utilising sub-clinical OC samples to make inferences about the cognitive impairment present in OCD. However, few studies have directly compared the two groups to establish whether they do, in fact, resemble each other in terms of cognitive task performance. Studies have suggested that both of these groups have a deficit in the ability to organise and manipulate information in working memory. This thesis will directly compare OCD patients to a sub-clinical OC sample on a number of measures of working memory to establish the extent to which the performance of these two samples actually compares.

There have also been few studies that have examined the FFM in OCD in comparison to other anxiety disorders. Bienvenu et al. (2004) investigated the FFM in depression and a number of different anxiety disorders, including OCD and panic disorder, using the Revised NEO

Personality Inventory (NEO PI-R). Bienvenu et al. (2004) found that, compared to individuals without depression or the anxiety disorders examined, patients with OCD reported significantly higher levels of Neuroticism and Openness. The panic disorder patients reported significantly higher levels of Neuroticism and significantly lower levels of Extraversion. The panic disorder patients also differed from the subjects without depression or other anxiety disorders on facets of Neuroticism and Extraversion while the OCD patients differed on facets of Neuroticism. This study compared the depressive and anxiety disorders of interest to a control group comprising individuals without the disorders of interest. However, it did not directly compare any of the depressive or anxiety disorders. This thesis will directly compare the FFM profiles of OCD patients and subjects with another anxiety disorder, specifically panic disorder.

A number of studies have also utilised sub-clinical OC samples to make inferences about the personality traits of individuals with OCD. Few studies have directly compared the two groups to determine whether they do, in fact, resemble each other. There have also been few studies that have examined the FFM in sub-clinical OC samples. This thesis will directly compare OCD patients with a sub-clinical OC sample on a measure of the FFM to establish the extent to which the personality traits of these two samples actually compare.

The focus of this thesis is the direct comparison of OCD patients to healthy and clinical controls and an analogous sub-clinical OC sample. While it is acknowledged that direct comparison of the panic disorder and sub-clinical OC subjects to the healthy controls would also potentially yield interesting information, it is not the priority of the present thesis. Specific hypotheses have not therefore been generated. However, given that the data will be collected for these two groups, post-hoc analyses will be conducted as an exploratory investigation into how these groups compare to each other and the healthy control group on measures of cognitive functioning and personality traits.

6.2 Aims

There are two general aims of this thesis. First, this thesis will investigate whether deficits in working memory exist in patients with OCD, and if so the specificity of these deficits. Second, this thesis will assess the personality traits of OCD patients using a measure of the FFM. In order to investigate working memory and personality traits, OCD patients will be directly compared to healthy controls, panic disorder patients and sub-clinical OC subjects.

Specifically, the thesis will investigate the ability of OCD patients to process visual information that is either easy- or difficult-to-verbally label. The aim is to establish whether the ability to verbally rehearse stimuli aids the performance of OCD patients on test of working memory; and whether the requirement to maintain visual representations of task stimuli leads to poorer performance in OCD patients. The OCD patients will be compared to healthy control subjects, patients with panic disorder and sub-clinical OC subjects.

The thesis will also investigate the ability of OCD patients to update and temporally order information in working memory. The aim is to establish whether the requirement to organise and manipulate information in working memory results in poorer performance in OCD in comparison to healthy controls, panic disorder patients and sub-clinical OC subjects.

Finally, the thesis will use the NEO PI-R to examine the relationship between OCD and the FFM in comparison to healthy controls, patients with panic disorder and sub-clinical OC subjects.

6.2.1 Cognitive task performance

The results from a number of neuropsychological studies suggest that there is a deficit in OCD related to maintaining visual representations of stimuli 'on line', and organising and manipulating information in working memory (Purcell et al., 1998a, 1998b; Savage et al., 1999; Savage et al., 2000). This thesis aims to explore the idea suggested by Purcell et al. (1998b) and Zielinski et al. (1991) that cognitive task performance is aided by the use of verbal mediation; the idea posited by Purcell et al. (1998b) that the use of visual representations of stimuli leads to poorer performance in patients with OCD; and the idea that there is a deficit in the 'strategic' aspects of memory processing in OCD (Savage et al., 1999). This thesis will also examine working memory performance in OCD as a function of task difficulty. Variants of two different working memory tasks will be used in this thesis – a delayed-matching-to-sample (DMS) task and a continuous performance working memory task (n-back task). These are the two most common tasks used in neuroimaging studies of working memory. They are well-validated measures of working memory and are associated with substantial imaging data (Wager & Smith, 2003).

To investigate whether the use of verbal mediation aids performance on working memory tasks in patients with OCD, and whether the use of visual representations of stimuli is problematic, participants will be administered three DMS tasks. The DMS task involves studying a memory set, actively maintaining the items during a delay, and responding to a probe item. The subject must determine whether the probe item was a member of the memory set (Wager & Smith, 2003). In this thesis, the stimuli used in the DMS tasks will be difficult-to-label objects (irregular), easy-to-label-objects (geometric), and spatial locations. Each task will be comprised of low and high demand trials, and perception and memory trials.

The thesis will directly compare the performance of the OCD patients on the DMS tasks with healthy control subjects, patients with panic disorder and sub-clinical OC subjects. It is expected that the OCD patients will perform more poorly than the healthy control subjects on the DMS tasks which do not permit verbal mediation (irregular objects, spatial locations), particularly on the high demand trials and the memory trials. It is expected that the OCD patients will be equivalent to the healthy control subjects on the perception and low demand trials. Given the lack of evidence for nonverbal memory impairment in panic disorder, it is

expected that the OCD patients will perform more poorly than these subjects on the DMS tasks that do not permit verbal mediation. It is expected that the performance of the OCD patients on the DMS tasks which do not permit verbal mediation will be equivalent to the sub-clinical OC subjects given the evidence that sub-clinical OC subjects show similar cognitive deficits to those observed in OCD. It is expected that the OCD patients will perform as well as healthy controls, panic disorder and sub-clinical OC subjects on the DMS task which permits verbal mediation (geometric objects).

The thesis also assesses whether patients with OCD, when compared to clinical and healthy control subjects, show impaired performance on working memory tasks requiring strategic memory processes such as organising and manipulating information. To test this, participants will complete a verbal and a spatial version of the n-back task. The n-back task involves viewing a continuous stream of items and deciding whether each item matches the stimulus presented *n* items back. The n-back task requires both continuous updating and memory for order (Wager & Smith, 2003). The n-back tasks are comprised of four separate components, each one increasing in difficulty. The 0-back and 1-back versions of the task are considered low working memory load. The 2-back and 3-back versions are considered high working memory load. The 2-back and 3-back trials involve executive processes (temporal coding) as well as active maintenance of verbal and spatial material (Smith & Jonides, 1999). The present thesis will directly compare the performance of the OCD patients with panic disorder, healthy controls and a sub-clinical OC group. Given the evidence that organising and manipulating information in working memory is impaired in OCD patients, it is expected that the OCD patients will perform more poorly than the healthy control subjects on the high working memory load versions of the n-back tasks (2-back and 3-back) where they are required to update and temporally order stimuli in working memory. It is expected that the OCD patients will demonstrate equivalent performance on the low working memory demand versions of the n-back task (0-back and 1-back). As there is little evidence for working memory impairments in panic disorder, it is also expected that the OCD patients will perform more poorly than these subjects on the high working memory load versions of the n-back tasks (2-back and 3-back). It is expected that the performance of the OCD patients on the n-back tasks will be equivalent to the sub-clinical OC subjects given the evidence that sub-clinical OC samples also show a deficit in the ability to manipulate information in working memory.

Measures of reaction time will also be recorded for each of the cognitive tasks. Martin et al. (1995) have suggested that OCD patients only tend to perform more slowly than control subjects on open-ended tasks, and when time constraints are placed on them, they perform at the normal rate. For example, Krikorian, Zimmerman and Fleck (2004) examined the performance of OCD patients on a sequential letter stop-signal task. In this study subjects were required to respond to briefly presented stimuli as quickly as possible. The reaction times of the OCD patients were no different to the control subjects. Roth et al. (2004) also reported that

OCD patients were not impaired on timed neuropsychological tasks. As there are time limits on each of the working memory tasks performed in this thesis, it is anticipated that OCD patients will record similar reaction times to the healthy controls, panic disorder and sub-clinical OC subjects.

The thesis will also investigate whether the performance of OCD patients on the working memory tasks is influenced by clinical state. A number of studies have found no correlation between symptom severity measures and cognitive task performance (Purcell et al., 1998b; Schmidtke et al., 1998; Kivircik et al., 2003; Moritz et al., 2003). The absence of significant correlations between clinical OCD severity and scores on neuropsychological tasks suggests that the neuropsychological profiles of the OCD patients may be reflective of 'trait' conditions of the disorder rather than a 'state' of the illness (Cavedini et al., 2001). It is anticipated that working memory performance will not be affected by the clinical state of the OCD patients.

The thesis will also investigate whether the performance of the OCD patients on the working memory tasks is influenced by medication status. Mataix-Cols et al. (2002) found that medication status did not affect performance on tests of working memory. It is anticipated that the medications status of the OCD patients will not affect performance on the working memory tasks.

This thesis will also investigate whether performance on the working memory tasks is influenced by symptom subtype. It has been suggested that certain OCD subtypes may be disadvantaged over and above other subtypes on particular tasks. For example, obsessionals may be more disadvantaged than washers on tasks requiring online cognitive management of complex information (e.g., working memory) (McKay et al., 2004). Given the relatively small sample of OCD patients in this study, a dimensional approach (scores on the subscales of the Padua Inventory [PI] will be correlated with working memory performance), rather than a categorical approach, will be used to assess the influence of symptom subtype on working memory performance. Very few studies that have examined the influence of OCD subtypes on neuropsychological performance using a dimensional approach. Mataix-Cols et al. (1999) found that poorer performance on a planning task was positively correlated with scores on the checking scale of the PI in a subclinical sample. Given the lack of previous research in this area, this investigation will be exploratory and, therefore, no specific hypotheses have been generated.

6.2.2 Personality

The thesis will investigate the personality traits of individuals with OCD and compare these responses to patients with panic disorder, healthy controls and a sub-clinical OC group on a measure of the FFM. No study has previously examined these relationships simultaneously. To test this, participants will complete the Revised NEO Personality Inventory (NEO PI-R). Few

studies have investigated the FFM in OCD and other anxiety disorders. Those that have examined the FFM in OCD and other anxiety disorders in comparison to control groups, have found that OCD and panic disorder patients report higher scores on the domain of Neuroticism (Bienvenu et al., 2001, 2004; Samuels et al., 2000; Leong, 2003), higher scores on the facets of Neuroticism (Bienvenu et al., 2001, 2004; Samuels et al., 2000; Leong, 2003) and lower scores on the domain of Extraversion and some of its facets (Bienvenu et al., 2001, 2004; Samuels et al., 2000; Leong, 2003). OCD is also associated with higher scores on the domain of Openness (Bienvenu et al., 2004), higher scores on the Openness facets of fantasy and feelings, lower scores on the Openness facet of actions, and higher scores on the Agreeableness facets of modesty, straightforwardness and tendermindedness (Samuels et al., 2000). Panic disorder patients also score lower on the Agreeableness facets of trust and compliance (Bienvenu et al., 2001). OCD and panic disorder patients also score lower on the Conscientiousness facet of competence (Samuels et al., 2000; Bienvenu et al., 2001), while OCD patients score lower on the Conscientiousness facet of self-discipline (Samuels et al., 2000; Leong, 2003).

Based on previous research, it is expected that the OCD patients will show significant differences on the domains of Neuroticism, Extraversion and Agreeableness and differences on some of the facets of Neuroticism, Extraversion, Openness, Agreeableness and Conscientiousness compared to healthy controls. Given the results of previous research on panic disorder and the FFM, it is expected that the OCD patients will resemble the panic disorder patients on the domains of Neuroticism, Extraversion, Openness and Conscientiousness and the Neuroticism, Extraversion and Conscientiousness facets of the NEO PI-R. The OCD patients should be distinguished from the panic disorder patients on the Agreeableness domain and facets, and the Openness facets of fantasy, feelings and actions. Based on previous research suggesting that sub-clinical OC subjects share similar personality features to OCD patients, it is anticipated that the personality traits of the OCD group will be no different to the sub-clinical OC group.

OCD is frequently associated with high rates of co-morbid depression and anxiety which may influence the assessment of personality traits in the disorder (Lyoo et al., 2001). There are only a few studies that have controlled for current mood when investigating personality traits in OCD (Lyoo et al., 2001; Rector et al., 2002; Leong, 2003; Fullana et al., 2004). This thesis will investigate the influence of depression and anxiety on differences between the OCD patients and the other experimental subjects on personality traits as measured by the NEO PI-R.

The thesis will also investigate which personality traits, as measured by the NEO PI-R, are the best predictors of obsessive-compulsive symptoms. Fullana et al. (2004), using the Eysenck Personality Questionnaire, found that psychoticism was the best predictor of obsessive-compulsive symptoms when comparing OCD and healthy control subjects and Neuroticism was the best predictor of obsessive-compulsive symptoms when comparing sub-clinical OC and

healthy control subjects. Lyoo et al. (2001) compared OCD patients and healthy control subjects on the Temperament and Character Inventory and found that harm avoidance and self-directedness significantly predicted the severity of obsessive-compulsive symptoms. As there is no data on the ability of the NEO PI-R to predict severity in OCD, this investigation will be purely exploratory.

6.3 Hypotheses

6.3.1 Cognitive task performance

Irregular object DMS task accuracy

The OCD patients will be no different to the sub-clinical OC subjects, but will be less accurate than the panic disorder patients and healthy controls on the high demand and memory trials of the irregular object DMS task.

The accuracy of the OCD patients will be no different to the panic disorder, sub-clinical OC and healthy control subjects on the low demand and perception trials of the irregular object DMS task.

Spatial locations DMS task accuracy

OCD patients will be no different to the sub-clinical OC subjects, but perform less accurately than panic disorder and healthy controls on the high demand and memory trials of the spatial locations DMS task.

The accuracy of the OCD patients will be no different to the panic disorder, sub-clinical OC and healthy control subjects on the low demand and perception trials of the spatial DMS task.

Geometric object DMS task accuracy

The accuracy of the OCD patients will be no different to the panic disorder patients, healthy controls and the sub-clinical OC subjects on each aspect of the geometric object DMS task.

DMS task reaction time

The reaction times of the OCD patients will be no different to the panic disorder group, healthy control group and sub-clinical OC subjects on the irregular object, geometric object and spatial locations DMS tasks.

Verbal n-back task

The accuracy of the OCD patients will be no different to the panic disorder patients, healthy control subjects and the sub-clinical OC subjects on the 0-back and 1-back versions of the verbal n-back task.

The accuracy of the OCD patients will be no different to the sub-clinical OC subjects, but lower than the panic disorder and healthy control subjects on the 2-back and 3-back versions of the verbal n-back task.

Spatial n-back task

The accuracy of the OCD patients will be no different to the panic disorder patients, healthy control subjects and the sub-clinical OC subjects on the 0-back and 1-back versions of the spatial n-back task.

The accuracy of the OCD patients will be no different to the sub-clinical OC subjects, but lower than the panic disorder and healthy control subjects on the 2-back and 3-back versions of the spatial n-back task.

N-back task reaction time

The reaction times of the OCD patients will be no different to the panic disorder group, healthy control group and sub-clinical OC subjects on the verbal and spatial n-back tasks.

Symptom severity

The performance of the OCD subjects on the DMS and n-back tasks will not be related to measures of symptom severity.

Medication status

There will be no difference between mediated and non-medicated OCD subjects on the DMS or n-back tasks.

6.3.2 Personality

Neuroticism domain

The OCD patients will score significantly higher on the domain of Neuroticism compared to the healthy control subjects. The OCD patients will score no differently on the domain of Neuroticism compared to the panic disorder and sub-clinical OC subjects.

Extraversion domain

The OCD patients will score significantly lower on the domain of Extraversion compared to the healthy control group. The OCD patients will score no differently on the domain of Extraversion compared to the panic disorder and sub-clinical OC subjects.

Openness domain

The OCD patients will score no differently on the domain of Openness compared to the healthy control subjects, panic disorder patients and sub-clinical OC subjects.

Agreeableness domain

The OCD patients will score significantly higher on the domain of Agreeableness compared to the healthy control group and the panic disorder group. The OCD patients will score no differently to the sub-clinical OC group on the domain of Agreeableness.

Conscientiousness domain

The OCD patients will score no differently on the domain of Conscientiousness compared to the healthy control subjects, panic disorder patients and sub-clinical OC subjects.

Neuroticism facets

The OCD patients will score significantly higher on all of the facets of Neuroticism compared to the healthy control subjects. The OCD patients will score no differently on the facets of Neuroticism compared to the panic disorder patients and sub-clinical OC subjects.

Extraversion facets

The OCD patients will score significantly lower on the Extraversion facets of assertiveness and activity compared to the healthy control group. The OCD patients will score no differently on the Extraversion facets compared to the panic disorder and sub-clinical OC group.

Openness facets

The OCD patients will score significantly higher on the Openness facets of fantasy and feelings but significantly lower on the Openness facet of actions compared to the healthy control subjects and the panic disorder patients. The OCD patients will score no differently on the Openness facets compared to the sub-clinical OC group.

Agreeableness facets

The OCD patients will score significantly higher on the Agreeableness facets of straightforwardness, modesty and tendermindedness compared to the healthy control group. The OCD patients will score significantly higher on the Agreeableness facets of straightforwardness, modesty, trust, compliance and tendermindedness compared to the panic disorder group. The OCD patients will score no differently to the sub-clinical OC group on the Agreeableness facets.

Conscientiousness facets

The OCD patients will score significantly lower on the Conscientiousness facets of competence and self-discipline compared to the healthy control subjects. The OCD patients will score no differently compared to the panic disorder and sub-clinical OC subjects on the facets of Conscientiousness.

CHAPTER 7: SELECTION AND DESCRIPTION OF PARTICIPANTS

7.1 Obsessive-compulsive disorder

Twenty Obsessive-compulsive disorder (OCD) patients, aged 18 to 65, were recruited from the Depression and Anxiety Research and Treatment Program (DART) at the Royal Melbourne Hospital, the Rural Mental Health Network (Bendigo; Castlemaine; Echuca; Kyneton; Swan Hill), the Anxiety Day Treatment Program (ADTP) at the Melbourne Clinic, the Obsessive Compulsive and Anxiety Disorders Foundation (OCADF) and private practice. Inclusion criteria was a primary diagnosis of OCD according to *DSM-IV* (APA, 1994) criteria. Subjects were diagnosed by their treating psychologist or psychiatrist and diagnosis was confirmed by the investigator using the Composite International Diagnostic Interview, 2.1 (CIDI-Auto; World Health Organisation (WHO), 1997). Subjects were either referred by their treating clinician or responded to advertisements placed in waiting rooms, the OCADF newsletter or local papers.

Exclusion criteria was a co-morbid axis I diagnosis of bipolar disorder, panic disorder, or social phobia, a delusional or psychotic disorder, a current diagnosis of substance dependence, a history of major head injury, brain tumour, a neurological disorder, or an estimated IQ below 70. Subjects had their depressive and anxiety symptoms measured using the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) and the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970) respectively. OCD patients also completed the Padua Inventory (PI; Sanavio, 1988) as a self-rated measure of the disturbance caused by their obsessive-compulsive behaviour. Estimated IQ and handedness were measured using the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) and the Edinburgh Inventory (Oldfield, 1971) respectively. The OCD patients also completed the self-report version of the Yale-Brown Obsessive-Compulsive Scale and the Symptom Checklist (Y-BOCS; Goodman et al., 1989b) to assess current and past symptom endorsement and to measure the severity of their obsessive-compulsive symptoms. Table 5 outlines the frequency of current and past symptom endorsement on the Y-BOCS checklist for the OCD patients.

Given the high prevalence of co-morbid Major Depression (MD) in OCD, patients with secondary MD were not excluded from the thesis to ensure that an adequate sample size was obtained. The number of patients in the present thesis with secondary MD following OCD was six (30%). Two (10%) of the OCD patients also had co-morbid specific phobia, one (5%) had co-morbid dysthymia and one (5%) had co-morbid generalised anxiety disorder. Eight (40%) of the OCD patients were medicated at the time of testing. Six (30%) were taking selective serotonin reuptake inhibitors (SSRIs) and two (10%) were taking tricyclic antidepressants.

Table 5

Frequencies of current and past symptom endorsement on the Y-BOCS symptom checklist for OCD patients

	No. (%) patients	
	Current Symptom	*Past Symptom*
Obsessions		
Aggressive	14 (70)	14 (70)
Contamination	10 (50)	11 (55)
Sexual	2 (10)	3 (15)
Hoarding	5 (25)	6 (30)
Religious	9 (45)	10 (50)
Symmetry	6 (30)	7 (35)
Miscellaneous	16 (80)	16 (80)
Somatic	8 (40)	10 (50)
Compulsions		
Washing	9 (45)	9 (45)
Checking	13 (65)	13 (65)
Repeating	10 (50)	8 (40)
Counting	7 (35)	7(35)
Ordering	6 (30)	6 (30)
Hoarding	4 (20)	6 (30)
Miscellaneous	11 (55)	11 (55)

7.2 Clinical controls

Panic disorder was selected as the clinical control group for convenience (this disorder was the most prevalent anxiety disorder presenting for treatment at the clinics where recruitment took place) and because it has the anxiety symptoms and the avoidance (of phobic objects or situations), but does not present the core symptoms of OCD (obsessions and compulsions) (Boldrini et al., 2004). Twenty panic disorder patients, aged 18 to 65, were recruited from the DART Program at the Royal Melbourne Hospital, the Rural Mental Health Network (Bendigo; Castlemaine; Echuca; Kyneton; Swan Hill), the ADTP at the Melbourne Clinic, the OCADF and private practice. Inclusion criteria was a primary diagnosis of panic disorder according to *DSM-IV* criteria. Subjects were diagnosed by their treating psychologist or psychiatrist and diagnosis was confirmed by the investigator using the CIDI-Auto. Subjects were either referred by their treating clinician or responded to advertisements placed in waiting rooms, the OCADF newsletter or local papers.

Exclusion criteria was a co-morbid OCD diagnosis, a delusional or psychotic disorder, a current diagnosis of substance dependence, a history of major head injury, a brain tumour, a neurological disorder or an estimated IQ below 70. Panic disorder patients had their depressive, anxiety and obsessive-compulsive symptoms assessed using the BDI-II, the STAI and the PI respectively. Estimated IQ and handedness were measured using the WASI and the Edinburgh Inventory respectively.

Three (15%) of the panic disorder patients had co-morbid depression, three (15%) had co-morbid social phobia, three (15%) had co-morbid specific phobia, one (5%) had co-morbid pain disorder and one (5%) had co-morbid post-traumatic stress disorder. Twelve (60%) of the panic disorder patients were medicated at the time of testing. Seven (35%) were taking benzodiazepines, four (20%) were taking SSRIs and one (5%) was taking a selective norepinephrine reuptake inhibitor (SNRI).

7.3 Non-psychiatric controls

Forty healthy control subjects, aged 18 to 65, were recruited from the general public via newspaper advertisements and screened for the presence of Axis I disorders using the CIDI-Auto (WHO, 1997). Subjects were excluded if they had an Axis I diagnosis, a history of major head injury, brain tumour, a neurological disorder, or an estimated IQ below 70. Control subjects also had their depressive, anxiety and obsessive-compulsive symptoms assessed using the BDI-II, the STAI and the PI respectively. Estimated IQ and handedness were assessed using the WASI and the Edinburgh Inventory respectively.

There were two non-psychiatric control groups in the present thesis. A sub-clinical OC group and a non-clinical control group. Sub-clinical OC samples can be defined in two ways: firstly, as a sample consisting of individuals who posses a particular type of psychological difficulty but whose symptomatology falls below the threshold for a *DSM-IV* diagnosis (i.e. scores highly on a self-report measure of obsessive-compulsive symptoms); secondly, as individuals in the general population who qualify for a *DSM-IV* diagnosis but are not seeking treatment for the disorder (i.e. subjects who meet criteria for OCD in population-based epidemiological studies) (Gibbs, 1996). The first definition was used in the present thesis.

Control subjects were classified as either high or low on obsessive-compulsiveness based on their scores on the PI. In the present thesis, a 'liberal' cut-off point was used to facilitate the recruitment of a sufficient sample size. Subjects with scores greater than 25 on the PI were assigned to the sub-clinical OC group (n = 20). Subjects with scores less than 20 were classified as non-OC and assigned to the healthy control group (n = 20). Previous research using the PI to classify subclinical OC subjects have used cut-off scores ranging from 77 to 109 to classify subclinical OC subjects and 23 to 77 to classify non-clinical control subjects (Mataix-Cols et al., 1997; Mataix-Cols et al., 1999; Mataix-Cols et al., 2000; Mataix-Cols, 2003; Fullana et al., 2004). While the cut-off score for the sub-clinical OC group was lower than most cut-offs used in previous research using sub-clinical OC samples, it was necessary to ensure an adequate sample size. Previous research has also reported that OC phenomena are dimensionally distributed in the general population and that a wide range of selection criteria can be used successfully in sub-clinical OC research (Mataix-Cols et al., 2000). Subjects assigned to the sub-clinical OC group also completed the Y-BOCS to measure the severity of their obsessive-compulsive symptoms.

7.4 Power analysis

In the present study recruitment difficulties compromised the sample size. The total sample recruited was 80. With power specified as 0.80 and a significance level of 0.05, a sample size of 80 will be able to detect moderate to large effect sizes (> 0.64). Effect sizes of this magnitude have previously been observed in OCD research using tasks assessing similar cognitive processes as the present study. A summary of these studies is included as Table 6.

Table 6
Summary of effect sizes from previous neuropsychological studies in OCD

Author	Task	Effect Size (Cohen's d)
Zielinski et al. (1991)	Corsi block task	0.70
Martinot et al. (1990)	Digit span	1.52
Singh et al. (2003)	Digits forward Cube test	0.55 1.22
van der Wee et al. (2003)	Spatial n-back	1.31
Cohen et al. (1996)	Digit symbol BVRT	0.64 0.98
Abbruzzese et al. (1995a)	OAT	0.69
Moritz et al. (2003)	Corsi blocks Spatial transformation	0.81 0.99
Boldrini et al. (2004)	Corsi blocks	0.50
Jurado et al. (2002)	Temporal ordering	0.70
Head et al. (1989)	Block design	0.86
Purcell et al. (1998b)	Spatial working memory Spatial recognition DMTS	0.85 0.86 0.65
Purcell et al. (1998a)	Spatial working memory Spatial recognition DMTS	0.93 0.75 0.71

Studies assessing normal personality traits in OCD are rare and, therefore, it is difficult to estimate expected effect sizes. Table 7 is a summary of some of the effect sizes observed in the available studies.

Table 7
Summary of effect sizes from previous personality studies in OCD

Author	Measure	Personality characteristic	Effect Size (Cohen's d)
Samuels et al. (2000)	NEO PI-R	Neuroticism	1.21
Fullana et al. (2004)	EPQ	Neurotisim Extraversion Psychoticism	2.46 1.56 1.58
Cruz-Fuentes et al. (2004)	TCI	Harm avoidance Self-directedness Cooperativeness	1.37 1.25 0.69

Given that previous research has reported moderate to large effect sizes for variables similar to those being used in the present study, it is not unreasonable to expect that the current study will have sufficient power to detect differences between OCD patients and the comparison groups on the variables of interest.

CHAPTER 8: MATERIALS AND PROCEDURE

8.1 Delayed-matching-to-sample tasks

Three delayed-matching-to-sample tasks (DMS) were used to assess the effect of verbal mediation and the use of visual representations on working memory performance in the patients with OCD. The three tasks comprised easy-to-label object working memory (geometric objects), difficult-to-label object working memory (irregular objects) and spatial locations working memory versions. The DMS tasks were constructed using the computer software Pipscript (© Psychware 1991-1998).

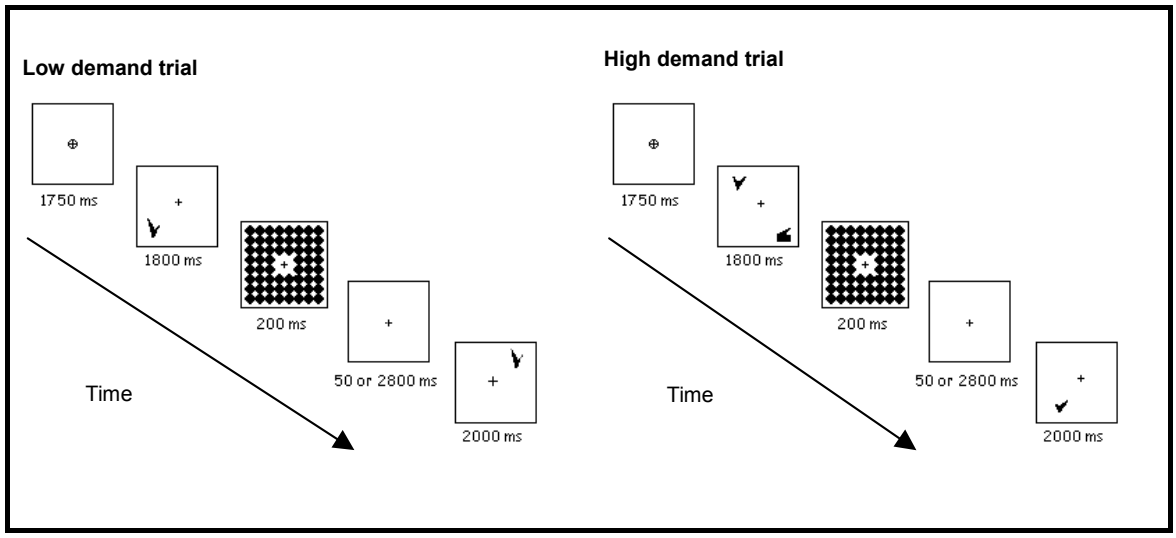
The DMS tasks used in the present thesis were modified from Smith et al. (1995) who used positron emission tomography (PET) to differentially link object and spatial working memory to distinct brain regions. In a series of experiments Smith et al. (1995) observed that the object DMS tasks primarily activated left-hemisphere regions including the inferotemporal and parietal areas, whereas the spatial task activated right hemisphere regions including the occipital, parietal and prefrontal areas. Smith et al. (1995) also found that the DMS task using easy-to-label objects also activated Broca's area, reflecting the verbal rehearsal that these objects permit. Smith and Jonides (1999) also found that the active maintenance of spatial information activates the right premotor cortex, while the active maintenance of object information activates the ventral regions of the prefrontal cortex. Spatial information is also typically represented more dorsally than object information (Smith & Jonides, 1999).

In the present thesis the trial events for each of the DMS tasks were identical, only the instructions to participants changed. Each trial consisted of an initial central fixation point for 1,750 milliseconds (ms) followed by the 1,800 ms presentation of the task stimuli. A target exposure duration of 1,800 ms was chosen given the results of a study by Postle, Jonides, Smith, Corkin and Growden (1997) that found that a clinical population (Parkinson's disease) required a mean target exposure duration of 1.8 seconds to achieve 80% accuracy on a similar DMS task. Following the task stimuli, a visual mask appeared for 200 ms to prevent an afterimage of the task stimuli from remaining on the screen. A fixation cross then appeared in the centre of the screen for the delay period. Within each condition there were two types of tests: a perceptual test and a memory test. The perceptual test involved a 250 ms delay between the offset of the target stimuli and the onset of the probe stimuli, while the memory tests involved a 3,000 ms delay. Following the delay period, a single probe stimulus appeared for 2,000 ms. Subjects responded to each trial by pushing one of two response keys with the right and left thumbs respectively. The right-hand key indicated a 'yes' response and the left-hand key a 'no' response. Each DMS task consisted of two 40-trial blocks with perceptual and memory trials randomly presented within each block. The order of the three tasks was counterbalanced within each group. Performance was recorded as percentage of correct responses (accuracy) and the time (in ms) taken to respond (reaction time).

8.1.1 Irregular object DMS task

In the irregular object DMS task, subjects judged whether the probe shape matched (or mismatched) any of the target shapes. Targets were approximately 1° in horizontal and visual angle and located at random points within a 4.96° radius of the centre of the screen. Within the irregular object DMS task there were two levels of working memory demand. In the low demand condition, the subjects were required to remember one irregular object. In the high demand condition, the subjects were required to remember two irregular objects. Irregular polygons were used in this task to minimise verbal strategies (Attneave & Arnoult, 1956; Vanderplas & Garvin, 1959). The trial events of the irregular object DMS task are depicted in Figure 1.

Figure 1
Irregular object DMS task trial events

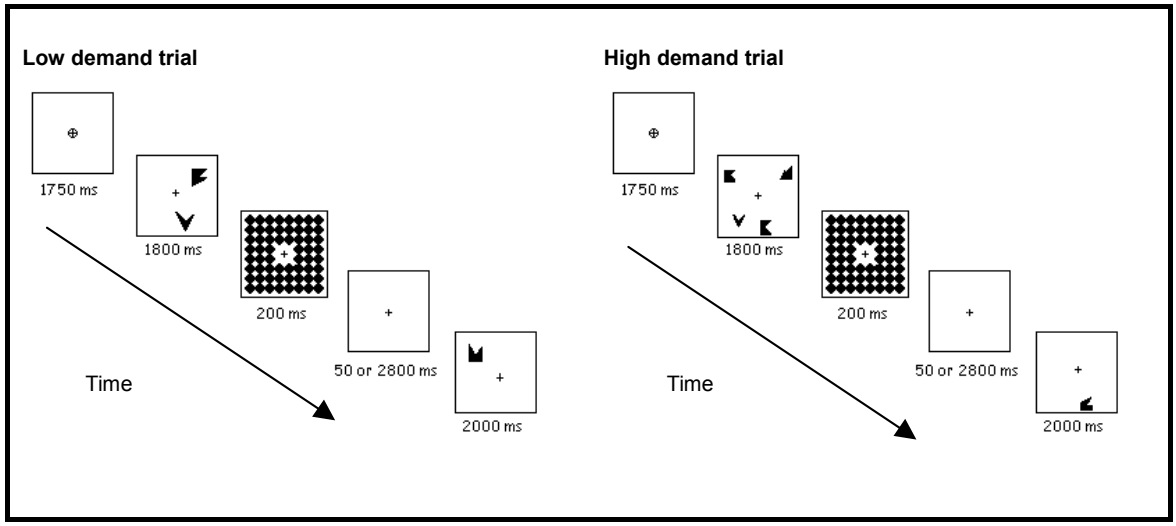


8.1.2 Spatial locations DMS task

In the spatial locations DMS task, subjects were instructed to judge whether the probe location matched (or mismatched) any of the target locations. Targets were approximately 1° in horizontal and visual angle and located at random points within a 4.96° radius of the centre of the screen. Within the spatial locations DMS task there were two levels of working memory demand. In the low demand condition, the subjects were required to remember two locations. In the high demand condition, the subjects were required to remember four locations. The trial events of the spatial locations DMS task are depicted in Figure 2.

Figure 2

Spatial locations DMS task trial events

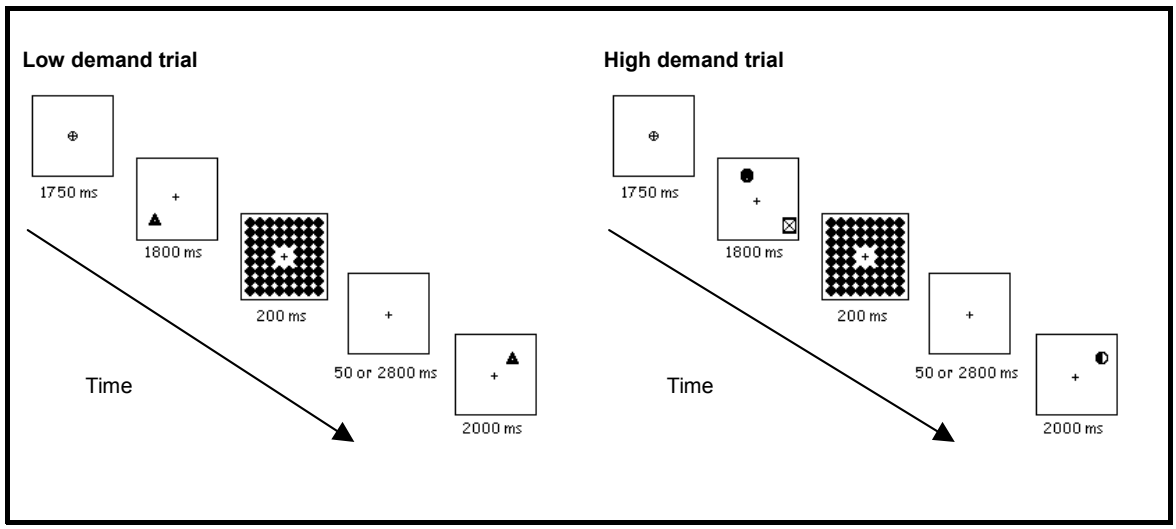


8.1.3 Geometric object DMS task

In the geometric object DMS task, subjects judged whether the probe shape matched (or mismatched) any of the target shapes. Targets were approximately 1° in horizontal and visual angle and located at random points within a 4.96° radius of the centre of the screen. Within the geometric object DMS task there were two levels of working memory demand. In the low demand condition, the subjects were required to remember one geometric object. In the high demand condition, the subjects were required to remember two geometric objects. The objects were geometric figures constructed so that each consisted of a geometric shape with a second shape embedded in it. The stimuli were based on shapes used by Smith et al. (1995) that were shown to permit verbal descriptions. The trial events of the geometric object DMS task are depicted in Figure 3.

Figure 3

Geometric object DMS task trial events



8.2 N-back task

To test the ability of the OCD patients to organise and manipulate information in working memory, subjects completed two n-back tasks as a measure of continuous performance working memory. As distinct from the DMS tasks, which are comprised of a series of discrete trials, the n-back task involves the presentation of a continuous stream of single letters requiring subjects to continually update their mental set while responding to previously seen stimuli (Callicott et al., 1999). 'n-back' refers to how far back in the sequence of stimuli the subject has to recall. The n-back task involves both continuous updating and memory for order (Wager & Smith, 2003). As with the DMS tasks, the n-back tasks were constructed using the computer software Pipscript (© Psychware 1991-1998).

The n-back tasks were modified from Smith and Jonides (1997) who used PET to link verbal and spatial working memory to distinct brain regions. The present thesis used two versions of the n-back task: a verbal version and a spatial version. Both versions used the same stimuli; only the instructions to the subjects varied between conditions. In the verbal condition, subjects were required to compare the verbal identity of the presented letters. In the spatial condition, participants were required to compare the location of the presented letters. A PET study by Smith and Jonides (1997) found that the verbal n-back task increased activation in the premotor and supplementary motor areas, Broca's area, the posterior parietal lobe and the dorsolateral prefrontal cortex. In contrast, spatial working memory primarily activated the prefrontal, parietal and occipital areas in the right hemisphere. Studies have also found that, among the frontal regions of the brain, the bilateral superior frontal sulcus and the dorsolateral prefrontal cortex show specialisation for continuous updating and temporal order memory (Smith & Jonides, 1999; Wager & Smith, 2003).

In the present thesis, subjects were presented with a series of single letters presented one at a time for a period of 1,000 ms. The letters were approximately 1° in horizontal and visual angle and located at random points within a 4.96° radius of the centre of the screen. There was a 2,000 ms interval between successive letters. The location and identity of the letters varied and the dimension that the subject attended to depended on the instructions. In the verbal condition, a 'yes' response was required (pressing right button on a response-box with right thumb) if the verbal identity of the presented letter matched the verbal identity of the letter presented *n* trials back, regardless of the letter case (i.e. upper versus lower). Otherwise, a 'no' response was required (pressing a left button with left thumb). In the spatial condition, a 'yes' response was required if the location of the presented letter matched the location of the letter *n* trials back. Otherwise, a 'no' response was required. Letters were pseudo randomly presented for the set A, a, B, b, D, d, E, e, F, f, G, g, H, h, M, m, N, n, Q, q, R, r. The mixing of cases in the verbal n-back task is intended to encourage subjects to encode and rehearse letter stimuli as verbal phonemes, instead of visual letter forms (Nystrom, Braver, Sabb, Delgado, Noll &

Cohen, 2000). A central fixation cross was presented 2,000 ms before and remained during the presentation of the letter. There were a total of 76 presentations per trial.

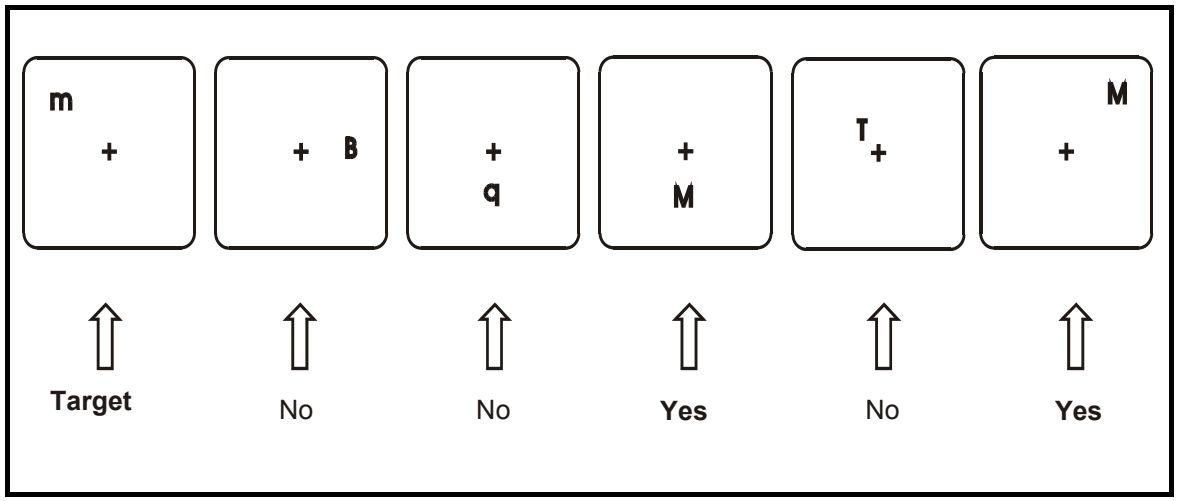
The n-back task has varying working memory load conditions. The 0-back and 1-back conditions are considered low working memory load. The 2-back and 3-back conditions are considered high working memory load task conditions. The 2-back and 3-back portions of the n-back task differ from the DMS paradigm in that they require coding the stored letters with respect to their temporal position, and constantly changing these temporal codes as new letters are presented. The n-back tasks, therefore, require subjects to perform computations on information stored in working memory (Smith & Jonides, 1997). Performance was recorded as percentage of correct responses (accuracy) and the time (in ms) taken to respond (reaction time).

8.2.1 Verbal n-back task

Verbal 0-back

In the verbal 0-back task, the first letter that appeared on the screen became the target letter for the rest of that series of letters. A 'yes' response was required (pressing the right button on the response-box with the right thumb) when the verbal identity of the presented letter matched the verbal identity of the letter initially presented. If the presented letter did not match the verbal identity of the first letter presented in the sequence, then a 'no' response was required (pressing the left button on the response-box with the left thumb). The trial events for the verbal 0-back task are displayed in Figure 4.

Figure 4
Verbal 0-back task trial events

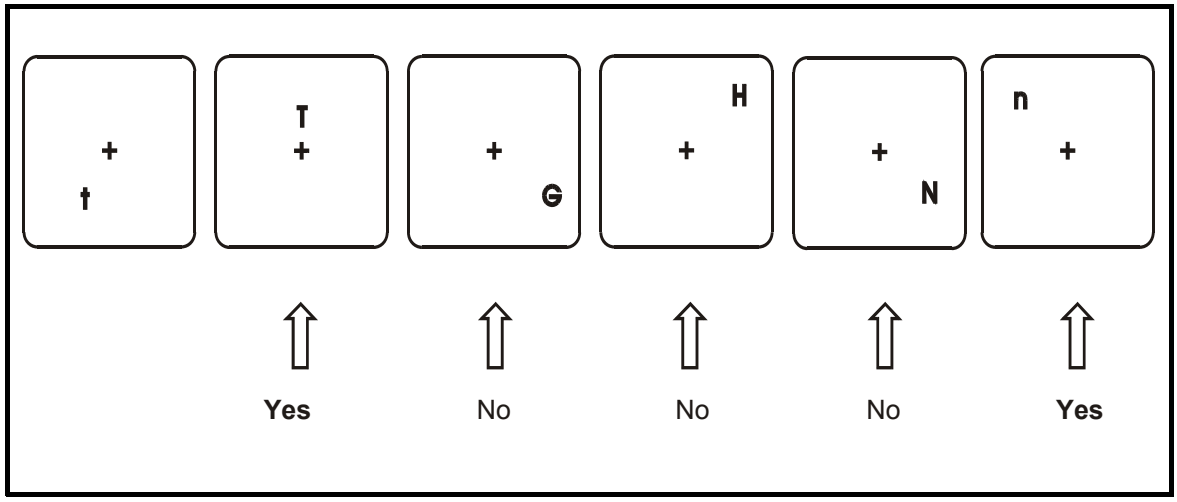


Verbal 1-back

In the verbal 1-back task, a 'yes' response was required (pressing the right button on the response-box with the right thumb) if the verbal identity of the presented letter matched the

verbal identity of the letter presented one trial back, regardless of the letter case (i.e. upper versus lower case). If the presented letter did not match the verbal identity of the letter presented one back in the sequence, then a 'no' response was required (pressing the left button on the response-box with the left thumb). The trial events for the verbal 1-back task are displayed in Figure 5.

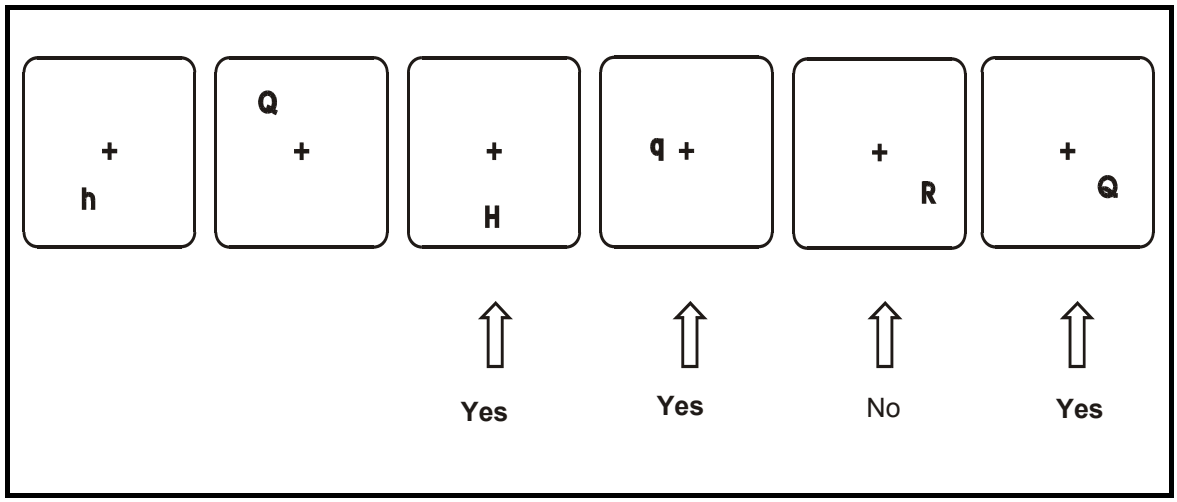
Figure 5
Verbal 1-back task trial events



Verbal 2-back

In the verbal 2-back task, a 'yes' response was required (pressing the right button on the response-box with the right thumb) if the verbal identity of the presented letter matched the verbal identity of the letter presented two trials back, regardless of the letter case (i.e. upper versus lower case). If the presented letter did not match the verbal identity of the letter presented two back in the sequence, then a 'no' response was required (pressing the left button on the response-box with the left thumb). The trial events for the verbal 2-back task are displayed in Figure 6.

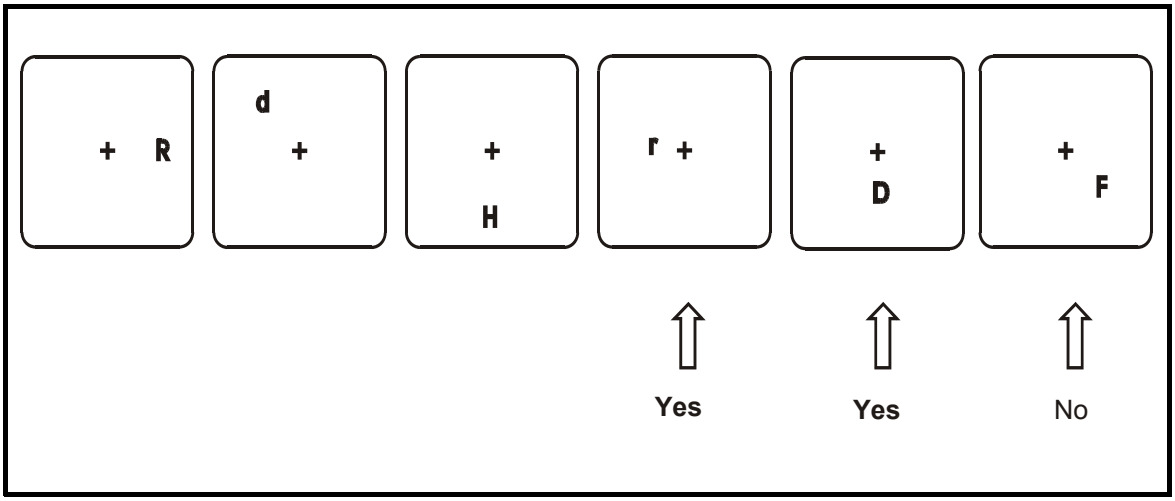
Figure 6
Verbal 2-back task trial events



Verbal 3-back

In the verbal 3-back task, a 'yes' response was required (pressing the right button on the response-box with the right thumb) if the verbal identity of the presented letter matched the verbal identity of the letter presented three trials back, regardless of the letter case (i.e. upper versus lower case). If the presented letter did not match the verbal identity of the letter presented three back in the sequence, then a 'no' response was required (pressing the left button on the response-box with the left thumb). The trial events for the verbal 3-back task are displayed in Figure 7.

Figure 7
Verbal 3-back task trial events

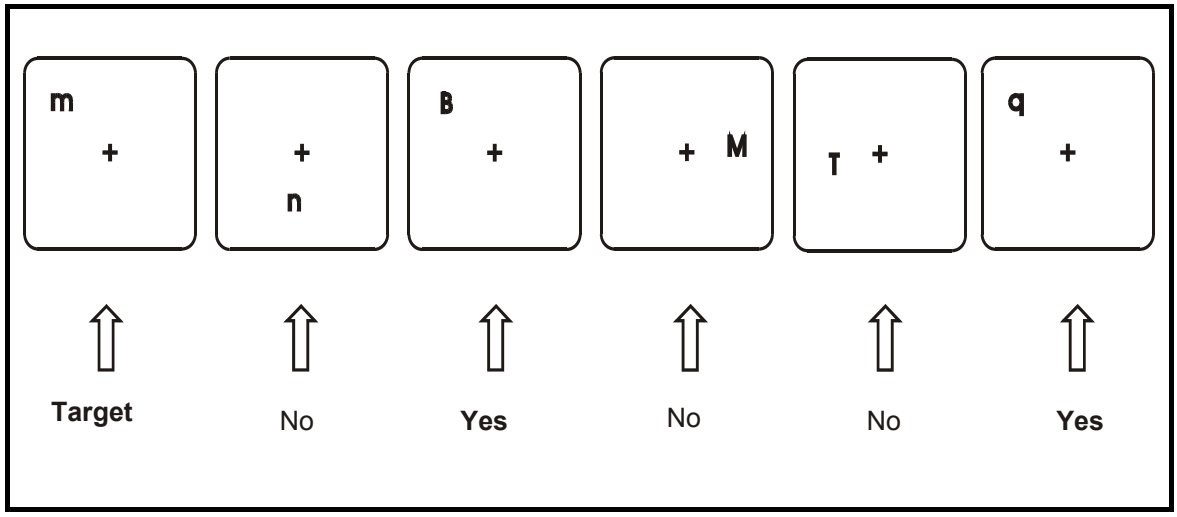


8.2.2 Spatial n-back task

Spatial 0-back

In the spatial 0-back task, the first location that appeared on the screen became the target location for the rest of that series of letters. A 'yes' response was required (pressing the right button on the response-box with the right thumb) when the spatial location of the presented letter matched the spatial location of the letter initially presented. If the presented letter did not match the spatial location of the first letter presented in the sequence, then a 'no' response was required (pressing the left button on the response-box with the left thumb). The trial events for the spatial 0-back task are displayed in Figure 8.

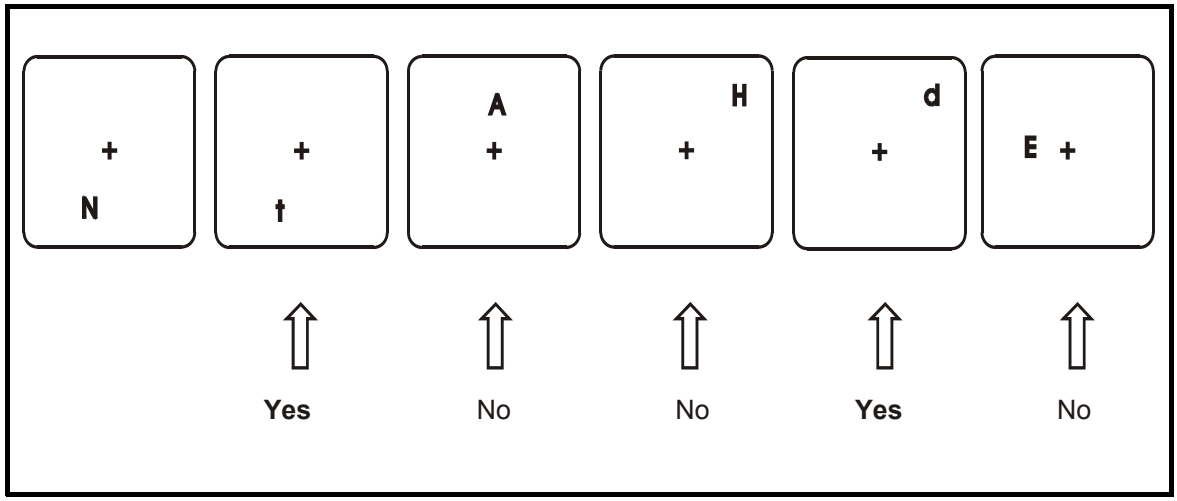
Figure 8
Spatial 0-back task trial events



Spatial 1-back

In the spatial 1-back task, a 'yes' response was required (pressing the right button on the response-box with the right thumb) if the spatial location of the presented letter matched the spatial location of the letter presented one trial back, regardless of the letter case (i.e. upper versus lower case). If the presented location did not match the spatial location of the letter presented one back in the sequence, then a 'no' response was required (pressing the left button on the response-box with the left thumb). The trial events for the spatial 1-back task are displayed in Figure 9.

Figure 9
Spatial 1-back task trial events

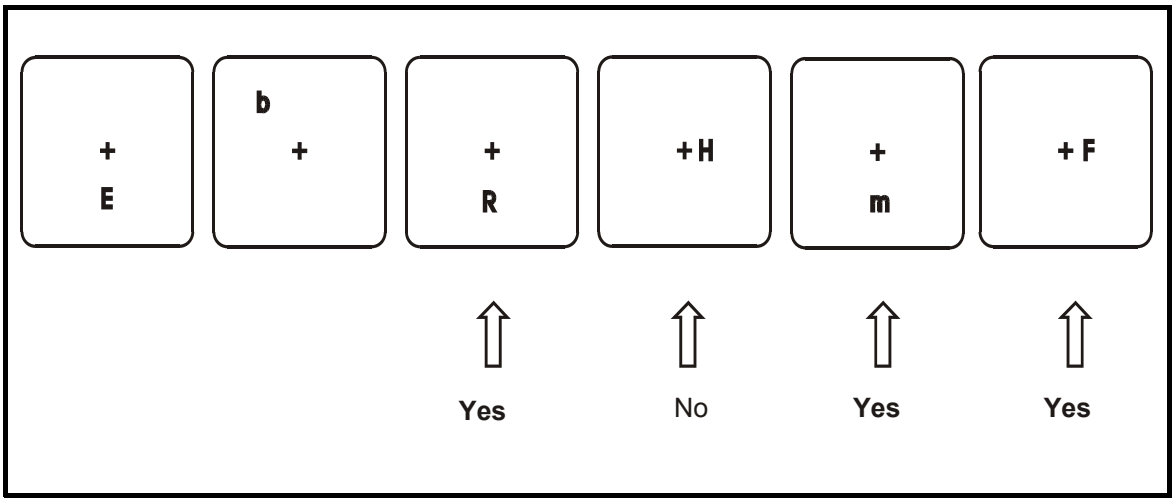


Spatial 2-back

In the spatial 2-back task, a 'yes' response was required (pressing the right button on the response-box with the right thumb) if the spatial location of the presented letter matched the spatial location of the letter presented two trials back, regardless of the letter case (i.e. upper

versus lower case). If the presented location did not match the spatial location of the letter presented two trials back in the sequence, then a 'no' response was required (pressing the left button on the response-box with the left thumb). The trial events for the spatial 2-back task are displayed in Figure 10.

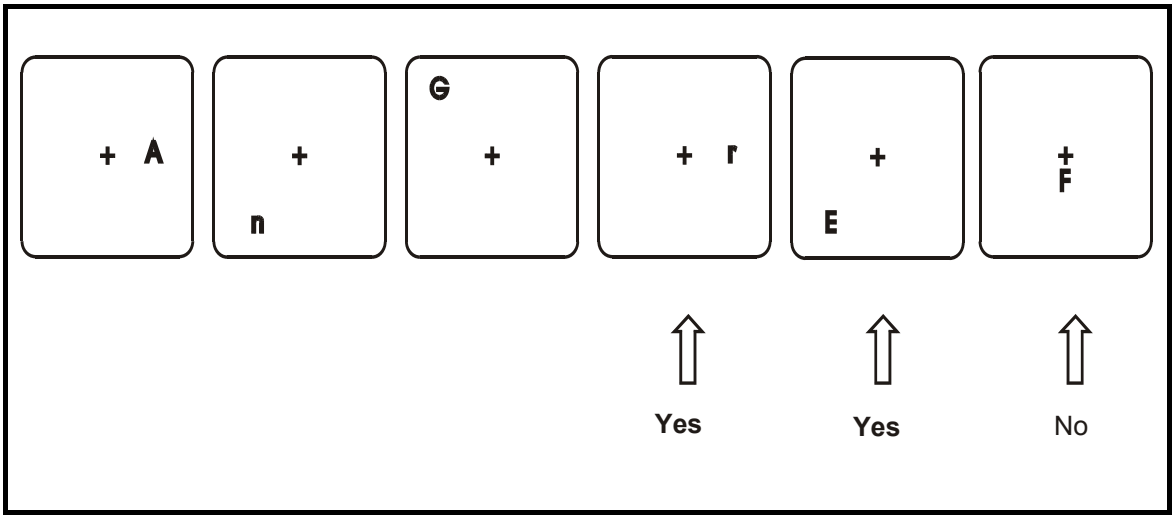
Figure 10
Spatial 2-back task trial events



Spatial 3-back

In the spatial 3-back task, a 'yes' response was required (pressing the right button on the response-box with the right thumb) if the spatial location of the presented letter matched the spatial location of the letter presented three trials back, regardless of the letter case (i.e. upper versus lower case). If the presented location did not match the spatial location of the letter presented three trials back in the sequence, then a 'no' response was required (pressing the left button on the response-box with the left thumb). The trial events for the spatial 3-back task are displayed in Figure 11.

Figure 11
Spatial 3-back task trial events



8.3 Wechsler Abbreviated Scale of Intelligence

To estimate the intelligence of the experimental groups subjects completed the two subtest version (FSIQ-2) of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999). The WASI is a short and reliable measure of intelligence for use in clinical and research settings. The WASI is individually administered and yields the three traditional Verbal, Performance, and Full Scale IQ scores (Wechsler, 1999).

The WASI consists of four subtests: Vocabulary, Block Design, Similarities, and Matrix Reasoning. These subtests are similar in format to their WISC-III and WAIS-III counterparts and are the subtests with the highest loadings on *g*, or general intellectual functioning. Administration of all four subtests is a means of quickly estimating an individual's verbal (VIQ), nonverbal (PIQ) and general cognitive functioning (FSIQ-4) in approximately 30 minutes. Only two subtests of the WASI - Vocabulary and Matrix Reasoning - are needed for estimating general cognitive functioning (FSIQ-2) in 15 minutes or less (Wechsler, 1999).

The average reliability coefficients calculated with an adult sample are 0.96, 0.96, and 0.98 for the VIQ, PIQ, and FSIQ-4, respectively. The reliability coefficients of the FSIQ-2 range from 0.93 to 0.98, with an average of 0.96. WASI scores possess adequate stability across time for all age bands. For the adult sample, the average stability coefficients range from 0.79 to 0.90 for the subtests and from 0.87 to 0.92 for the IQ scales. The stability coefficient for the FSIQ-2 in the adult sample is 0.88 (Wechsler, 1999).

8.4 Edinburgh Inventory

Subjects completed the Edinburgh Inventory (Oldfield, 1971) as a measure of handedness. The Edinburgh Inventory is used as a substitute for observing handedness in the performance of everyday tasks. The 22-item questionnaire is a simple and brief method of assessing handedness on a quantitative scale. The questionnaire assesses handedness by asking subjects to indicate their preference in the use of hands in a number of tasks (e.g. writing, throwing, using a comb) (Oldfield, 1971).

8.5 Beck Depression inventory-II

The Beck Depression Inventory-second edition (BDI-II; Beck et al., 1996) was used to measure the severity of depressive symptoms in the experimental subjects. The BDI-II is a 21-item self-report instrument for measuring the severity of depression in adults and adolescents aged 13 years or older. The 21 items cover depressive behaviours such as sleep disturbance and guilt feelings. The sum of item scores ranges from 0 to 63. Depressive symptoms are considered 'minimal' in the range 0 to 13. Scores between 14 and 19 represent 'mild' depression, scores between 20 and 28 represent 'moderate' depression and scores between 29 and 63 represent 'severe' depression (Beck et al., 1996).

The BDI-II has demonstrated excellent test-retest correlations of 0.93 ($p < .001$). The BDI-II also has excellent internal consistency. In a sample of psychiatric outpatients the BDI-II had an alpha coefficient of 0.93, and in a sample of college students an alpha of 0.92 (Beck et al., 1996). In terms of convergent and discriminant validity, the BDI-II correlates more positively with the Hamilton Psychiatric Rating Scale for Depression (Hamilton, 1960) ($r = 0.71$) than the Hamilton Rating Scale for Anxiety (Hamilton, 1959) ($r = 0.47$) (Beck et al., 1996).

8.6 Speilberger State-Trait Anxiety Scale

To measure state and trait anxiety symptoms, experimental subjects completed the Speilberger State-Trait Inventory (STAI; Spielberger et al., 1970). The STAI is comprised of separate self-report scales for measuring two distinct anxiety concepts: state anxiety (STAI-S) and trait anxiety (STAI-T). The STAI-T scale consists of 20 statements that ask people to describe general anxiety symptoms. The STAI-S scale also consists of 20 statements, but the instructions require subjects to indicate how they feel at a particular moment in time.

The test-retest correlations for the STAI-T scale are reasonable (ranging from 0.73 to 0.86). The test-retest correlation's for the STAI-S are relatively low (ranging from 0.16 to 0.54). However, low correlations for the STAI-S scale are to be expected because a valid measure of state anxiety should reflect the influence of unique situational factors existing at the time of testing (Spielberger et al., 1970). The internal consistency of both STAI subscales is reasonably good (ranging from 0.83 to 0.92). In studies of validity, the STAI-S scale has shown moderate to high concurrent validity with the Institute for Personality and Ability Testing Anxiety Scale (Cattell & Scheier, 1963), the Taylor Manifest Anxiety Scale (Taylor, 1953), and the Zuckerman Affective Adjective Checklist (Zuckerman, 1960) (Spielberger et al., 1970).

8.7 Padua Inventory

To assess obsessive-compulsive behaviour in all four experimental groups, the Padua Inventory (PI; Sanavio, 1988) was administered. The PI is a 60-item self-report measure that describes common obsessional and compulsive behaviour. Each item is rated on a 0 to 4 scale regarding degree of disturbance: 0 indicates that the item is not at all disturbing while 4 indicates that it is very much disturbing (Sanavio, 1988). Factor analyses of the PI items have consistently identified four subscales of Impaired Mental Control, Contamination, Checking and Urges (Kyrios et al., 1996; Sanavio, 1988; Sternberger & Burns, 1991; van Oppen, 1992). The four subscales recommended by Sanavio (1988) were used in the present study.

The PI has demonstrated satisfactory internal consistency (0.90 in males, 0.94 in females) and test-retest reliability (0.78 for males, 0.83 for females). The PI correlates with the Maudsley Obsessional-Compulsive Questionnaire (Hodgson & Rachman, 1977) (0.70), Leyton Obsessional-Compulsive Inventory (Cooper, 1970) (0.71 with symptom scales and 0.66 with

trait scales) and the self-rating obsessional scale (Sandler & Hazari, 1960) (0.61). The PI has also shown discrimination between outpatients with OCD and similar outpatients with other neurotic disorders (Sanavio, 1988).

8.8 Yale-Brown Obsessive-Compulsive Scale and Symptom Checklist

The self-report Yale-Brown Obsessive-Compulsive Scale and the Symptom Checklist (Y-BOCS; Goodman et al., 1989b) was used to measure the severity of obsessive-compulsive symptoms in the OCD and sub-clinical OC subjects. The Y-BOCS is a 10-item self-report scale, each item rated from 0 (no symptoms) to 4 (extreme symptoms). For all items, a higher numerical score corresponds to greater illness severity. The total Y-BOCS score is the sum of items 1 to 10 (range, 0 to 40). There are separate sub-totals for severity of obsessions (sum of items 1 through 5) and compulsions (sum of items 6 through 10). Symptoms are assessed with regard to how much they occupy the patient's time, interfere with normal functioning, cause subjective distress, are actively resisted by the patient, and can actually be controlled by the patient (Goodman et al., 1989b).

The Y-BOCS Symptom Checklist includes over 50 different types of obsessions and compulsions divided into 15 larger categories according to the behavioural expression (eg, washing or cleaning) or thematic content (eg, aggression or contamination) of the symptoms. The list was derived from the clinical experience of the Y-BOCS developers and from material contained in other symptom inventories (Goodman et al., 1989b).

The self-rated Y-BOCS has shown excellent internal consistency (alphas 0.84 or higher), test-retest reliability (*rs* ranging from 0.40 to 0.83) and strong convergent validity ($r = 0.75$) with the interview. The self-report also discriminates well between OCD and non-OCD patients and is useful for detecting OCD in non-clinical samples (Steketee, Frost, & Bogart, 1996).

8.9 NEO Personality Inventory - Revised

To assess the normal personality traits of the experimental groups, form S of the Revised NEO Personality Inventory (NEO PI-R; Costa & McCrae, 1992) was administered. Form S of the NEO PI-R is the self-report version of the NEO PI-R and contains 240 items answered on a 5-point Likert scale. The NEO PI-R is a concise measure of the five major dimensions of personality: Neuroticism, Extraversion, Openness, Agreeableness and Conscientiousness. Each domain is represented by six specific scales that measure facets of the domain. Neuroticism facets are anxiety, angry hostility, depression, self-consciousness, impulsiveness and vulnerability. Extraversion facets are warmth, gregariousness, assertiveness, activity, excitement-seeking and positive emotions. Openness facets are fantasy, aesthetics, feelings, actions, ideas and values. Agreeableness facets are trust, straightforwardness, altruism, compliance, modesty and tender-mindedness. Conscientiousness facets are competence, order, dutifulness, achievement-striving, self-discipline and deliberation.

In the present thesis, T-scores for the five domains and 30 facets were calculated according to the method of Costa and McCrae (1992) using different reference means and standard deviation for men and women. These distributions have a mean of 50 and a standard deviation of 10. The T-scores are considered 'average' in the range 45 to 55. Scores less than 45 are considered 'low', scores between 55 and 65 are considered 'high' and scores greater than 65 are considered 'very high'.

The internal consistency of the NEO PI-R, for the individual facet scales, ranges from 0.56 to 0.81 for the self-report version. The 48-item domain scales have alpha coefficients ranging from 0.86 to 0.95. The NEO PI-R also has good test-retest reliability with coefficients ranging from 0.68 to 0.83 for the Neuroticism, Extraversion and Openness scales, 0.63 for the Agreeableness scale and 0.79 for the Conscientiousness scale. The NEO PI-R has also demonstrated good convergent and discriminate validity with numerous other inventories (Costa & McCrae, 1992).

8.10 Computerised Composite International Diagnostic Interview 2.1

To confirm the clinical diagnosis of the OCD and panic disorder patients, and to screen for the presence of Axis I disorders in the healthy control group and the sub-clinical OC group, each subject completed the computerised version of the Composite International Diagnostic Interview version 2.1 (CIDI-Auto; WHO, 1997).

The CIDI-Auto is a comprehensive, standardised instrument for assessment of mental disorders according to the definitions and criteria of ICD-10 and DSM-IV. It is intended for use in epidemiological and cross-cultural studies as well as for clinical and research purposes (WHO, 1997). The CIDI-Auto has demonstrated good psychometric properties including good sensitivity (0.86) and acceptable specificity (0.52). The agreement between the clinical standard diagnosis and CIDI-auto diagnosis is also acceptable (73%) (Peters & Andrews, 1995).

8.11 Demographic Questionnaire

Participants completed a demographic questionnaire which gathered information regarding age, gender, medical history and medication status.

8.12 Testing Procedure

The OCD and panic disorder patients were tested at the clinic where they presented for treatment. The healthy controls and sub-clinical OC subjects were assessed at the Swinburne Centre for Neuropsychology. All assessments were completed on the same IBM compatible notebook computer using a standardised procedure. At the beginning of the first testing session, subjects were presented with the plain language statement and any questions they had regarding the testing procedure were answered. Once the subject understood the instructions

and agreed to participate they were asked to sign and date the plain language statement and an informed consent form. The clinical interview and neuropsychological assessments were completed on separate days.

In session one, each subject completed the lifetime version of the CIDI-Auto, the WASI and the demographic questionnaire. The CIDI-Auto was administered on an IBM compatible notebook computer. Administration of the CIDI-Auto was undertaken according to the standardised instructions in the interviewer's manual (WHO, 1997). After completing the CIDI-Auto the subjects performed the two subtest version of the WASI (FSIQ-2). The Vocabulary and Matrix Reasoning subtests of the WASI were administered using the standardised procedure (Wechsler, 1999). Session one lasted between 60 and 90 minutes.

The BDI-II, STAI-T, PI, Y-BOCS (for OCD and sub-clinical OC subjects) and the NEO PI-R were completed by the subjects at home. Prior to taking the questionnaires home, each subject had the questionnaires explained and any questions answered.

Subjects returned one week later to complete session two. In session two, subjects completed the STAI-S as well as the DMS tasks and the n-back tasks. The order of presentation of the cognitive tasks was counterbalanced within each experimental group.

The computerised cognitive tasks were administered on an IBM compatible laptop computer. Subjects were seated 0.60 metres from the screen. Responses to all cognitive tasks were made using a two-button response box. The cognitive tasks were explained to the subject verbally and then an example of the trial events was show on the computer screen. A printed version of the trial events was also shown to the subject to ensure that they understood the instructions. When the subject understood the requirements of the task, they completed a practice trial. If required, the subjects completed more practice trials until they were confident they understood the task instructions. For the DMS tasks, the subject completed two blocks of experimental trials for each task. The order of presentation of the DMS tasks was counterbalanced within each group. For the n-back tasks, the subjects completed one block of experimental trials for each task. The order of presentation of the n-back tasks was also counterbalanced within each group. A detailed description of the computerised testing procedure is included as Appendix A. Session two lasted between 90 and 120 minutes.

CHAPTER 9: RESULTS: DEMOGRAPHIC AND CLINICAL CHARACTERISTICS

9.1 Introduction

In this chapter, the participants are examined with respect to their demographic (age, gender, handedness and estimated IQ) and clinical characteristics (current depression, state anxiety, trait anxiety, disturbance of obsessive-compulsive symptoms and severity of obsessive-compulsive symptoms). For all analyses an alpha level of .05 was chosen for the detection of significant differences. Bonferroni corrections were not applied to the analyses to ensure that moderate effect sizes were detected and to guard against the possibility of type II error. Setting the alpha level to .01, with an expected moderate effect size (Cohen's d = 0.50), would have required at least 96 participants per group to have an 80% chance of detecting a difference in two tailed testing (Power = .80) (Devilly, 2004). A sample size of such magnitude was not achievable for this thesis. The thesis did, however, report two-tailed statistics even though the hypotheses were directional.

9.2 Demographic variables

9.2.1 Data screening

Prior to analysis, the demographic variables of age, gender, handedness and estimated IQ were examined for accuracy of data entry, missing values and fit between their distribution and the assumptions of Multivariate Analysis of Variance (MANOVA). The variables were examined separately for each of the experimental groups using the Statistica (StatSoft Inc, 2004) descriptives procedure. All variables were within range, and means and standard deviations were plausible. There were no missing values. The handedness variable did not meet the assumptions for MANOVA and was therefore examined separately using non-parametric statistics. A full description of the data screening technique employed is included as Appendix B.

9.2.2 Results

To confirm that the OCD patients did not differ from the healthy control subjects, the panic disorder patients or the sub-clinical OC subjects on the demographic characteristics of age, gender or estimated IQ, a MANOVA was conducted using three planned contrasts. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. To confirm that the experimental groups did not differ on the demographic characteristic of handedness, the non-parametric test for k independent samples, Kruskal-Wallis, and separate Mann-Whitney U tests were conducted comparing the OCD patients to each of the other experimental groups. Specifically, the tests compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. With no missing data, and no cases excluded for assumption violations, there were 20 cases in

each experimental group. Mean age, mean estimated IQ and gender ratios for the OCD, panic disorder, sub-clinical OC and healthy control subjects are displayed in Table 8.

Table 8

Demographic characteristics (age, estimated IQ, gender) of the OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 20)		panic disorder (n = 20)		sub-clinical OC (n = 20)		healthy controls (n = 20)			
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	Wilks' λ	*F*
									0.92	**0.74**
Age (years)	40.40	10.72	46.60	10.99	42.10	14.90	43.80	12.51		0.44
Estimated IQ	111.70	9.27	113.15	9.97	114.20	9.04	116.85	10.01		0.38
Gender (F:M)	16:4		15:5		15:5		17:3			0.85

When comparing OCD, panic disorder, sub-clinical OC and healthy control subjects on demographic variables, no overall multivariate effect was observed (Wilks' λ = 0.92, F[9, 180.25] = 0.74, p = .68). There were no overall group differences on measures of age (F[3, 76] = 0.91, p = .44), estimated IQ (F[3, 76] = 1.03, p = .38), or gender (F[3, 76] = 0.26, p = .85).

Planned comparisons confirmed that the OCD patients did not differ from the healthy control subjects on the demographic variables of age (t[38] = - 0.87, p = .39), estimated IQ (t[38] = - 1.70, p = .10), or gender (t[38] = 0.38, p = .71).

Similarly, the OCD patients did not differ from the panic disorder patients on measures of age (t[38] = -1.58, p = .12), estimated IQ (t[38] = - 0.48, p = .63) or gender (t[38] = - 0.38, p = .71).

There were also no differences between the OCD patients and the sub-clinical OC subjects on measures of age (t[38] = - 0.43, p = .67), estimated IQ (t[38] = - 0.83, p = .41), or gender (t[38] = - 0.38, p = .71).

Post-hoc Tukey Honestly Significantly Different (HSD) tests were performed to ensure that there were no significant differences between the other experimental groups on the demographic variables of age, gender and estimated IQ. No significant differences were observed (p > .05).

The handedness ratios for the OCD, panic disorder, sub-clinical OC and healthy control subjects are displayed in Table 9.

Table 9

Handedness ratios for the OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 20)	panic disorder (n = 20)	sub-clinical OC (n = 20)	healthy controls (n = 20)	χ^2
Hand (right: left)	18:2	17:3	18:2	19:1	1.11

There were no significant differences between the four experimental groups on the demographic variable of handedness ($\chi^2[3] = 1.11$, $p = .77$). The OCD patients did not differ on the measure of handedness when compared to the healthy control subjects ($U = 190$, $z = 0.27$, $p = .79$), the panic disorder patients ($U = 190$, $z = 0.27$, $p = .79$) or the sub-clinical OC subjects ($U = 200$, $z = 0.00$, $p = 1.00$).

Post-hoc multiple comparisons of mean ranks were performed to ensure that there were no significant differences between the other experimental groups on the demographic variable of handedness. No significant differences were observed ($p > .05$).

9.2.3 Summary

In the current thesis the four experimental groups were well matched with respect to the demographic characteristics of age, estimated IQ, gender and handedness.

9.3 Clinical characteristics

9.3.1 Data screening

Prior to analysis, BDI-II score, STAI-S score, STAI-T score, PI score and Y-BOCS score were examined for accuracy of data entry and missing values. BDI-II, STAI-S, STAI-T and PI scores were also examined to determine whether they met the assumptions of MANOVA. Y-BOCS scores were examined to determine whether they met the assumptions of one-way analysis of variance (ANOVA). The variables were examined separately for each of the experimental groups using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. There was no missing data. The BDI-II and PI variables did not meet the assumptions for MANOVA and were therefore examined separately using non-parametric statistics. With no missing data and no cases excluded for assumption violations there were 20 cases in each experimental group. A full description of the data screening technique employed is included as Appendix C.

9.3.2 Results

To determine whether the groups differed on STAI-S score and STAI-T score, a MANOVA was conducted using three planned contrasts. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. The means and

standard deviations for the STAI-S and STAI-T variables for the four experimental groups are presented in Table 10.

Table 10
Means and standard deviations for STAI-S and STAI-T scores for OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 20)		panic disorder (n = 20)		sub-clinical OC (n = 20)		healthy controls (n = 20)			
	M	SD	M	SD	M	SD	M	SD	Wilks' λ	*F*
									0.56	**8.29***
STAI-S	40.65	9.30	40.95	11.42	34.25	11.10	29.20	5.95		6.76*
STAI-T	52.15	10.43	52.25	11.42	44.05	11.58	31.40	5.76		18.99*

*Note: * p < .001,* STAI-S = State Trait Anxiety Inventory - State Form, STAI-T = State Trait Anxiety Inventory - Trait Form

Comparison of the OCD, panic disorder, sub-clinical OC and healthy control subjects on STAI-S and STAI-T scores yielded an overall multivariate effect (Wilks' λ = 0.56, F[6, 150] = 8.29, p < .001). The experimental groups differed on both STAI-S scores (F[3, 76] = 6.76, p < .001) and STAI-T scores (F[3, 76] = 18.99, p < .001).

There was an overall multivariate effect for the planned comparison between the OCD and healthy control subjects (Wilks' λ = 0.49, F[2, 75] = 18.87, p < .001). The OCD patients scored significantly higher than the healthy control subjects on both STAI-S (t[38] = 3.74, p < .001) and STAI-T scores (t[38] = 6.51, p < .001).

For the planned comparison between OCD and panic disorder patients, there was no overall multivariate effect (Wilks' λ = 0.99, F[2, 75] = 0.01, p = .99). The OCD group did not differ from the panic disorder group on STAI-S score (t[38] = 0.10, p = .92) or STAI-T score (t[38] = - 0.03, p = .98).

An overall multivariate effect was observed for the planned comparisons between the OCD and sub-clinical OC subjects on STAI-S and STAI-T scores (Wilks' λ = 0.92, F[2, 75] = 3.43, p < .05). The OCD patients scored significantly higher than the sub-clinical OC group on both STAI-S (t[38] = 2.09, p < .05) and STAI-T scores (t[38] = 2.54, p < .05).

A number of other differences between the experimental groups were observed following the post-hoc Tukey HSD tests. The healthy control subjects scored significantly lower on STAI-S than the panic disorder patients (p < .01). The healthy control subjects also scored lower on the STAI-T compared to both the panic disorder (p < .001) and the sub-clinical OC subjects (p < .01).

To investigate whether the groups differed on BDI-II score PI score, the non-parametric test for k independent samples, Kruskal-Wallis, and separate Mann-Whitney U tests were conducted comparing: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD

versus sub-clinical OC. The means and standard deviations for BDI-II and PI scores for the four experimental groups are displayed in Table 11.

Table 11
Means and standard deviations for BDI-II and PI scores for the OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 20)		panic disorder (n = 20)		sub-clinical OC (n = 20)		healthy controls (n = 20)			
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	df	χ^2
BDI-II	21.80	11.06	20.60	14.03	12.90	7.91	3.05	3.68	3	33.92*
PI	74.70	27.27	41.20	32.14	55.10	29.25	9.95	5.43	3	45.22*

*Note: * p < .001, BDI-II = Beck Depression Inventory - 2nd Edition, PI = Padua Inventory*

There were significant differences between the four experimental groups on the measures of current depression (BDI-II: $\chi^2[3] = 33.92$, $p < .001$] and disturbance of obsessive-compulsive symptoms (PI: $\chi^2[3] = 45.22$, $p < .001$].

Compared to the healthy control subjects, OCD patients scored significantly higher on the BDI-II ($U = 19.50$, $z = - 4.90$, $p < .001$) and the PI ($U = .00$, $z = - 5.41$, $p < .001$).

The OCD patients were no different to the panic disorder patients on the BDI-II ($U = 187.00$, $z = - 0.35$, $p = .74$), however, the scored significantly higher on the PI ($U = 80.50$, $z = - 3.23$, $p < .01$).

Compared to the sub-clinical OC subjects, OCD patients were significantly higher on the BDI-II ($U = 102.50$, $z = - 2.64$, $p < .01$) and the PI ($U = 116.50$, $z = - 2.26$, $p < .05$).

Post-hoc multiple comparisons of mean ranks was performed to investigate other differences between the experimental groups on the measures of BDI-II and PI. The healthy control group scored significantly lower on the BDI-II compared to the panic disorder patients ($p < .001$) and the sub-clinical C subjects ($p < .01$). The healthy control group also scored lower on the PI compared to the panic disorder ($p < .01$) and the sub-clinical OC subjects ($p < .001$). The panic disorder and sub-clinical OC subjects did not differ on BDI-II scores ($p = .82$) or PI scores ($p = .72$).

To investigate whether the OCD group and the sub-clinical OC group differed on Y-BOCS score, a way-one ANOVA was conducted. Means and standard deviations of Y-BOCS scores for the OCD and sub-clinical OC groups are displayed in Table 12.

Table 12
Means and standard deviations of Y-BOCS scores for OCD and sub-clinical OC subjects

	OCD (n = 20)		sub-clinical OC (n = 20)			
	M	*SD*	*M*	*SD*	*df*	*F*
Y-BOCS	17.40	5.45	9.00	8.04	1,38	14.96*

*Note: * p < .001,* Y-BOCS = Yale-Brown Obsessive-Compulsive Scale

The OCD group scored significantly higher on the measure of severity of obsessive-compulsive symptoms when directly compared to the sub-clinical OC subjects (Y-BOCS: $F[1, 38] = 14.96$, $p < .001$). The severity of the OCD patient's symptoms was in the mild to moderate range and, as expected, the subclinical OC subjects scored in the subclinical range on the Y-BOCS.

9.3.3 Summary

The clinical characteristics of the experimental groups appeared to accurately represent the defining characteristics of each group. Given the differences in clinical characteristics between the groups, further analysis of any differences between the OCD patients and the other groups on the measures of working memory and personality will be undertaken with these differences in mind. The use of clinical variables as covariates in ANOVA procedures in behavioural research has attracted some criticism (Miller & Chapman, 2001). In this thesis clinical variables will not be included as covariates in the ANOVA procedures. However, to investigate whether clinical variables influence cognitive performance in the OCD group, correlation analysis will be performed to identify whether there is any relationship between clinical state and cognitive impairment. To investigate whether clinical variables contribute to any differences observed between the OCD group and the other experimental groups on the personality measures, separate regression equations will be calculated to determine the extent to which clinical state accounts for differences on measures of normal personality.

CHAPTER 10: RESULTS: WORKING MEMORY TASKS

10.1 Introduction

In this chapter, the accuracy and reaction times of the OCD patients on the three DMS tasks in comparison to healthy controls, panic disorder and sub-clinical OC subjects are examined separately. Next, the accuracy and reaction times of the OCD patients on the two n-back tasks are examined in comparison to healthy controls, panic disorder and sub-clinical OC subjects. Due to assumption violations, the 0-back and 1-back versions of the two n-back tasks are examined separately using non-parametric statistics. The performance of the OCD subjects on the n-back task is then examined in relation to demographic and clinical characteristics, medication status, and symptom subtype. For all analyses an alpha level of .05 was chosen for the detection of significant differences. All statistics are two-tailed.

10.2 Irregular object DMS task accuracy

10.2.1 Data screening

Prior to analysis, the irregular object DMS task accuracy variables were examined for accuracy of data entry, missing values, and fit between their distributions and the assumptions of ANOVA. Irregular object DMS task accuracy comprised four variables: low demand/perception, low demand/memory, high demand/perception and high demand/memory. These variables were inspected using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS (SPSS Inc, 2003) MVA procedure. One OCD case had missing values for the irregular object DMS task accuracy variables. There were no missing values for the panic disorder, sub-clinical OC or control groups. The OCD case with the missing data was deleted from the analysis. A full description of the data screening technique employed is included in Appendix D.

10.2.2 Results

Accuracy on the irregular object DMS task was analysed using a 4 x 2 x 2 ANOVA procedure. The between-subject factor was group (OCD, panic disorder, sub-clinical OC, healthy controls) and the within-subject variables were task demand (low, high) and task delay (perception, memory). To test the *a priori* hypotheses regarding the accuracy of the OCD patients on the irregular object DMS task, planned comparisons were conducted for overall accuracy, low and high demand accuracy and perception and memory accuracy. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. With one OCD case removed with missing data, and one case with outliers removed from the panic disorder group, there were 19 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in both the healthy control and sub-clinical OC groups. Mean accuracy and

standard deviations for the four experimental groups on the irregular object DMS task are displayed in Table 13.

Table 13

Means and standard deviations for irregular object DMS task accuracy (% correct) for OCD, panic disorder, sub-clinical OC and healthy control subjects

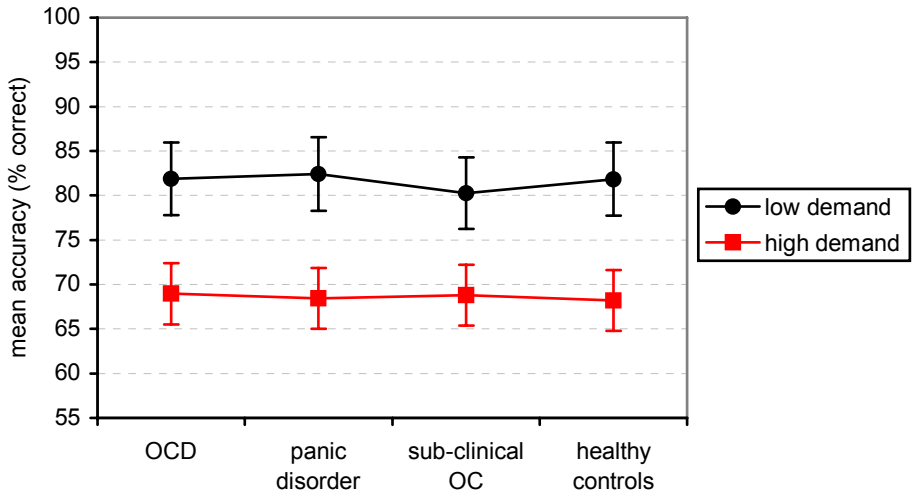
	OCD (n = 19)		panic disorder (n = 19)		sub-clinical OC (n = 20)		healthy controls (n = 20)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Overall accuracy	75.32	9.15	75.32	9.10	74.50	12.85	75.20	5.53
Low demand trials	81.89	9.60	82.42	9.33	80.25	12.53	81.85	6.89
High demand trials	68.95	11.76	68.42	11.77	68.80	14.45	68.20	6.10
Perception trials	79.05	11.20	81.00	9.80	78.75	13.25	80.05	10.64
Memory trials	71.79	9.19	69.63	10.37	70.30	14.21	70.15	6.88

The main effect of group was not significant (F[3, 74] = 0.04, p = .99). The experimental groups did not differ in terms of overall mean accuracy on the irregular object DMS task. Planned comparisons confirmed that on the measure of overall accuracy, the OCD patients were no different to the healthy controls (t[37] = 0.08, p = .93), the panic disorder patients (t[36] = 0.03, p = .99) or the sub-clinical OC subjects (t[37] = 0.31, p = .76).

The main effect of demand was significant (F[1, 74] = 149.10, p < .001). The accuracy of the experimental groups was significantly lower on the high demand trials of the irregular object DMS task than the low demand trials. However, the interaction between demand level and group was not significant (F[3, 74] = 0.23, p = .87). The mean accuracy of the OCD patients on the low and high demand trials compared to the panic disorder, sub-clinical OC and healthy subjects is displayed in Figure 12.

Figure 12

Mean accuracy of the OCD, panic disorder, sub-clinical OC and healthy control subjects on the low and high demand trials of the irregular object DMS task

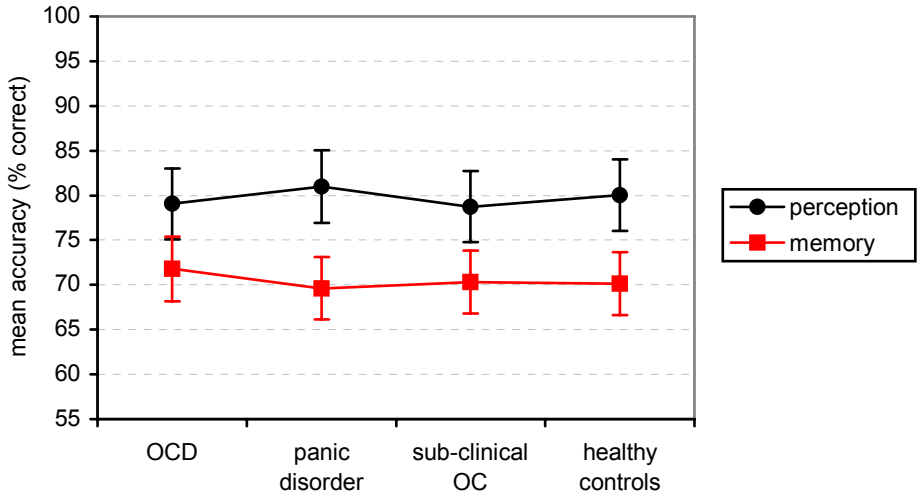


As predicted, the accuracy of the OCD patients was no different compared to the healthy controls, panic disorder or sub-clinical OC subjects on the low demand trials of the irregular object DMS task (healthy controls: t[37] = - 0.01, p = .99; panic disorder: t[36] = - 0.16, p = .87; sub-clinical OC: t[37] = 0.50, p = .62). The hypothesis that the accuracy of the OCD patients would be no different to the sub-clinical OC subjects on the high demand trials of the irregular object DMS task was also supported (t[37] = 0.08, p = .93). However, contrary to the hypothesis, the accuracy of the OCD patients was no different on the high demand trials compared to the healthy controls (t[37] = 0.15, p = .88) and panic disorder patients (t[36] = 0.16, p = .87).

The main effect of task delay was significant (F[1, 74] = 60.00, p < .001). The accuracy of the experimental groups was significantly lower on the memory trials (long delay) of the irregular object DMS task than the perception trials (brief delay). However, the interaction between group and task delay (F[3, 74] = 0.52, p = .67) was not significant. Figure 13 displays the mean accuracy of the OCD patients on the perception and memory trials of the irregular object DMS task in comparison to the panic disorder, sub-clinical OC and healthy control subjects.

Figure 13

Mean accuracy of the OCD, panic disorder, sub-clinical OC and healthy control subjects on the perception and memory trials of the irregular object DMS task



As predicted, the accuracy of the OCD patients was no different to the other experimental groups on the perception trials of the irregular object DMS task (healthy controls: t[37] = - 0.29, p = .77; panic disorder: t[36] = - 0.55, p = .58; sub-clinical OC: t[37] = 0.05, p = .96). The hypothesis that the accuracy of the OCD patients would be no different to the sub-clinical OC subjects on the memory trials of the irregular object DMS task was also supported (t[37] = 0.50, p = .62). However, contrary to the hypothesis the accuracy of the OCD patients was also no different to the healthy controls (t[37] = 0.47, p = .64) or panic disorder patients (t[36] = 0.61, p = .54) on the memory trials of the irregular object DMS task

10.2.3 Summary

In the present thesis, OCD patients were as accurate as healthy control subjects, panic disorder patients and sub-clinical OC subjects on a task requiring the active maintenance of representations of difficult-to-label objects in working memory.

10.3 Irregular object DMS task reaction time

10.3.1 Data screening

Prior to analysis, the irregular object DMS task reaction time variables were examined for accuracy of data entry, missing values, and fit between their distributions and the assumptions of ANOVA. There were four irregular object DMS task reaction time variables: low demand/perception, low demand/memory, high demand/perception and high demand/memory. The reaction time variables were inspected separately for each experimental group using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. One OCD case had missing values for irregular object DMS task reaction times. There were no missing values for the panic disorder, sub-clinical OC or healthy control groups. The OCD case with the missing data was deleted from the analysis. A full description of the data screening procedure employed is included as Appendix E.

10.3.2 Results

Reaction times on the irregular object DMS task were analysed using a 4 x 2 x 2 ANOVA procedure. The between-subject factor was group (OCD, panic disorder, sub-clinical OC, healthy controls) and the within-subject variables were task demand (low, high) and task delay (perception, memory). To test the *a priori* hypotheses regarding the reaction times of the OCD patients, planned contrasts were performed for overall reaction time, low and high demand reaction time and perception and memory reaction time. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. With one OCD case with missing data removed, and no cases excluded for assumption violations, there were 19 cases in the OCD group and 20 cases in the other experimental groups. Mean reaction times for the four experimental groups on the irregular object DMS task are displayed in Table 14.

Table 14

Means and standard deviations for irregular object DMS task reaction times (ms) for OCD, panic disorder, sub-clinical OC and healthy control subjects

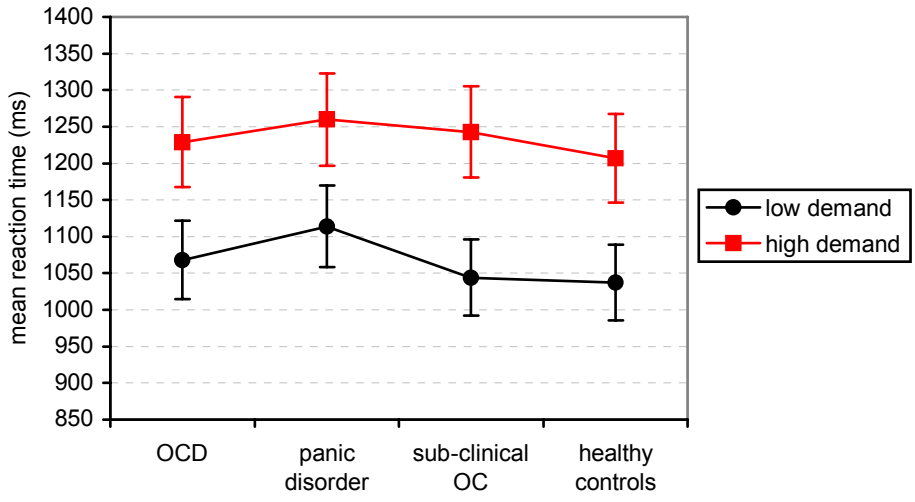
	OCD (n = 19)		panic disorder (n = 20)		sub-clinical OC (n = 20)		healthy controls (n = 20)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Overall reaction time	1142	159	1180	136	1136	159	1114	133
Low demand trials	1068	154	1114	139	1044	172	1037	143
High demand trials	1229	174	1260	147	1243	161	1207	143
Perception trials	1151	176	1182	145	1132	182	1135	146
Memory trials	1133	147	1178	140	1141	151	1093	140

The main effect of group was not significant (F[3, 75] = 0.65, p = .59). The experimental groups did not differ on overall mean reaction time on the irregular object DMS task. Planned comparisons confirmed that on the measure of overall reaction time the OCD patients were no different to the healthy controls (t[37] = 0.55, p = .58), the panic disorder patients (t[37] = - 0.80, p = .43) or the sub-clinical OC subjects (t[37] = 0.10, p = .92).

The main effect of demand was significant (F[1, 75] = 338.57, p < .001). The experimental groups performed more quickly on the low demand trials of the irregular object DMS task than the high demand trials. However, the interaction between task demand and group was not significant (F[3, 75] = 1.36, p = .26). The mean reaction times of the OCD patients in comparison to panic disorder, sub-clinical OC and healthy control subjects on the low and high demand trials of the irregular object DMS task are displayed in Figure 14.

Figure 14

Mean reaction times for the OCD, panic disorder, sub-clinical OC and healthy control subjects on the low and high demand trials of the irregular object DMS task

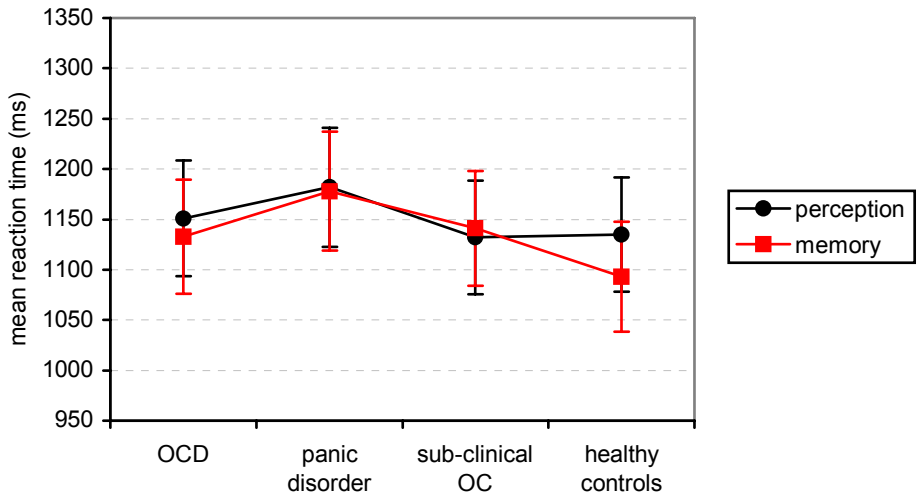


As predicted, the reaction times of the OCD patients on the low demand trials were no different to the healthy controls (t[37] = 0.60, p = .55), panic disorder patients (t[37] = - 0.94, p = .35) or sub-clinical OC subjects (t[37] = 0.46, p = .65). As predicted, the reaction times of the OCD patients were also no different on the high demand trials compared to the healthy controls (t[37] = 0.47, p = .64), the panic disorder patients (t[37] = - 0.61, p = .54) and the sub-clinical OC subjects (t[37] =
- 0.26, p = .79).

The main effect of delay was not significant (F[1, 75] = 0.94, p = .33). The mean reaction times of the four experimental groups were no different on the perception trials compared to the memory trials. The interaction between delay and group was also not significant (F[3, 75] = 1.05, p = .37). The mean reaction times of the four experimental groups on the perception and memory trials are displayed in Figure 15.

Figure 15

Mean reaction times for the OCD, panic disorder, sub-clinical OC and healthy control subjects on the perception and memory trials of the irregular object DMS task



As predicted, the mean reaction times of the OCD patients were no different to the other experimental groups on the perception trials (healthy controls: t[37] = 0.35, p = .73; panic disorder: t[37] = - 0.56, p = .58; sub-clinical OC: t[37] = 0.37, p = .71) or the memory trials (healthy controls: t[37] = 0.74, p = .46; panic disorder: t[37] = - 1.01, p = .32; sub-clinical OC: t[37] = - 0.22, p = .83) of the irregular object DMS task.

10.3.3 Summary

The results from the present thesis indicated that OCD patients perform as quickly as healthy control, panic disorder patients and sub-clinical OC subjects on a task requiring the active maintenance of difficult-to-label objects in working memory.

10.4 Spatial locations DMS task accuracy

10.4.1 Data screening

Prior to analysis, the spatial locations DMS task accuracy variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of ANOVA. Spatial locations DMS task accuracy comprised four variables: low demand/perception, low demand/memory, high demand/perception, high demand/memory. These variables were inspected using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. One OCD case had missing values for the spatial DMS task accuracy variables. There were no missing values for the panic disorder, sub-clinical OC or healthy control groups. The OCD case with the missing data was deleted from the analysis. A full description of the data screening procedure is included as Appendix F.

10.4.2 Results

Accuracy performance on the spatial locations DMS task was analysed using a 4 x 2 x 2 ANOVA procedure with group as the between-subject factor (OCD, panic disorder, sub-clinical OC, healthy controls) and task demand (low, high) and task delay (perception, memory) as the within-subject variables. To test the *a priori* hypotheses regarding the accuracy of the OCD patients, planned comparisons were conducted for overall accuracy performance, low and high demand accuracy and perception and memory accuracy. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. To measure the effect size of any significant group differences, Cohen's *d* was calculated using the Effect Size Generator for Windows: version 2.2 (Devilly, 2004). With one OCD case with missing data excluded, and one sub-clinical OC case with an outlier excluded, there were 19 cases in the OCD group, 20 in the panic disorder group, 19 in the sub-clinical OC group and 20 in the healthy control group. Means and standard deviations for spatial locations DMS task accuracy for the four experimental groups are displayed in Table 15.

Table 15

Means and standard deviations for spatial locations DMS task accuracy (% correct) for OCD, panic disorder, sub-clinical OC and healthy control subjects

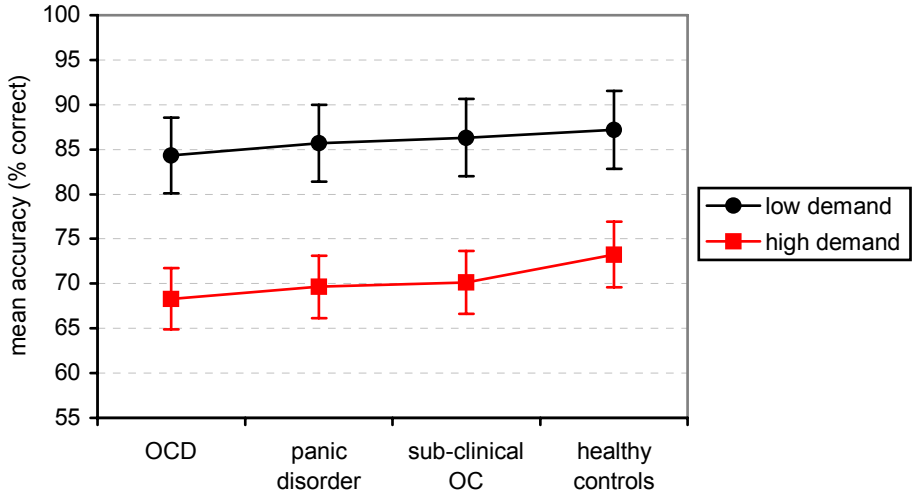
	OCD (n = 19)		panic disorder (n = 20)		sub-clinical OC (n = 19)		healthy controls (n = 20)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Overall accuracy	76.26	7.17	77.65	8.76	78.26	6.45	80.35	7.23
Low demand trials	84.32	8.37	85.70	6.12	86.32	5.01	87.20	7.80
High demand trials	68.32	8.82	69.65	12.64	70.16	9.51	73.25	9.16
Perception trials	81.63	9.92	82.15	9.14	82.16	5.19	83.15	7.29
Memory trials	71.00	8.72	73.15	10.51	74.37	9.51	77.25	9.16

The main effect of group was not significant (F[3, 74] = 0.94, p = .43). The experimental groups did not differ on overall accuracy on the spatial locations DMS task. Planned comparisons confirmed that the accuracy of the OCD patients on the spatial locations DMS task was no different compared to the healthy control subjects (t[37] = - 1.64, p = .10), the panic disorder patients (t[37] = - 0.58, p = .57) or the sub-clinical OC subjects (t[36] = - 0.81, p = .42).

The main effect of task demand was significant (F[1, 74] = 233.52, p < .001). The accuracy of the participants was significantly lower on the high demand trials of the spatial locations DMS task than the low demand trials. However, there was no significant interaction between task demand and group (F[3, 74] = 0.29, p = .83). The mean accuracy of the OCD patients on the low and high demand trials compared to the panic disorder, sub-clinical OC and healthy control subjects is displayed in Figure 16.

Figure 16

Mean accuracy of the OCD, panic disorder, sub-clinical OC and healthy control subjects on the low and high demand trials of the spatial locations DMS task



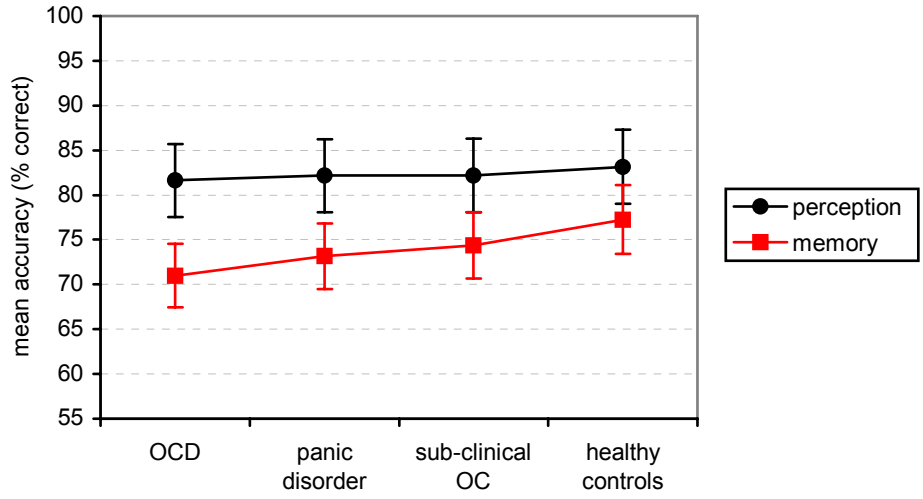
As predicted, the accuracy of the OCD patients was no different to healthy controls, panic disorder or sub-clinical OC subjects on the low demand trials of the spatial locations DMS task (healthy controls: t[37] = - 1.30, p = .20; panic disorder: t[37] = - 0.63, p = .53; sub-clinical OC: t[36] = - 0.93, p = .36). As predicted, the accuracy of the OCD patients was also no different to the sub-clinical OC subjects on the high demand trials of the spatial locations DMS task (t[36] = - 0.56, p = .58]. However, contrary to the hypothesis the accuracy of the OCD patients was also no different to the healthy controls (t[37] = - 1.53, p = .13) and panic disorder patients (t[37] = - 0.41, p = .68) on the high demand trials of the spatial locations DMS task.

The main effect of task delay was significant (F[1, 74] = 60.97, p < .001). The experimental groups were more accurate on the perception trials than the memory trials. However, there was no significant interaction between group and task delay (F[3, 74] = 0.90, p = .45). The mean

accuracy of the OCD patients on the perception and memory trials compared to the panic disorder patients, sub-clinical OC subjects and healthy control subjects is displayed in Figure 17.

Figure 17

Mean accuracy of the OCD, panic disorder, sub-clinical OC and healthy control subjects on the perception and memory trials of the spatial locations DMS task



As predicted, the accuracy of the OCD patients was no different to the healthy control, panic disorder or sub-clinical OC subjects on the perception trials of the spatial locations DMS task (healthy controls: t[37] = - 0.60, p = .55; panic disorder: t[37] = - 0.21, p = .83; sub-clinical OC: t[36] = - 0.20, p = .84). As predicted, the accuracy of the OCD patients was also no different to the sub-clinical OC subjects on the memory trials of the spatial locations DMS task (t[37] = - 1.11, p = .27). The hypothesis that the accuracy of the OCD patients would be poorer than the healthy control subjects on the memory trials of the spatial locations DMS task was also supported (t[36] = - 2.07, p < .05, d = 0.70, P = 0.69). Contrary to the hypothesis, the accuracy of the OCD patients was no different to the panic disorder patients on the memory trials of the spatial locations DMS task (t[37] = - 0.72, p = .47).

10.4.3 Summary

In the present thesis, OCD patients demonstrated they were able to accurately encode representations of spatial locations in working memory compared to healthy controls, panic disorder patients and sub-clinical OC subjects. Compared to panic disorder patients and sub-clinical OC subjects, the OCD patients were also able to accurately encode and maintain representations of spatial locations in working memory. However, compared to healthy control subjects, OCD patients demonstrated impairment in the ability to accurately maintain representations of spatial locations in working memory.

10.5 Spatial locations DMS task reaction time

10.5.1 Data screening

Prior to analysis, the spatial locations DMS task reaction time variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of ANOVA. Spatial locations DMS task reaction time comprised four variables: low demand/perception, low demand/memory, high demand/perception and high demand/memory. The reaction time variables was inspected for each experimental group using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. One OCD case had a missing value for spatial locations DMS task reaction time. There were no missing values for the panic disorder, sub-clinical OC or control groups. The OCD case with the missing data was deleted from the analysis. A complete description of the data screening procedure employed is included as Appendix G.

10.5.2 Results

Mean reaction times for the spatial locations DMS task were analysed using a 4 x 2 x 2 ANOVA procedure with group as the between-subject factor (OCD, panic disorder, sub-clinical OC, healthy controls) and task demand (low, high) and task delay (perception, memory) as the within-subject variables. To test the *a priori* hypotheses regarding the reaction times of the OCD patients, planned comparisons were conducted for overall reaction time, low and high demand reaction time and perception and memory reaction time. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. With one OCD case with missing data excluded, and no cases excluded for assumption violations, there were 19 cases in the OCD group and 20 cases in each of the other experimental groups. The mean reaction times of the four experimental groups for the spatial locations DMS task are displayed in Table 16.

Table 16

Means and standard deviations for spatial locations DMS task reaction times (ms) for OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 19)		panic disorder (n = 20)		sub-clinical OC (n = 20)		healthy controls (n = 20)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Overall reaction time	1053	133	1117	184	1056	192	1060	146
Low demand trials	991	138	1053	187	1014	190	1003	160
High demand trials	1132	147	1194	192	1107	205	1128	145
Perception trials	1074	148	1124	188	1078	205	1071	152
Memory trials	1030	136	1109	191	1031	186	1049	158

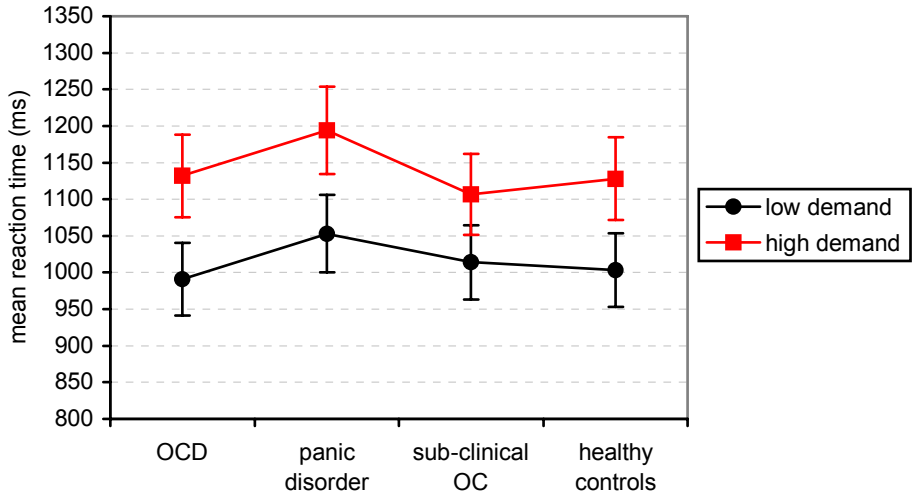
The main effect of group was not significant (F[3, 75] = 0.64, p = .59). The reaction times of the experimental groups did not differ on the spatial locations DMS task. Planned comparisons confirmed that the reaction times of the OCD patients were no different to the healthy control

subjects (*t*[37] = - 0.06, *p* = .95), the panic disorder patients (*t*[37] = - 1.16, *p* = .25) or the sub-clinical OC subjects (*t*[37] = - 0.04, *p* = .97) on the spatial locations DMS task.

The main effect for task demand was significant (*F*[1, 75] = 170.05, *p* < .001). The reaction times of the participants were significantly slower when performing the high demand trials of the spatial locations DMS task than the low demand trials. However, the interaction between task demand and group was not significant (*F*[3, 75] = 1.65, *p* = .19). The mean reaction times of the four experimental groups on the low and high demand versions of the spatial locations DMS task are displayed in Figure 18.

Figure 18

Mean reaction times on the low and high demand trials of the spatial locations DMS task for the OCD, panic disorder, sub-clinical OC and healthy control subjects

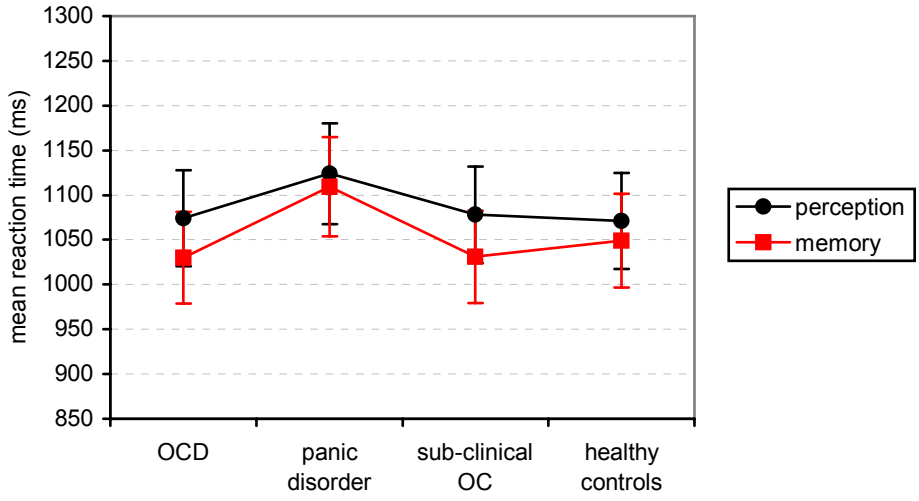


As predicted, the mean reaction times of the OCD patients were no different to the healthy controls (*t*[37] = - 0.24, *p* = .81), the panic disorder patients (*t*[37] = - 1.17, *p* = .24) or the sub-clinical OC subjects (*t*[37] = - 0.54, *p* = .59) on the low demand trials of the spatial locations DMS task. Similarly, on the high demand trials of the spatial locations DMS task, the reaction times of the OCD patients were no different to the healthy control subjects (*t*[37] = 0.10, *p* = .92), the panic disorder patients (*t*[37] = - 1.07, *p* = .29) or the sub-clinical OC subjects (*t*[37] = 0.44, *p* = .66) as predicted.

The main effect of task delay was significant (*F*[1, 75] = 8.29, *p* < .01). The reaction times of the participants were significantly faster on the perception trials than on the memory trials. However, the interaction between group and task delay was not significant (*F*[3, 75] = 0.29, *p* = .83). Figure 19 displays the mean reaction times of the experimental groups on the perception and memory trials of the spatial locations DMS task.

Figure 19

Mean reaction times on the perception and memory trials of the spatial locations DMS task for the OCD, panic disorder, sub-clinical OC and healthy control subjects



As predicted, the reaction times of the OCD patients were no different to the healthy controls (t[37] = 0.10, p = .92), the panic disorder patients (t[37] = - 0.87, p = .38) or the sub-clinical OC subjects (t[37] = 0.00, p = 1.00) on the perception trials. The reaction times of the OCD patients were also no different to the healthy controls (t[37] = - 0.23, p = .82), the panic disorder patients (t[37] = - 1.36, p = .18) or the sub-clinical OC subjects (t[37] = - 0.01, p = .93) on the memory trials as predicted.

10.5.3 Summary

In the present thesis, OCD patients performed as quickly as healthy control, panic disorder and sub-clinical OC subjects on a task requiring the encoding and maintenance of representations of spatial locations in working memory.

10.6 Geometric object DMS task accuracy

10.6.1 Data screening

Prior to analysis, the geometric object DMS task accuracy variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of ANOVA. Geometric object DMS task accuracy comprised four variables: low demand/perception, low demand/memory, high demand/perception and high demand/memory. These variables were inspected using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. One OCD case had missing values for the geometric object DMS task accuracy variables. There were no missing values for the panic disorder, sub-clinical OC or healthy control groups. The OCD case with the missing data was

deleted from the analysis. A full description of the data screening procedure employed is included as Appendix H.

10.6.2 Results

The accuracy of the OCD patients on the geometric object DMS task was analysed using a 4 x 2 x 2 ANOVA procedure with group as the between-subject factor (OCD, panic disorder, sub-clinical OC, healthy controls) and task demand (low, high) and task delay (perception, memory) as the within-subject variables. To test the *a priori* hypotheses regarding the accuracy of the OCD patients, planned comparisons were conducted for overall accuracy, low and high demand accuracy and perception and memory accuracy. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. With one OCD case with missing data excluded, and no cases excluded for assumption violations, there were 19 cases in the OCD group and 20 cases in each of the other experimental groups. Mean accuracy on the geometric object DMS task for the four experimental groups is displayed in Table 17.

Table 17
Means and standard deviations for geometric object DMS task accuracy (% correct) for OCD, panic disorder, sub-clinical OC and healthy control subjects

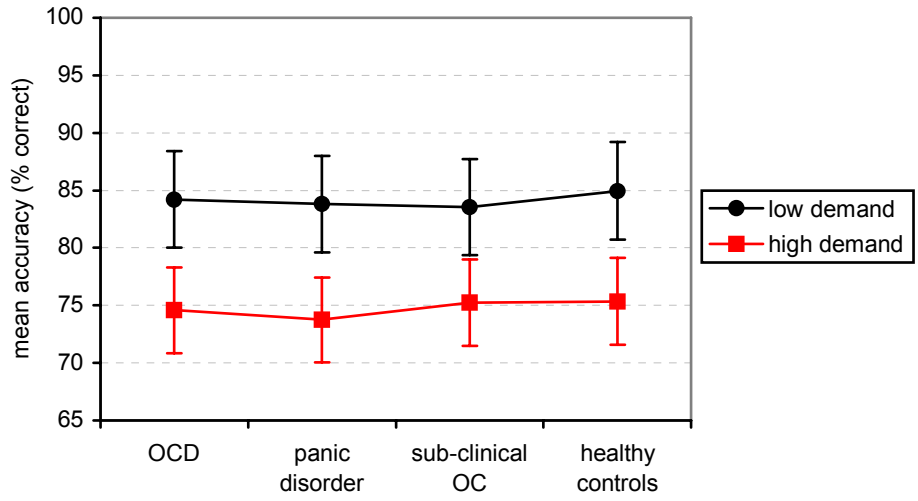
	OCD (n = 19)		panic disorder (n = 20)		sub-clinical OC (n = 20)		healthy controls (n = 20)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Overall accuracy	79.37	6.95	78.70	4.80	79.40	9.86	80.30	8.64
Low demand trials	84.21	9.35	83.80	7.03	83.55	10.34	84.95	10.28
High demand trials	74.58	7.65	73.75	5.87	75.25	10.22	75.65	8.95
Perception trials	82.53	8.38	82.50	6.71	84.60	10.50	85.40	10.36
Memory trials	76.16	8.13	74.95	7.06	74.15	11.01	75.15	8.50

The main effect of group was not significant (F[3, 75] = 0.14, p = .94). The experimental groups did not differ in terms of overall mean accuracy on the geometric object DMS task. Planned comparisons confirmed that the overall accuracy of the OCD patients was no different compared to the healthy controls (t[37] = - 0.37, p = .71), the panic disorder patients (t[37] = 0.26, p = .79) or the sub-clinical OC subjects (t[37] = 0.01, p = .99).

The main effect of task demand was significant (F[1, 75] = 87.83, p < .001). The accuracy of the participants was significantly lower on the high demand trials of the geometric object DMS task than the low demand trials. However, the interaction between task demand and group was not significant (F[3, 75] = 0.14, p = .93). The mean accuracy of the four experimental groups on the low and high demand trials of the geometric object DMS task are displayed in Figure 20.

Figure 20

Mean accuracy on the low and high demand versions of the geometric object DMS task for the OCD, panic disorder, sub-clinical OC and healthy control subjects



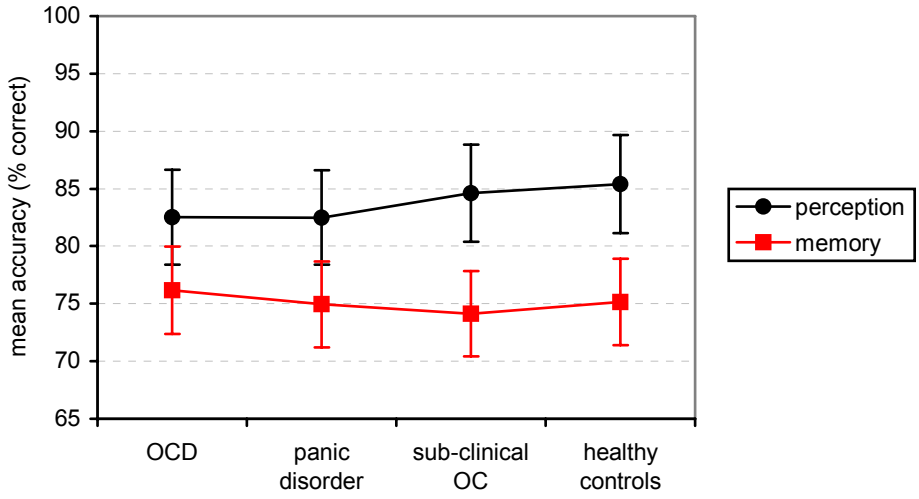
As predicted, the accuracy of the OCD patients was no different to the healthy controls (t[37] = - 0.22, p = .83), panic disorder patients (t[37] = 0.15, p = .88) or the sub-clinical OC subjects (t[37] = 0.23, p = .82) on the low demand trials of the geometric object DMS task. Similarly, on the high demand trials the accuracy of the OCD patients was no different than the healthy controls (t[37] = - 0.43, p = .67), the panic disorder patients (t[37] = 0.31, p = .75) or the sub-clinical OC subjects (t[37] = - 0.25, p = .81) as predicted.

The main effect of task delay was significant (F[1, 75] = 67.39, p < .001). The participants were significantly more accurate when performing the perception trials than the memory trials. However, the interaction of task delay and group was not significant (F[3, 75] = 0.90, p = .45). The mean accuracy of the experimental groups on the perception and memory trials of the geometric object DMS task is displayed in Figure 21.

As predicted, the accuracy of the OCD patients on the perception trials of the geometric object DMS task was no different to the healthy controls (t[37] = - 0.97, p = .33), panic disorder patients (t[37] = - 0.00, p = 1.00), or sub-clinical OC subjects (t[37] = - 0.68, p = .50). On the memory trials, the accuracy of the OCD patients was also no different to the healthy controls (t[37] = 0.37, p = .71), panic disorder patients (t[37] = 0.46, p = .65) or sub-clinical OC subjects (t[37] = 0.72, p = .47) as predicted.

Figure 21

Mean accuracy on the perception and memory trials of the geometric object DMS task for the OCD, panic disorder, sub-clinical OC and healthy control subjects



10.6.3 Summary

The results indicated that OCD patients perform as accurately as healthy controls, panic disorder patients and sub-clinical OC subjects on a task requiring encoding and maintenance of representations of easy-to-label object stimuli in working memory.

10.7 Geometric object DMS task reaction time

10.7.1 Data screening

Prior to analyses, the geometric object DMS task reaction time variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of ANOVA. Geometric object DMS task reaction time comprised four variables: low demand/perception, low demand/memory, high demand/perception and high demand/memory. The reaction time variables were inspected for each experimental group using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. One OCD case had missing values for the geometric object DMS task reaction time variables. There were no missing values for the panic disorder, sub-clinical OC or control groups. The OCD case with the missing data was deleted from the analysis. A detailed description of the data screening procedure is included as Appendix I.

10.7.2 Results

The reaction times of the OCD patients on the geometric object DMS task were analysed using a 4 x 2 x 2 ANOVA procedure with group as the between-subject factor (OCD, panic disorder, sub-clinical OC, healthy controls) and task demand (low, high) and task delay (perception,

memory) as the within-subject variables. To test the *a priori* hypotheses regarding the reaction times of the OCD patients, planned comparisons were conducted for overall reaction time, low and high demand reaction time and perception and memory reaction time. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. With one OCD case with missing data excluded, and one panic disorder case excluded for assumption violations, there were 19 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. Mean reaction times for the four experimental groups on the geometric object DMS task are displayed in Table 18.

Table 18

Means and standard deviations for Geometric Object DMS task reaction times (ms) for OCD, panic disorder, sub-clinical OC and healthy control subjects

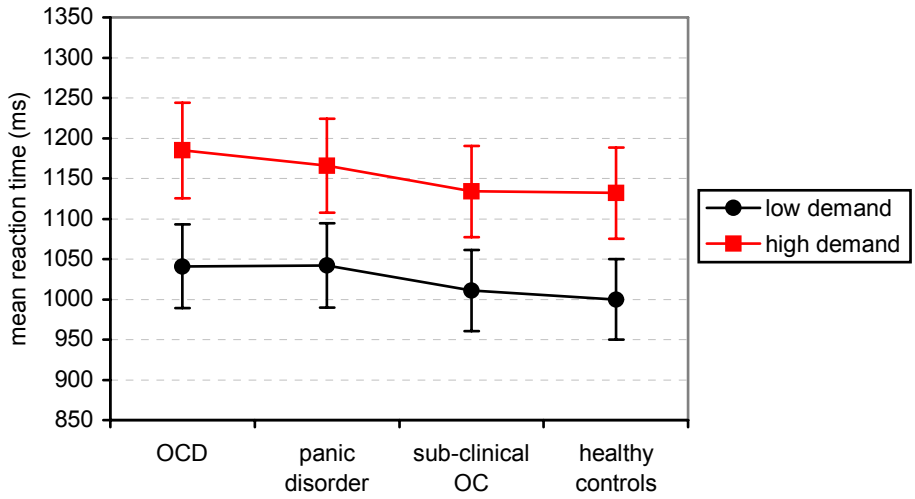
	OCD (n = 19)		panic disorder (n = 19)		Sub-clinical OC (n = 20)		healthy controls (n = 20)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Overall reaction time	1109	140	1101	118	1069	136	1062	166
Low demand trials	1041	146	1042	132	1011	150	1000	179
High demand trials	1185	136	1166	112	1134	132	1132	162
Perception trials	1091	136	1087	122	1045	148	1042	189
Memory trials	1130	149	1117	126	1096	140	1086	159

The main effect of group was not significant ($F[3, 74] = 0.50$, $p = .68$). The overall mean reaction times of the experimental groups were no different on the geometric object DMS task. Planned comparisons confirmed that the overall mean reaction time of the OCD patients was no different to the healthy control subjects ($t[37] = 1.02$, $p = .31$), panic disorder patients ($t[36] = 0.22$, $p = 0.82$) or sub-clinical OC subjects ($t[37] = 0.90$, $p = .37$).

The main effect of task demand was significant ($F[1, 74] = 260.83$, $p < .001$). The reaction times of the participants were significantly faster on the low demand trials than the high demand trials. However, the interaction between task demand and group was not significant ($F[3, 74] = 0.40$, $p = .76$). The mean reaction times of the four experimental groups on the low demand and high demand trials of the geometric object DMS task are displayed in Figure 22.

Figure 22

Mean reaction times for the OCD, panic disorder, sub-clinical OC and healthy control subjects on the low and high demand trials of the geometric object DMS task

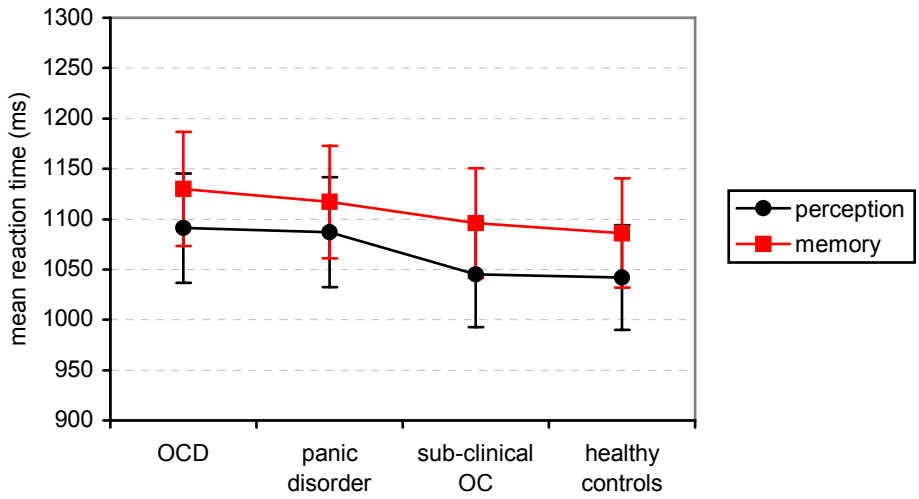


As predicted, the reaction times of the OCD patients were no different to the healthy controls (t[37] = 0.81, p = .42), panic disorder patients (t[36] = - 0.02, p = .98) or the sub-clinical OC subjects (t[37] = 0.62, p = .54) on the low demand trials of the geometric object DMS task. Similarly, on the high demand trials, the reaction times of the OCD patients were no different to the healthy controls (t[37] = 1.20, p = .23), panic disorder patients (t[36] = 0.48, p = .63) or the sub-clinical OC subjects (t[37] = 1.17, p = .25) as predicted.

The main effect of task delay was significant (F[1, 74] = 19.86, p < .001). The reaction times of the participants were significantly quicker on the perception trials than the memory trials. However, the interaction between task delay and group was not significant (F[3, 74] = 0.23, p = .88). The mean reaction times of the four experimental groups on the perception and memory trials of the geometric object DMS task are displayed in Figure 23.

Figure 23

Mean reaction times for the OCD, panic disorder, sub-clinical OC and healthy control subjects on the perception and memory trials of the geometric object DMS task



As predicted, the reaction times of the OCD patients were no different on the perception trials compared to the healthy controls (t[37] = 1.08, p = .28), the panic disorder patients (t[36] = 0.21, p = .83) or the sub-clinical OC subjects (t[37] = 1.04, p = .30). As predicted, the reaction times of the OCD patients were also no different to the healthy controls (t[37] = 0.87, p = .39), the panic disorder patients (t[36] = 0.22, p = .83) or the sub-clinical OC subjects (t[37] = 0.68, p = .50) on the memory trials.

10.7.3 Summary

The present thesis found that compared to healthy controls, panic disorder and sub-clinical OC subjects, OCD patients perform as quickly on a task requiring the encoding and maintenance of easy-to-label object stimuli in visual working memory.

10.8 Verbal n-back task accuracy (0-back and 1-back trials)

10.8.1 Data screening

Prior to analysis, the verbal 0-back and 1-back accuracy variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of MANOVA. The variables were inspected using the Statistica descriptives procedure. All variables were within range, however, although the means were plausible, the standard deviations for the 1-back task were quite high. Missing value analysis was undertaken using the SPSS MVA procedure. One OCD case and one panic disorder case had missing values for the n-back task accuracy variables. There were no missing values for the sub-clinical OC or control groups. The OCD and panic disorder cases with missing data were deleted from the analysis.

10.8.2 Normality

The distribution of the verbal 0-back and 1-back accuracy variables were evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. All of the variables exceeded two standard errors of skewness and kurtosis and inspection of the graphical data suggested that there were severe departures from normality for these variables. Few errors were made on the 0-back and 1-back versions of the verbal n-back task, resulting in a skewed distribution that was inappropriate for transformation. Due to the severe violations of the normality assumption, the non-parametric test for k independent samples, Kruskal-Wallis, and separate Mann-Whitney U test were used to investigate group differences on these variables.

10.8.3 Results

To test the hypothesis that the accuracy of the OCD patients would be no different to the healthy control, panic disorder, or sub-clinical OC subjects on the 0-back and 1-back versions of the verbal n-back task, the Kruskal-Wallis ANOVA-by-ranks test was used to assess any overall group differences. To test whether the OCD group differed from each of the experimental groups, separate Mann-Whitney U tests were conducted. Specifically these tests compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. With one OCD case and one panic disorder case with missing data excluded, and no cases excluded for assumption violations, there were 19 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. Mean accuracy for the four experimental groups on the 0-back and 1-back versions of the verbal n-back task are displayed in Table 19.

Table 19

Means and standard deviations for 0-back and 1-back accuracy trials of the verbal n-back task for OCD, panic disorder, sub-clinical OC and healthy control subjects

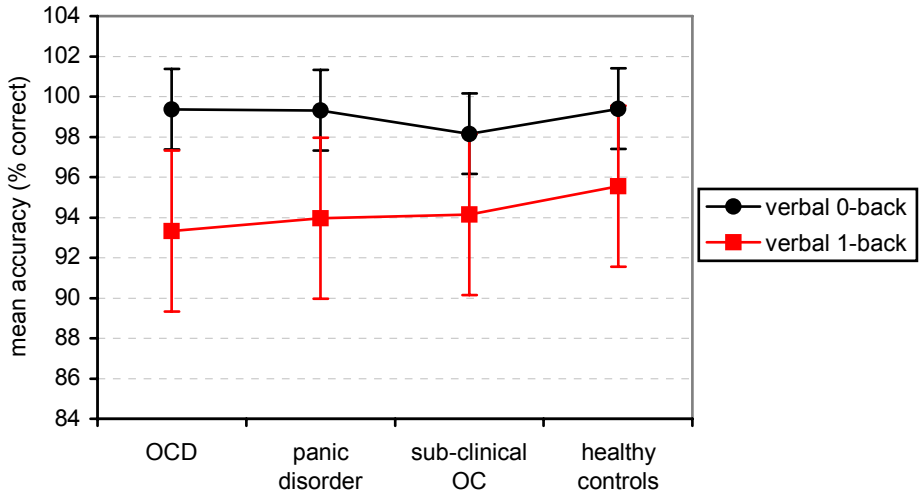
	OCD (n = 19)		panic disorder (n = 19)		sub-clinical OC (n = 20)		healthy controls (n = 20)		χ^2	*p*
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*		
Verbal 0-back	99.37	1.12	99.32	1.29	98.15	6.43	99.40	1.10	0.26	1.00
Verbal 1-back	93.32	11.11	93.95	8.85	94.15	10.09	95.55	7.65	1.89	0.60

Overall, there were no significant differences between the four experimental groups on verbal 0-back accuracy (χ^2 [3] = 0.26, p = 1.00), or verbal 1-back accuracy (χ^2 [3] = 1.89, p = .60).

The mean accuracy of the four experimental groups on the 0-back and 1-back trials of the verbal n-back task is displayed in Figure 24.

Figure 24

Mean accuracy of the OCD, panic disorder, sub-clinical OC and healthy control subjects on the 0-back and 1-back trials of the verbal n-back task



As predicted, the accuracy of the OCD patients on the verbal 0-back task was no different compared to the healthy control subjects (U = 186.50, z = - 0.10, p = .92), the panic disorder patients (U = 180.00, z = 0.01, p = .99) and the sub-clinical OC subjects (U = 187.00, z = - 0.08, p = .93). As predicted, the accuracy of the OCD patients on the verbal 1-back task was also no different compared to the healthy controls (U = 143.50, z = - 1.31, p = .19), panic disorder patients (U = 168.50, z = - 0.35, p = .73) and the sub-clinical OC subjects (U = 152.50, z = - 1.05, p = .29).

10.9 Verbal n-back task accuracy (2-back and 3-back trials)

10.9.1 Data screening

Prior to analysis, the verbal 2-back and 3-back accuracy variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of MANOVA. The variables were inspected using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. One OCD case and one panic disorder case had missing values for verbal n-back task accuracy. There were no missing values for the sub-clinical OC or healthy control cases. The OCD and panic disorder cases with the missing data were deleted from the analysis. A detailed description of the data screening technique employed is included as Appendix J.

10.9.2 Results

To test the *a priori* hypothesis that the accuracy of the OCD patients would be no different to the sub-clinical OC subjects but would be lower than the panic disorder patients and healthy control subjects on the 2-back and 3-back trials of the verbal n-back task, a MANOVA was conducted using three planned contrasts. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. To measure the effect size of any significant group differences, Cohen's *d* was calculated using the Effect Size Generator for Windows: version 2.2 (Devilly, 2004). With one OCD case and one panic disorder case with missing data excluded, and no cases excluded for assumption violations, there were 19 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. Means and standard deviations for verbal 2-back and 3-back accuracy for the four experimental groups are displayed in Table 20.

Table 20

Means and standard deviations for 2-back and 3-back accuracy trials of the verbal n-back task for OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 19)		panic disorder (n = 19)		sub-clinical OC (n = 20)		healthy controls (n = 20)		Wilks' λ	*F*
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*		
									0.84	**2.29***
Verbal 2-back	76.42	21.12	80.53	15.27	78.75	14.73	87.20	9.87		1.72
Verbal 3-back	58.68	23.91	70.16	15.52	70.60	15.97	76.55	10.50		3.70*

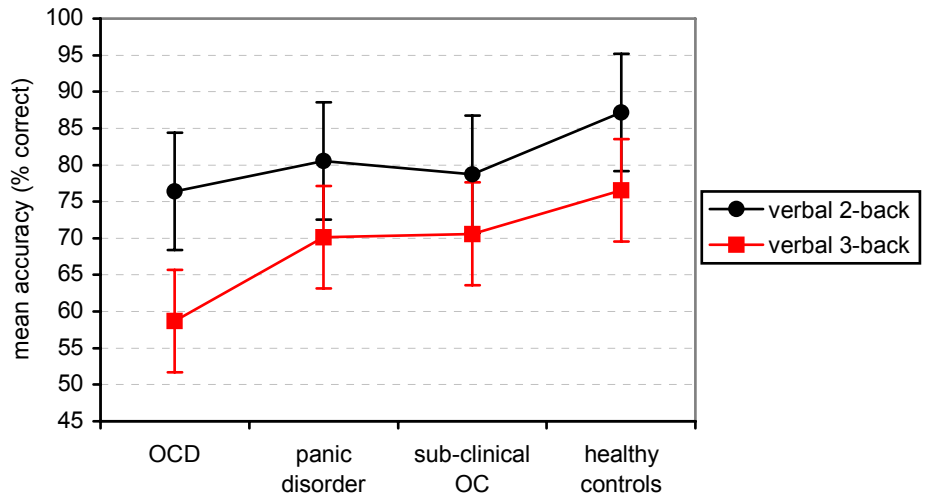
Note: * p < .05

Comparison of the OCD, panic disorder, sub-clinical OC and healthy control subjects on the 2-back and 3-back versions of the verbal n-back yielded an overall multivariate effect (Wilks' λ = 0.84, $F[6, 146] = 2.29$, $p < .05$). While the experimental groups did not differ on verbal 2-back task accuracy ($F[3, 74] = 1.72$, $p = .17$), there was a significant difference between groups on verbal 3-back task accuracy ($F[3, 74] = 3.70$, $p < .05$).

The mean accuracy of the four experimental groups on the verbal 2-back and verbal 3-back tasks is displayed in Figure 25.

Figure 25

Mean accuracy on verbal 2-back and 3-back trials for the OCD, panic disorder, sub-clinical OC and healthy control subjects



Planned comparison between OCD patients and healthy controls yielded an overall multivariate effect (Wilks' λ = 0.87, F[2, 73] = 5.30, p < .01). As hypothesised, the OCD group were less accurate than the healthy control subjects on both the verbal 2-back task (t[37] = - 2.15, p < .05, d = 0.65, P = 0.51) and the verbal 3-back task (t[37] = - 3.27, p < .01, d = 0.97, P = 0.84).

Planned comparison between OCD patients and panic disorder patients did not yield an overall multivariate effect (Wilks' λ = 0.93, F[2, 73] = 2.59, p = .08). Contrary to the hypothesis, the accuracy of the OCD patients was no different to the panic disorder patients on the verbal 2-back task (t[36] = - 0.81, p = .42). However, the hypothesis that the OCD patients would be less accurate than the panic disorder patients on the verbal 3-back task was supported (t[36] = - 2.07, p < .05, d = 0.57, P = 0.40) with a moderate effect size.

Planned comparison between OCD patients and sub-clinical OC subjects also yielded an overall multivariate effect (Wilks' λ = 0.91, F[2, 73] = 3.57, p < .05). As predicted, the accuracy of the OCD patients was no different to the sub-clinical OC subjects on the verbal 2-back task (t[37] = - 0.46, p = .64). However, contrary to the hypothesis, the OCD patients performed less accurately on the verbal 3-back task (t[37] = - 2.18, p < .05, d = 0.59, P = 0.43), with a moderate effect size.

Post-hoc analysis, using Tukey's unequal N HSD test, was undertaken to investigate whether there were any differences on verbal 2-back or 3-back accuracy between the other experimental groups. There were no significant differences between the healthy controls, panic disorder patients or sub-clinical OC subjects on verbal 2-back or 3-back accuracy (p > .05).

10.9.3 Influence of demographic and clinical variables on verbal n-back accuracy in the OCD patients

Correlations were performed to examine the relationship between impaired cognitive performance and clinical characteristics for the patients with OCD. Table 21 displays the correlations between the clinical variables - BDI-II, STAI-S, STAI-T, PI and Y-BOCS scores - and verbal 2-back and verbal 3-back accuracy scores.

Table 21
Correlations between clinical variables and verbal 2-back and 3-back accuracy scores

	Clinical variables				
Task	BDI-II	STAI-S	STAI-T	PI	Y-BOCS
Verbal 2-back	- 0.05	0.19	0.02	- 0.23	0.16
Verbal 3-back	- 0.02	0.30	- 0.10	- 0.01	0.38

There were no significant correlations between verbal 2-back or 3-back accuracy scores and the clinical variables of BDI-II, STAI-S, STAI-T, PI and Y-BOCS scores ($p > .05$).

Correlations were performed to examine the relationship between impaired cognitive performance and demographic characteristics for the patients with OCD. Table 22 displays the correlations between the demographic variables of age, gender, handedness and estimated IQ, and verbal 2-back and verbal 3-back accuracy scores.

Table 22
Correlations between demographic variables and verbal 2-back and 3-back accuracy scores

	Demographic variables			
Task	Age	Gender	Handedness	Estimated IQ
Verbal 2-back	- 0.39	0.30	0.25	- 0.05
Verbal 3-back	- 0.40	0.25	0.06	0.03

There were no significant correlations between verbal 2-back or 3-back accuracy scores and the demographic variables of age, gender, handedness and estimated IQ ($p > .05$).

10.9.4 Influence of medication on verbal n-back accuracy in the OCD patients

To evaluate the effects of medication within the OCD group on verbal n-back accuracy performance, OCD patients were divided into two subgroups: medicated and non-medicated. Skewness and kurtosis statistics, normal probability plots and bivariate scatterplots were inspected for signs of violations of the normality and linearity assumptions. No major violations were observed. Levene's test confirmed no violation of the assumption of homogeneity of variance (verbal 2-back: $F[1, 17] = 0.39$, $p = .54$; verbal 3-back: $F[1, 17] = 0.30$, $p = .59$). For OCD patients, separate one-way ANOVAs displayed no significant differences between medicated and non-medicated subjects on verbal 2-back accuracy performance ($F[1, 17] = 1.48$, $p = .24$) or verbal 3-back accuracy performance ($F[1, 17] = 1.27$, $p = .28$).

10.9.5 Influence of symptom subtypes on verbal n-back accuracy in the OCD patients

Correlations were performed to examine the relationship between impaired cognitive performance and symptom subtypes for the patients with OCD. Scores were calculated for the PI subscales contamination, checking, doubting and impaired control over mental activities. Table 23 displays the correlations between the PI subscales and verbal 2-back and verbal 3-back accuracy scores.

Table 23
Correlations between PI subscales and verbal 2-back and 3-back accuracy scores

	PI subscales			
Task	Contamination	Checking	Doubting	Impaired control
Verbal 2-back	- 0.43	- 0.05	0.09	- 0.24
Verbal 3-back	- 0.17	0.09	0.20	- 0.21

There were no significant correlations between verbal 2-back or 3-back accuracy scores and the PI subscales ($p > .05$), although the correlation between contamination obsessions and verbal 2-back accuracy was moderate.

10.10 Verbal n-back task reaction time

10.10.1 Data screening

Prior to analysis, the verbal n-back task reaction time variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of MANOVA. verbal n-back task reaction time comprised four variables: verbal 0-back, verbal 1-back, verbal 2-back and verbal 3-back reaction time. Multicollinearity was assessed using SPSS regression collinearity diagnostics. One dimension had a condition index greater than 30 and was associated with two variables with variance proportions greater than 0.50. As the criteria for multicollinearity was met, it was decided to use one-way ANOVA to compare the overall mean reaction time for the verbal n-back task between experimental groups. Overall reaction time for the verbal n-back task was subsequently examined for accuracy of data entry, missing values and fit between its distribution and the assumptions of ANOVA. The overall reaction time variable was inspected for each experimental group using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. One OCD case and one panic disorder case had missing values for verbal n-back reaction time. There were no missing values for the sub-clinical OC or control groups. The OCD case and the panic disorder case with the missing data were deleted from the analysis. A detailed description of the data screening technique is included as Appendix K.

10.10.2 Results

To test the *a priori* hypothesis that the mean reaction time of the OCD patients would be no different to the healthy controls, panic disorder patients and sub-clinical OC subjects on the verbal n-back task, a one-way ANOVA was conducted using three planned contrasts. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. With one OCD case and one panic disorder case with missing data excluded, and no cases excluded for assumption violations, there were 19 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. Mean reaction times for the four experimental groups on the verbal n-back task are displayed in Table 24.

Table 24
Means and standard deviations of verbal n-back task reaction times (ms) for OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 19)		panic disorder (n = 19)		sub-clinical OC (n = 20)		healthy controls (n = 20)		*F*	*p*
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*		
Overall reaction time (ms)	878	145	916	204	873	170	851	159	0.48	.69

Overall, there were no differences in verbal n-back task reaction time between the four experimental groups ($F[3, 74] = 0.48$, $p = .69$).

As predicted, the mean reaction times of the OCD patients were no different to the other experimental groups on the verbal n-back task (healthy controls: $t[37] = 0.49$, $p = .62$; panic disorder: $t[36] = -0.68$, $p = .50$; sub-clinical OC: $t[37] = 0.12$, $p = .91$).

10.11 Summary of verbal n-back task results

In the present thesis, OCD patients were as accurate as healthy controls, panic disorder patients and sub-clinical OC subjects on a task requiring the active maintenance, but not updating and ordering of verbal stimuli in working memory.

However, compared to healthy controls, panic disorder patients and sub-clinical OC subjects, OCD patients were significantly less accurate on a task where they were required to continually update and temporally order representations of verbal stimuli in working memory. The accuracy of the healthy controls, panic disorder patients and sub-clinical OC subjects did not differ on these measures.

In the present thesis, the impaired accuracy performance of the OCD patients on the verbal n-back task was not the result of demographic or clinical characteristics, or of medication. There was also no significant correlations between performance on the verbal n-back task and symptom subtypes in OCD.

The results also indicated that compared to healthy controls, panic disorder patients and sub-clinical OC subjects, OCD patients performed as quickly on a task requiring the encoding, updating and temporal ordering of verbal task stimuli in working memory.

10.12 Spatial n-back task accuracy (0-back and 1-back trials)

10.12.1 Data screening

Prior to analysis, the spatial 0-back and 1-back accuracy variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of MANOVA. The variables were inspected using the Statistica descriptives procedure. All variables were within range and, although the means were plausible, the standard deviations - particularly for the 1-back task - were quite high. Missing value analysis was undertaken using the SPSS MVA procedure. One OCD case and one panic disorder case had missing values for the spatial n-back task accuracy variables. There were no missing values for the sub-clinical OC or control groups. The OCD and panic disorder cases with missing data were deleted from the analysis.

10.12.2 Normality

The distribution of the spatial 0-back and 1-back accuracy variables were evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. All of the variables exceeded two standard errors of skewness and all but the spatial 1-back scores for the control group exceeded two standard errors of kurtosis. Inspection of the graphical data suggested that there were severe departures from normality for all of the 0- and 1-back variables. As with the verbal n-back task, few errors were made on the 0- and 1-back versions of the spatial n-back task which resulted in a skewed distribution inappropriate for transformation. Due to the severe violations of the normality assumption the non-parametric test for k independent samples, Kruskal-Wallis, and separate Mann-Whitney U test were used to investigate group differences on these variables.

10.12.3 Results

To test the *a priori* hypothesis that the accuracy of the OCD patients would be no different to the healthy control, panic disorder, or sub-clinical OC subjects on the 0-back and 1-back versions of the spatial n-back task, the Kruskal-Wallis ANOVA-by-ranks test was conducted to assess any overall group differences. To test whether the OCD group differed from each of the experimental groups, separate Mann-Whitney U tests were conducted. Specifically, these tests compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. For any significant differences between groups, effect size was investigated by calculating Cohen's d using the Effect Size Generator for Windows: version 2.2 (Devilly, 2004). With one OCD case and one panic disorder case with missing data excluded,

and no cases excluded for assumption violations, there were 19 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. Mean accuracy for the four experimental groups on the 0-back and 1-back versions of the spatial n-back tasks are displayed in Table 25.

Table 25

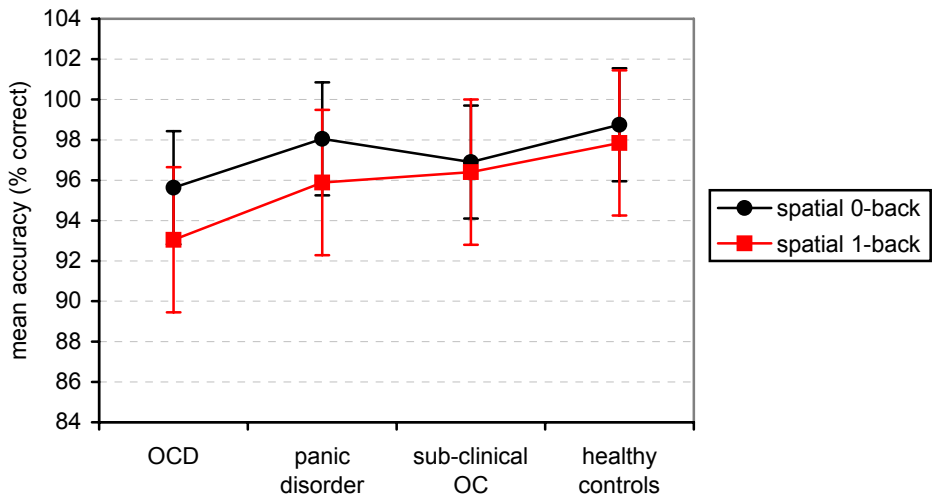
Means and standard deviations of 0-back and 1-back accuracy trials of the spatial n-back task for OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 19)		panic disorder (n =19)		sub-clinical OC (n = 20)		healthy controls (n = 20)		χ^2	*p*
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*		
Spatial 0-back	95.63	10.05	98.05	3.60	96.90	6.87	98.75	3.18	0.72	.87
Spatial 1-back	93.05	11.68	95.89	6.57	96.40	6.27	97.85	2.35	4.13	.25

Overall, there were no significant differences between the four experimental groups on spatial 0-back accuracy (χ^2[3] = 0.72, *p* = .87) or spatial 1-back accuracy (χ^2[3] = 4.13, *p* = .25). The mean accuracy of the four experimental groups on the 0-back and 1-back trials of the spatial n-back task are displayed in Figure 26.

Figure 26

Mean accuracy of the OCD, panic disorder, sub-clinical OC and healthy control subjects on the 0-back and 1-back trials of the spatial n-back task



As predicted, the accuracy of the OCD patients on the spatial 0-back task was no different to the healthy control subjects (*U* = 176.00, *z* = - 0.39, *p* = .69), the panic disorder patients (*U* = 172.00, *z* = 0.25, *p* = .80) or the sub-clinical OC subjects (*U* = 189.50, *z* = - 0.01, *p* = .99).

As predicted, the accuracy of the OCD patients on the spatial 1-back task was also no different to the healthy controls (*U* = 120.50, *z* = - 1.95, *p* = .05), panic disorder (*U* = 142.00, *z* = - 1.12, *p*

= .26) or sub-clinical OC subjects (*U* = 143.50, *z* = - 1.31, *p* = .19). However, the difference between the OCD and healthy control groups on spatial 1-back accuracy did approach significance (*p* = .05) and had a moderate effect size (*d* = 0.57, P = 0.54).

10.13 Spatial n-back task accuracy (2-back and 3-back trials)

10.13.1 Data screening

Prior to analysis, the spatial 2-back and 3-back accuracy variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of MANOVA. The variables were inspected using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. One OCD case and one panic disorder case had missing values for spatial n-back task accuracy. There were no missing values for the sub-clinical OC or control cases. The OCD and panic disorder cases with the missing data were deleted from the analysis. A detailed description of the data screening procedure is included as Appendix L.

10.13.2 Results

To test the *a priori* hypothesis that the accuracy of the OCD patients would be no different to the sub-clinical OC subjects but be less accurate than the panic disorder patients and healthy control subjects on the 2-back and 3-back trials of the spatial n-back task, a MANOVA was conducted using three planned contrasts. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. To measure the effect size of any significant group differences, Cohen's *d* was calculated using the Effect Size Generator for Windows: version 2.2 (Devilly, 2004). With one OCD case and one panic disorder case with missing data excluded, and no cases excluded for assumption violations, there were 19 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. The mean accuracy scores for the spatial 2-back and 3-back trials for the four experimental groups are displayed in Table 26.

Table 26

Means and standard deviations of 2-back and 3-back accuracy trials of the spatial n-back task for OCD, panic disorder, sub-clinical OC and healthy control subjects

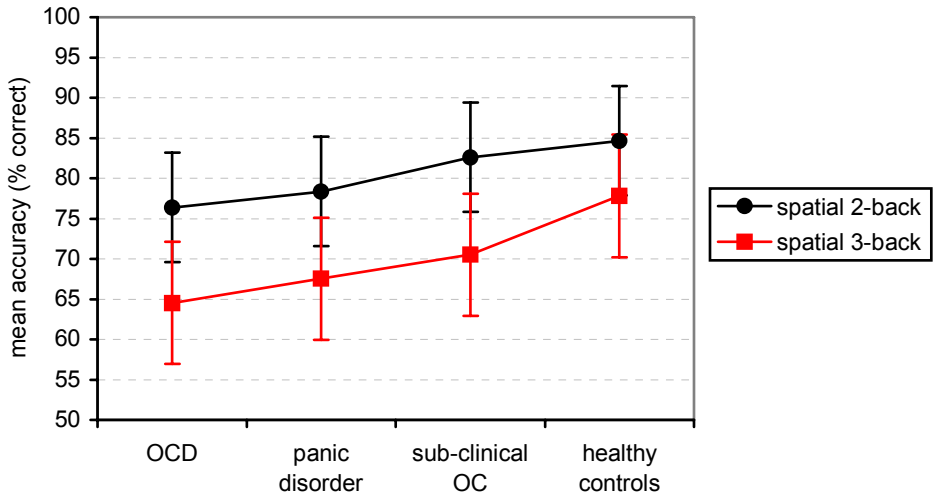
	OCD (n = 19)		panic disorder (n = 19)		sub-clinical OC (n = 20)		healthy controls (n = 20)		Wilks' λ	*F*
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*		
									0.92	**1.10**
Spatial 2-back	76.37	20.18	78.37	17.48	82.60	15.86	84.65	11.35		1.04
Spatial 3-back	64.53	24.59	67.53	17.14	70.50	14.87	77.80	12.06		2.03

Overall, comparison of the OCD, panic disorder, sub-clinical OC and control subjects on the

2-back and 3-back versions of the spatial n-back did not yield a multivariate effect (Wilks' λ = 0.92, *F*[6, 146] = 1.10, *p* = .37). There were no overall differences between experimental groups on spatial 2-back accuracy (*F*[3, 74] = 1.04, *p* = .38), or spatial 3-back accuracy (*F*[3, 74] = 2.03, *p* = .12). Figure 27 displays the mean accuracy of the four experimental groups on the spatial 2-back and 3-back versions of the n-back task.

Figure 27

Mean accuracy of the OCD, panic disorder, sub-clinical OC and healthy control subjects on the 2-back and 3-back versions of the spatial n-back task



Planned comparison between the OCD patients and healthy control subjects did not yield an overall multivariate effect (Wilks' λ = 0.93, *F*[2, 73] = 2.71, *p* = .07), although it was approaching significance. Contrary to the hypothesis, the accuracy of the OCD group was no different to the control group on the spatial 2-back task (*t*[37] = - 1.57, *p* = .12). However, the hypothesis that the OCD patients would be less accurate than the healthy controls on the spatial 3-back task was supported (*t*[37] = - 2.34, *p* < .05, *d* = .69, *P* = .55) with a moderate effect size.

Planned comparison between OCD patients and panic disorder patients did not yield an overall multivariate effect (Wilks' λ = 1.00, *F*[2, 73] = 0.14, *p* = .87). Contrary to the hypothesis, the accuracy of the OCD patients was no different to the panic disorder patients on the spatial 2-back task (*t*[36] = - 0.37, *p* = .71) or the spatial 3-back task (*t*[36] = - 0.52, *p* = .60).

Planned comparison between OCD patients and sub-clinical OC subjects also did not yield an overall multivariate effect (Wilks' λ = 0.98, *F*[2, 73] = 0.74, *p* = .48). As predicted, the accuracy of the OCD group was no different to the sub-clinical OC group on the spatial 2-back task (*t*[37] = - 1.18, *p* = .24) or the spatial 3-back task (*t*[37] = - 1.05, *p* = .30).

Post-hoc Tukey unequal *N* HSD analysis was undertaken to investigate whether there were any differences on spatial 2-back or 3-back accuracy between the other experimental groups. There were no significant differences between the healthy controls, panic disorder patients or sub-clinical OC groups on verbal 2-back or 3-back accuracy ($p > .05$).

10.13.3 Influence of demographic and clinical variables on spatial n-back accuracy in the OCD patients

Correlations were performed to examine the relationship between impaired cognitive performance and the clinical characteristics of the patients with OCD. Table 27 displays the correlations between the clinical variables - BDI-II, STAI-S, STAI-T, PI and Y-BOCS scores - and spatial 3-back accuracy scores.

Table 27
Correlations between clinical variables and spatial 3-back accuracy score

	Clinical variables				
Task	BDI-II	STAI-S	STAI-T	PI	Y-BOCS
Spatial 3-back	- 0.14	0.09	- 0.16	- 0.15	0.05

There were no significant correlations between spatial 3-back accuracy and the clinical variables of BDI-II, STAI-S, STAI-T, PI and Y-BOCS scores ($p > .05$).

Correlations were performed to examine the relationship between impaired cognitive performance and the demographic characteristics of the patients with OCD. Table 28 displays the correlations between the demographic variables of age, gender, handedness and estimated IQ, and spatial 3-back accuracy scores.

Table 28
Correlations between demographic variables and spatial 3-back accuracy score

	Demographic variables			
Task	Age	Gender	Handedness	Estimated IQ
Spatial 3-back	- 0.32	0.37	0.09	- 0.19

There were no significant correlations between spatial 3-back accuracy and the demographic variables of age, gender, handedness and estimated IQ ($p > .05$).

10.13.4 Influence of medication of spatial n-back task accuracy in the OCD patients

To evaluate the effects of medication within the OCD group on spatial n-back accuracy performance, OCD patients were divided into subgroups: medicated and non-medicated. Inspection of skewness and kurtosis statistics, normal probability plots and bivariate scatterplots confirmed no violations of the assumptions of normality or linearity. Levene's test confirmed no violations of the homogeneity of variance assumption (spatial 2-back: $F[1, 17] = 1.38$, $p = .26$;

spatial 3-back: F[1, 17] = 2.81, p = .11). For OCD patients, separate one-way ANOVAs indicated no significant differences between medicated and non-medicated subjects on spatial 2-back accuracy (F[1, 17] = 0.46, p = .50) or spatial 3-back accuracy (F[1, 17] = 0.74, p = .40).

10.13.5 Influence of symptom subtypes on spatial n-back accuracy in the OCD patients

Correlations were performed to examine the relationship between impaired cognitive performance and symptom subtypes for the patients with OCD. Scores were calculated for the PI subscales contamination, checking, doubting and impaired control over mental activities. Table 29 displays the correlations between the PI subscales and spatial 3-back accuracy scores.

Table 29
Correlations between PI subscales and spatial 3-back accuracy scores

	PI subscales			
Task	Contamination	Checking	Doubting	Impaired control
Spatial 3-back	- 0.25	- 0.09	0.05	- 0.13

There were no significant correlations between spatial 3-back accuracy scores and the PI subscales (p > .05).

10.14 Spatial n-back task reaction time

10.14.1 Data screening

Prior to analysis, the spatial n-back task reaction time variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of MANOVA. Spatial n-back task reaction time comprised four variables: spatial 0-back, spatial 1-back, spatial 2-back and spatial 3-back reaction time. Multicollinearity was assessed using SPSS regression collinearity diagnostics. While none of the dimensions had a condition index greater than 30 there was one dimension with a condition index greater than 15 associated with two variables with variance proportions greater than .50. While criteria for multicollinearity was not met it was decided to use one-way ANOVA to compare the overall mean reaction time for the spatial n-back task between experimental groups as this procedure was employed to compare reaction times on the verbal n-back task. Overall reaction time for the spatial n-back task was subsequently examined for accuracy of data entry, missing values and fit between its distribution and the assumptions of one-way ANOVA. The spatial n-back task overall reaction time variable was inspected for each experimental group using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. One OCD case and one panic disorder case had missing values for spatial n-back reaction time. There were no missing values for the sub-clinical OC or healthy control groups. The OCD case and the panic

disorder case with the missing data were deleted from the analysis. A detailed description of the data screening procedure is included as Appendix M.

10.14.2 Results

To test the *a priori* hypothesis that the reaction times of the OCD patients would be no different to the panic disorder patients, healthy control subjects and the sub-clinical OC subjects on the spatial n-back task, a one-way ANOVA was conducted using three planned contrasts. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. With one OCD case and one panic disorder case with missing data excluded, and no cases excluded for assumption violations, there were 19 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. The mean reaction times for the four experimental groups on the spatial n-back task are displayed in Table 30.

Table 30

Means and standard deviations of spatial n-back task reaction times (ms) for OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 19)		panic disorder (n = 19)		sub-clinical OC (n = 20)		healthy controls (n = 20)		*F*	*p*
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*		
Overall reaction time (ms)	846	148	871	191	836	195	817	168	0.31	.82

Overall, there was no difference in spatial n-back task reaction time between the four experimental groups ($F[3, 74] = 0.31$, $p = .82$).

As hypothesised, the reaction times of the OCD patients on the spatial n-back task were no different to the other experimental groups (healthy controls: $t[37] = 0.50$, $p = .62$; panic disorder: $t[36] = - 0.44$, $p = 67$; sub-clinical OC: $t[37] = 0.18$, $p = .86$).

10.15 Summary of spatial n-back results

In the present thesis, the OCD patients were are accurate as healthy controls, panic disorder patients and sub-clinical OC subjects on a task requiring the encoding and maintenance, but not updating and temporal ordering, of spatial locations in working memory.

Compared to healthy control subjects, OCD patients were impaired on a task requiring the encoding, updating and temporal ordering of spatial locations in working memory. However, the accuracy of the OCD patients did not differ from panic disorder patients or sub-clinical OC subjects on this task.

In the present thesis, the impaired accuracy of the OCD patients on the spatial 3-back task was not the result of demographic or clinical characteristics, or of medication status. There was also no significant correlation between performance on the spatial 3-back task and symptom subtypes in OCD.

The results also indicated that compared to healthy controls, panic disorder patients and sub-clinical OC subjects, OCD patients performed as quickly on a task requiring the encoding, updating and temporal ordering of spatial locations in working memory.

10.16 Summary of cognitive results

A summary of the results from the three DMS tasks and two n-back tasks are displayed in Table 31.

Table 31
Summary of cognitive task results

	Comparison		
Task	OCD versus healthy controls	OCD versus panic disorder	OCD versus sub-clinical OC
DMS task accuracy			
Irregular Objects	OCD =	OCD =	OCD =
Spatial Locations	OCD significantly ↓ on memory trials	OCD =	OCD =
Geometric Objects	OCD =	OCD =	OCD =
DMS task reaction time			
Irregular Objects	OCD =	OCD =	OCD =
Spatial Locations	OCD =	OCD =	OCD =
Geometric Objects	OCD =	OCD =	OCD =
Verbal n-back accuracy			
0-back	OCD =	OCD =	OCD =
1-back	OCD =	OCD =	OCD =
2-back	OCD significantly ↓	OCD =	OCD =
3-back	OCD significantly ↓	OCD significantly ↓	OCD significantly ↓
Verbal n-back reaction time			
Overall	OCD =	OCD =	OCD =
Spatial n-back accuracy			
0-back	OCD =	OCD =	OCD =
1-back	OCD =	OCD =	OCD =
2-back	OCD =	OCD =	OCD =
3-back	OCD significantly ↓	OCD =	OCD =
Spatial n-back reaction time			
Overall	OCD =	OCD =	OCD =

CHAPTER 11: RESULTS: PERSONALITY

11.1 Introduction

In this chapter, the five domains of the NEO PI-R are examined to identify whether there are significant differences between the OCD patients and the healthy controls, panic disorder patients and sub-clinical OC subjects. Differences between the experimental groups on the facets of each domain of the NEO PI-R are then examined separately. The differences between the OCD patients and the other experimental groups on the domains and facets of the NEO PI-R were then examined in relation to current depression and state anxiety. Finally, regression analysis is undertaken to identify which personality variables are the best predictors of obsessive-compulsive symptoms in each of the experimental groups. For all analyses an alpha level of .05 was chosen for the detection of significant differences. All statistics are two-tailed.

11.2 NEO PI-R domains

11.2.1 Data screening

Prior to analysis, the NEO PI-R domain variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of MANOVA. The NEO PI-R domains comprised five variables: Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness. These variables were inspected using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. Two OCD cases and one panic disorder case had missing values for the NEO PI-R domain variables. There were no missing values for the sub-clinical OC or control cases. The OCD and panic disorder cases with the missing data were deleted from the analysis. A full description of the data screening procedure is included as Appendix N.

11.2.2 Results

To compare the OCD patients to the healthy controls, panic disorder and sub-clinical OC subjects on the domains of the NEO PI-R, a MANOVA was conducted using three planned contrasts. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. To measure the effect size of any significant group differences, Cohen's *d* was calculated using the Effect Size Generator for Windows: version 2.2 (Devilly, 2004). With two OCD cases and one panic disorder case with missing data excluded, and no cases excluded for assumption violations, there were 18 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. Mean NEO PI-R domain T-scores for the four experimental groups are displayed in Table 32.

Table 32

Means and standard deviations of NEO PI-R domain T-scores for OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 18)		panic disorder (n =19)		sub-clinical OC (n = 20)		healthy controls (n = 20)				
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*Wilks' λ*	*F*	
									0.48	**3.89**	**
Neuroticism	69.94	9.42	66.95	12.24	59.70	12.24	45.45	16.85		13.55	**
Extraversion	39.11	8.98	40.53	10.80	45.55	14.80	52.50	8.00		5.84	*
Openness	52.33	9.20	58.00	14.29	53.60	10.73	59.20	6.14		1.93	
Agreeableness	47.83	13.06	46.79	17.20	45.85	10.89	51.80	12.75		0.73	
Conscientiousness	40.17	8.52	43.00	12.17	48.30	11.31	45.85	13.24		1.78	

Note: * $p < .01$, ** $p < .001$

When comparing OCD, panic disorder, sub-clinical OC and control subjects on the domains of the NEO PI-R, an overall multivariate effect was observed (Wilks' $\lambda = 0.48$, $F[15, 190.88] = 3.89$, $p < .001$). The experimental groups differed significantly on the domains of Neuroticism ($F[3, 73] = 13.55$, $p < .001$) and Extraversion ($F[3, 73] = 5.84$, $p < .01$). The groups did not differ on the domains of Openness ($F[3, 73] = 1.93$, $p = .13$), Agreeableness ($F[3, 73] = 0.73$, $p = .54$) or Conscientiousness ($F[3, 73] = 1.78$, $p = .16$).

When comparing OCD patients and healthy controls, an overall multivariate effect was observed on the domains of the NEO PI-R (Wilks' $\lambda = 0.60$, $F[5, 69] = 9.26$, $p < .001$). As predicted, the OCD patients scored significantly higher on the domain of Neuroticism ($t[36] = 5.77$, $p < .001$, $d = 1.79$, $P = 1.00$), significantly lower on the domain of Extraversion ($t[36] = - 3.74$, $p < .001$, $d = 1.57$, $P = 1.00$) and no differently on the domain of Conscientiousness ($t[36] = - 1.52$, $p = .13$) compared to the healthy control subjects. Contrary to the hypothesis, the OCD patients scored significantly lower on the domain of Openness compared to healthy control subjects ($t[36] = - 2.02$, $p < .05$, $d = 0.88$, $P = 0.84$). The prediction that the OCD patients would score significantly higher on the domain of Agreeableness was not supported ($t[36] = - 0.90$, $p = .37$).

Planned comparisons between OCD patients and the panic disorder patients did not yield an overall multivariate effect on the domains of the NEO PI-R (Wilks' $\lambda = 0.95$, $F[5, 69] = 0.80$, $p = .55$). As predicted, the OCD patients scored no differently to the panic disorder patients on the domains of Neuroticism ($t[35] = 0.70$, $p = .49$), Extraversion ($t[35] = - 0.39$, $p = .70$), Openness ($t[35] = - 1.64$, $p = .10$) or Conscientiousness ($t[35] = - 0.75$, $p = .46$). Contrary to the hypothesis, the OCD patients did not score significantly higher on the domain of Agreeableness ($t[35] = 0.23$, $p = .82$) compared to the panic disorder patients.

Planned comparisons between OCD patients and the sub-clinical OC subjects did not yield an overall multivariate effect on the domains of the NEO PI-R (Wilks' $\lambda = 0.88$, $F[5, 69] = 1.87$, $p = .11$). As predicted, the OCD patients scored no differently to the sub-clinical OC subjects on the domains of Extraversion ($t[36] = - 1.80$, $p = .08$), Openness ($t[36] = - 0.37$, $p = .71$), or

Agreeableness (t[36] = 0.45, p = .66). Contrary to the hypothesis, the OCD patients scored significantly higher on the domain of Neuroticism (t[36] = 2.41, p < .05, d = 0.94, P = 0.88) and significantly lower on the domain of Conscientiousness (t[36] = - 2.18, p < .05, d = 0.81, P = 0.79), compared to the sub-clinical OC subjects.

Post-hoc Tukey unequal N HSD tests were conducted to identify any significant differences between the healthy controls, panic disorder and sub-clinical OC subjects. The results indicated that the healthy control subjects scored significantly lower on the Neuroticism domain compared to the panic disorder (p < .001) and the sub-clinical OC subjects (p < .01). The healthy control subjects also scored significantly higher on the Extraversion domain compared to the panic disorder patients (p < .01).

11.2.3 Summary

The results indicated that on the domains of the NEO PI-R, OCD patients reported significantly higher levels of Neuroticism, and significantly lower levels of Extraversion and Openness compared to healthy control subjects. The OCD patients did not differ significantly from the panic disorder patients on any of the NEO PI-R domains. Compared to a sub-clinical OC group, OCD patients reported significantly higher levels of Neuroticism and significantly lower levels of Conscientiousness.

11.3 The influence of depression and anxiety on NEO PI-R domain scores

To investigate whether current depression and state anxiety accounted for the differences observed between the OCD patients and the healthy control and sub-clinical OC subjects on the domains of the NEO PI-R, a series of multiple regression analyses were undertaken. Due to the small sample size these analyses are tentative and exploratory.

11.3.1 OCD versus healthy control subjects

As the OCD group reported higher levels of current depression and state anxiety compared to the healthy control group, analysis was undertaken to evaluate the degree to which BDI-II and STAI-S scores influenced the differences on the Neuroticism, Extraversion and Openness domains between these two groups. Separate analyses were conducted with Neuroticism, Extraversion and Openness as the dependent variables, and group membership, BDI-II and STAI-S scores as the independent variables.

Neuroticism

In regression analysis, the independent variables should have some relationship with the dependent variable (preferably above .30), but the correlations between the independent variables should not be too high (Pallant, 2005). For the regression of BDI-II and STAI-S scores on Neuroticism, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 33.

Table 33

Correlations among Neuroticism, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	Neuroticism	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	- 0.67*	-		
BDI-II	0.67*	- 0.75*	-	
STAI-S	0.71*	- 0.58*	0.73*	-

Note: * p < .001

The independent variables all had significant correlations with Neuroticism. The intercorrelations between the independent variables did not appear to be too high. A simple bivariate regression analysis was performed to establish the amount of variance in Neuroticism score that could be explained by group membership. A summary of the regression statistics is displayed in Table 34.

Table 34

Regression of group membership on Neuroticism for the comparison of OCD and healthy control subjects

Model summary					
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.67	0.45	29.63	1,36	.00
Coefficients					
	B	*SE B*	β	*t*	*p*
Constant	78.11	4.47		17.46	.00
Group	- 8.17	1.50	- 0.67	- 5.44	.00

When group was used as a single predictor for Neuroticism, the direct model was significant and accounted for 45% of the variance in Neuroticism. Group made a unique and significant contribution to the prediction of Neuroticism score. To evaluate whether group membership still predicted significant portions of Neuroticism after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 35.

Table 35

Hierarchical regression of BDI-II, STAI-S and group variables on Neuroticism for the comparison of OCD and healthy control subjects

Model summary

	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.75	0.56	22.00	2,35	.00			
2. BDI-II, STAI-S, Group	0.78	0.61	17.74	3,34	.00	0.05	4.64	.04

Coefficients

	B	*SE B*	β	*t*	*p*
1. Constant	19.77	9.16		2.16	.04
BDI-II	0.47	0.24	0.32	1.96	.06
STAI-S	0.92	0.31	0.48	2.94	.01
2. Constant	36.80	11.77		3.13	.00
BDI-II	0.11	0.28	0.08	0.40	.69
STAI-S	0.87	0.30	0.45	2.90	.01
Group	- 4.26	1.98	- 0.35	- 2.16	.04

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.91, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than 0.20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 56% of the variance in Neuroticism score. STAI-S scores made a unique and significant contribution to the prediction of Neuroticism score. The contribution of BDI-II scores to the prediction of Neuroticism was approaching significance. The addition of group in model two significantly increased the amount of Neuroticism variance explained. In the new model, both STAI-S scores and group made a unique and significant contribution to the prediction of Neuroticism score. After controlling for current depression and state anxiety, group membership still significantly predicted Neuroticism score.

Extraversion

For the regression of BDI-II and STAI-S scores on Extraversion scores, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 36.

Table 36

Correlations among Extraversion, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	Extraversion	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	0.63*	-		
BDI-II	- 0.57*	- 0.75*	-	
STAI-S	- 0.57*	- 0.58*	0.73*	-

Note: * $p < .001$

The independent variables all had substantial correlations with Extraversion. The intercorrelations between the independent variables did not appear to be too high. A simple regression analysis was performed first to establish the amount of variance in Extraversion score that could be explained by group membership. A summary of the regression statistics are displayed in Table 37.

Table 37
Regression of group membership on Extraversion for the comparison of OCD and healthy control subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.63	0.40	23.64	1,36	.00
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	34.65	2.74		12.66	.00
Group	4.46	0.92	0.63	4.86	.00

When group was used as a single predictor for Extraversion, the direct model was significant and accounted for 40% of the variance in Extraversion score. Group made a unique and significant contribution to the prediction of Extraversion score. To evaluate whether group membership still predicted significant portions of Extraversion after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 38.

Table 38
Hierarchical regression of BDI-II, STAI-S and group variables on Extraversion for the comparison of OCD and healthy control subjects

	Model summary							
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.61	0.38	10.49	2,35	.00			
2. BDI-II, STAI-S, Group	0.68	0.46	9.58	3,34	.00	0.08	5.23	.03
	Coefficients							
	B	*SE B*	β	*t*	*p*			
1. Constant	62.13	6.35		9.79	.00			
BDI-II	- 0.28	0.17	- 0.33	-1.71	.10			
STAI-S	- 0.37	0.22	- 0.33	-1.69	.10			
2. Constant	49.70	8.09		6.14	.00			
BDI-II	- 0.02	0.19	- 0.03	-0.12	.90			
STAI-S	- 0.33	0.21	- 0.29	-1.59	.12			
Group	3.11	1.36	0.44	2.29	.03			

SPSS regression statistics were first investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers

(Mahalanobis distance = 8.91, critical value = χ^2[3] = 16.27, p < .001). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 38% of the variance in Extraversion score. However, neither BDI-II scores nor STAI-S scores made a unique and significant contribution to the prediction of Extraversion score. The addition of group in the second model significantly increased the amount of Extraversion variance explained. Group made a unique and significant contribution to the prediction of Extraversion score. After controlling for current depression and state anxiety, group membership still significantly predicted Extraversion score.

Openness

For the regression of BDI-II and STAI-S scores on Openness, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 39.

Table 39
Correlations among Openness, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	Openness	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	0.41*	-		
BDI-II	- 0.56**	- 0.75**	-	
STAI-S	- 0.51*	- 0.58**	0.73**	-

Note: * p < .01, ** p < .001

The independent variables were all significantly correlated with Openness scores. The intercorrelations between the independent variables did not appear to be too high. A simple regression analysis was performed first to establish the amount of variance in Openness score that could be explained by group membership. A summary of the regression statistics is displayed in Table 40.

Table 40
Regression of group membership on Openness for the comparison of OCD and healthy control subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.41	0.17	7.46	1,36	.01
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	50.04	2.50		20.02	.00
Group	2.29	0.84	0.41	2.73	.01

When group was used as a single predictor for Openness, the direct model was significant and accounted for 17% of the variance in Openness score. Group made a unique and significant

contribution to the prediction of Openness score. To evaluate whether group membership still predicted significant portions of Openness after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 41.

Table 41

Hierarchical regression of BDI-II, STAI-S and group variables on Openness for the comparison of OCD and healthy control subjects

Model summary

	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.58	0.33	8.74	2,35	.00			
2. BDI-II, STAI-S, Group	0.58	0.33	5.67	3,34	.00	0.00	0.02	.90

Coefficients

	B	*SE B*	β	*t*	*p*
1. Constant	65.81	5.11		12.88	.00
BDI-II	- 0.26	0.13	- 0.39	-1.96	.06
STAI-S	- 0.20	0.18	- 0.23	-1.12	.27
2. Constant	66.39	7.00		9.49	.00
BDI-II	- 0.27	0.17	- 0.41	-1.64	.11
STAI-S	- 0.20	0.18	- 0.23	-1.12	.27
Group	- 0.14	1.17	- 0.03	-0.12	.90

SPSS regression statistics were first investigated to ensure that none of the assumptions of multiple regression were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.91, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 33% of the variance in Openness score. However, neither BDI-II scores nor STAI-S scores made a unique and significant contribution to the prediction of Openness score. The addition of group in model 2 did not significantly increase the amount of Openness variance explained. In the new model, none of the variables made a unique and significant contribution to the prediction of Openness score. After controlling for current depression and state anxiety, group membership did not significantly predict Openness score.

11.3.2 OCD versus sub-clinical OC subjects

As the OCD group reported higher levels of current depression and state anxiety than the sub-clinical OC group, analysis was undertaken to evaluate the degree to which BDI-II and STAI-S scores influenced differences on the Neuroticism and Conscientiousness domains. Separate analyses were conducted with Neuroticism and Conscientiousness as the dependent variables, and group membership, BDI-II and STAI-S scores as the independent variables.

Neuroticism

For the regression of BDI-II and STAI-S scores on Neuroticism, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 42.

Table 42

Correlations among Neuroticism, BDI-II and STAI-S scores for the comparison of OCD and sub-clinical OC subjects

Variables	Neuroticism	Group	BDI-II	STAI-S
Group (OCD = 1, sub-clinical OC = 2)	- 0.43*	-		
BDI-II	0.62**	- 0.42*	-	
STAI-S	0.57**	- 0.28	0.61**	-

Note: * $p < .01$, ** $p < .001$

The independent variables all had significant correlations with Neuroticism. The intercorrelations between the independent variables did not appear to be too high. A simple regression analysis was performed to establish the amount of variance in Neuroticism score that could be explained by group membership. A summary of the regression statistics is displayed in Table 43.

Table 43

Regression of group membership on Neuroticism for the comparison of OCD and sub-clinical OC subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, sub-clinical OC = 2)	0.43	0.19	8.22	1,36	.01
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	75.07	4.08		18.41	.00
Group	- 5.12	1.79	- 0.43	- 2.87	.01

When group membership was used as a single predictor of Neuroticism, the model was significant and accounted for 19% of the variance in Neuroticism score. Group made a unique and significant contribution to the prediction of Neuroticism score. To evaluate whether group membership predicted significant portions of Neuroticism after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered in step two. A summary of the hierarchical regression results is displayed in Table 44.

Table 44

Hierarchical regression of group, BDI-II and STAI-S scores on Neuroticism for the comparison of OCD and sub-clinical OC subjects

	Model summary							
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.66	0.44	13.71	2,35	.00			
2. BDI-II, STAI-S, Group	0.69	0.47	10.14	3,34	.00	0.03	2.12	.16

	Coefficients				
	B	*SE B*	β	*t*	*p*
1. Constant	43.59	5.55		7.86	.00
BDI-II	0.48	0.18	0.43	2.68	.01
STAI-S	0.34	0.18	0.31	1.92	.06
2. Constant	50.33	7.16		7.03	.00
BDI-II	0.39	0.19	0.35	2.10	.04
STAI-S	0.33	0.18	0.30	1.90	.07
Group	- 2.37	1.63	- 0.20	- 1.46	.16

SPSS regression statistics were examined to ensure that none of the assumption of multiple regression were violated. Normal probability plots and residual scatterplots did not suggest violations of the normality, linearity or homoscedasticity assumptions. Mahalanobis distance was 9.78, below the critical value of $\chi^2[3] = 16.27$. Tolerance values were all greater than 0.20 and collinearity diagnostics confirmed no issues of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 44% of the variance in Neuroticism score. BDI-II score made a unique and significant contribution to the prediction of Neuroticism. STAI-S was approaching significance in its prediction of Neuroticism. In model two, the addition of group did not significantly increase the amount of variance in Neuroticism explained. In the new model, only BDI-II scores predicted significant amounts of the Neuroticism variance. After controlling for current depression, group did not significantly predict Neuroticism score.

Conscientiousness

For the regression of BDI-II score on Conscientiousness, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 45.

Table 45

Correlations among Conscientiousness, BDI-II and STAI-S scores for the comparison of OCD and sub-clinical OC subjects

Variables	Conscientiousness	Group	BDI-II	STAI-S
Group (OCD = 1, sub-clinical OC = 2)	0.38*	-		
BDI-II	- 0.59**	- 0.42*	-	
STAI-S	- 0.53**	- 0.28	0.61**	-

Note: * $p < .01$, ** $p < .001$

The independent variables all correlated significantly with Conscientiousness. The intercorrelations between the independent variables did not appear to be too high. A simple bivariate regression analysis was performed to establish the amount of variance in Conscientiousness score that could be explained by group membership. A summary of the regression statistics is displayed in Table 46.

Table 46

Regression of group membership on Conscientiousness for the comparison of OCD and sub-clinical OC subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, sub-clinical OC = 2)	0.38	0.15	6.15	1,36	.02
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	36.10	3.74		9.65	.00
Group	4.07	1.64	0.38	2.48	.02

When group membership was used as a single predictor of Conscientiousness, the model was significant and accounted for 15% of the variance in Conscientiousness score. Group made a unique and significant contribution to the prediction of Conscientiousness score. To evaluate whether group membership predicted significant portions of Conscientiousness after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered in step two. A summary of the hierarchical regression results is displayed in Table 47.

Table 47

Hierarchical regression of BDI-II and STAI-S scores and group on Conscientiousness for the comparison of OCD and sub-clinical OC subjects

	Model summary							
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.63	0.39	11.30	2,35	.00			
2. BDI-II, STAI-S, Group	0.63	0.41	7.96	3,34	.00	0.02	1.16	.29
	Coefficients							
	B	*SE B*	β	*t*	*p*			
1. Constant	61.86	5.17		11.96	.00			
BDI-II	- 0.42	0.17	- 0.42	- 2.52	.02			
STAI-S	- 0.28	0.17	- 0.28	- 1.65	.11			
2. Constant	57.14	6.77		8.45	.00			
BDI-II	- 0.36	0.18	- 0.36	- 2.04	.05			
STAI-S	- 0.27	0.17	- 0.27	- 1.61	.12			
Group	1.66	1.54	0.16	1.08	.29			

SPSS regression statistics were examined to ensure that none of the assumptions of multiple regression were violated. Normal probability plots and residual scatterplots did not suggest violations of the normality, linearity or homoscedasticity assumptions. Mahalanobis distance

was 9.78, below the critical value of $\chi^2[3] = 16.27$. Tolerance values were all greater than 0.20 and collinearity diagnostics confirmed no issues of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 39% of the variance in Conscientiousness score. BDI-II score made a unique and significant contribution to the prediction of Conscientiousness. The contribution of STAI-S to the prediction of Conscientiousness was not significant. The addition of group did not significantly increase the amount of variance in Conscientiousness explained. In the new model, only BDI-II scores predicted significant amounts of the Conscientiousness variance. After controlling for current depression, group did not significantly predict Conscientiousness score.

11.3.3 Summary

After controlling for measures of current depression and state anxiety, the OCD patients and healthy control subjects still differed on the Neuroticism and Extraversion domains. On the Openness domain, the OCD patients and healthy control subjects were no longer different after controlling for depression and anxiety symptoms. For the comparison of OCD patients and sub-clinical OC subjects, group differences on both Neuroticism and Conscientiousness disappeared after controlling for current depression.

11.4 Neuroticism facets

11.4.1 Data screening

Prior to analysis, the Neuroticism facet variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of MANOVA. Neuroticism facets comprised six variables: anxiety, angry hostility, depression, self-consciousness, impulsiveness, vulnerability. These variables were inspected using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. Two OCD cases and one panic disorder case had missing values for the Neuroticism facets. There were no missing values for the sub-clinical OC or healthy control cases. The OCD and panic disorder cases with the missing data were deleted from the analysis. For a full description of the data screening process employed, refer to Appendix O.

11.4.2 Results

To test the hypotheses regarding the Neuroticism facets and OCD patients in comparison to the healthy controls, panic disorder and sub-clinical OC subjects, a MANOVA was conducted using three planned contrasts. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. To measure the effect size of any significant group differences, Cohen's *d* was calculated using the Effect Size Generator for Windows: version 2.2 (Devilly, 2004). With two OCD cases and one panic disorder case with

missing data excluded, and no cases excluded for assumption violations, there were 18 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. Mean Neuroticism facet T-scores for the four experimental groups are displayed in Table 48.

Table 48

Means and standard deviations of Neuroticism facet T-scores for OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 18)		panic disorder (n =19)		sub-clinical OC (n = 20)		healthy controls (n = 20)				
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	Wilks' λ	*F*	
									0.44	**3.63**	**
N1 Anxiety	65.50	9.82	66.47	10.22	58.89	13.30	44.30	13.16		14.66	**
N2 Angry Hostility	64.56	10.18	58.79	15.79	56.53	9.94	49.00	14.50		4.77	*
N3 Depression	70.83	9.54	68.95	10.30	58.90	13.39	45.40	11.26		20.70	**
N4 Self-consciousness	66.39	9.60	65.37	13.50	61.11	12.58	42.00	11.44		17.87	**
N5 Impulsiveness	54.72	11.05	50.37	13.58	51.79	10.64	45.25	11.76		2.17	
N6 Vulnerability	68.94	10.96	66.11	14.39	58.55	13.60	43.75	11.34		15.35	**

Note: * $p < .01$, ** $p < .001$

When comparing OCD, panic disorder, sub-clinical OC and control subjects on the facets of Neuroticism, an overall multivariate effect was observed (Wilks' $\lambda = 0.44$, $F[18, 192.82] = 3.63$, $p < .001$). The experimental groups differed significantly on measures of anxiety ($F[3, 73] = 14.66$, $p < .001$), angry hostility ($F[3, 73] = 4.77$, $p < .01$), depression ($F[3, 73] = 20.70$, $p < .001$), self-consciousness ($F[3, 73] = 17.87$, $p < .001$), and vulnerability ($F[3, 73] = 15.35$, $p < .001$). The groups did not differ on the measure of impulsiveness ($F[3, 73] = 2.17$, $p = .10$).

When comparing OCD patients and healthy controls, an overall multivariate effect was observed on the facets of Neuroticism (Wilks' $\lambda = 0.56$, $F[6, 68] = 8.80$, $p < .001$). As predicted, the OCD patients scored higher on the facets of anxiety ($t[36] = 5.53$, $p < .001$, $d = 1.83$, $P = 1.00$), angry hostility ($t[36] = 3.72$, $p < .001$, $d = 1.24$, $P = 0.96$), depression ($t[36] = 6.95$, $p < .001$, $d = 2.44$, $P = 1.00$), self-consciousness ($t[36] = 6.31$, $p < .001$, $d = 2.31$, $P = 1.00$), impulsiveness ($t[36] = 2.47$, $p < .05$, $d = 0.83$, $P = 0.70$) and vulnerability ($t[36] = 6.12$, $p < .001$, $d = 2.26$, $P = 1.00$).

Planned comparisons between OCD patients and the panic disorder patients did not yield an overall multivariate effect on the facets of Neuroticism (Wilks' $\lambda = 0.96$, $F[6, 68] = 0.50$, $p = .81$). As predicted, the OCD patients scored no differently to the panic disorder patients on the facets of anxiety ($t[35] = - 0.25$, $p = .80$), angry hostility ($t[35] = 1.36$, $p = .18$), depression ($t[35] = 0.51$, $p = .61$), self-consciousness ($t[35] = 0.26$, $p = .80$), impulsiveness ($t[35] = 1.12$, $p = .27$) and vulnerability ($t[35] = 0.68$, $p = .50$).

Planned comparison between OCD patients and the sub-clinical OC subjects did not yield an overall multivariate effect on the facets of Neuroticism (Wilks' $\lambda = 0.84$, $F[6, 68] = 2.11$, $p = .06$). Contrary to the hypothesis, the OCD patients did score higher on the facets of depression

(t[36] = 3.26, p < .01, d = 1.03, P = 0.87) and vulnerability (t[36] = 2.52, p < .05, d = 0.84, P = 0.71). As predicted, there were no differences between the OCD and sub-clinical OC subjects on the Neuroticism facets of anxiety (t[36] = 1.72, p = .09), angry hostility (t[36] = 1.92, p = .06), self-consciousness (t[36] = 1.37, p = .18) and impulsiveness (t[36] = 0.76, p = .45).

Post-hoc Tukey unequal N HSD tests were conducted to identify any significant differences between the healthy controls, panic disorder and sub-clinical OC subjects on the facets of Neuroticism. The results indicated that the healthy control subjects scored significantly lower on the Neuroticism facets of anxiety, depression, self-consciousness and vulnerability compared to the panic disorder (p < .001) and the sub-clinical OC subjects (p < .01). The sub-clinical OC subjects also scored significantly lower on the Neuroticism facet of depression compared to the panic disorder patients (p < .05).

11.4.3 Summary

The results indicated that on the facets of Neuroticism, OCD patients reported significantly higher levels of anxiety, angry hostility, depression, self-consciousness, impulsiveness and vulnerability compared to healthy control subjects. The OCD patients did not differ significantly from the panic disorder patients on any of the Neuroticism facets. Compared to a sub-clinical OC group, OCD patients reported significantly higher levels of depression and vulnerability.

11.5 The influence of depression and anxiety on Neuroticism facet scores

11.5.1 OCD versus healthy control subjects

As the OCD patients reported higher scores on the clinical measures of current depression and state anxiety analysis was undertaken to evaluate the degree to which BDI-II and STAI-S scores influenced differences on each of the Neuroticism facets. Separate analyses were conducted with each of the Neuroticism facets as the dependent variable and group, BDI-II, and STAI-S scores as the independent variables.

N1: Anxiety

For the regression of BDI-II and STAI-S scores on the anxiety facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 49.

Table 49

Correlations among the anxiety facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	N1: anxiety	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	- 0.68*	-		
BDI-II	0.63*	- 0.75*	-	
STAI-S	0.79*	- 0.58*	0.73*	-

Note: * p < .001

The independent variables all had significant correlations with anxiety. A simple bivariate regression analysis was performed to establish the amount of variance in anxiety score that could be explained by group membership. A summary of the regression statistics is displayed in Table 50.

Table 50

Regression of group membership on the anxiety facet for the comparison of OCD and healthy control subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.68	0.46	31.11	1,36	.00
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	72.57	3.78		19.25	.00
Group	- 7.01	1.26	- 0.68	- 5.58	.00

When group was used as a single predictor for anxiety, the direct model was significant and accounted for 46% of the variance in anxiety score. Group made a unique and significant contribution to the prediction of anxiety score. To evaluate whether group membership still predicted significant portions of anxiety after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 51.

Table 51

Hierarchical regression of group, BDI-II and STAI-S scores on the facet of anxiety

	Model Summary							
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.79	0.63	29.20	2,35	.00			
2. BDI-II, STAI-S, Group	0.84	0.70	26.69	3,34	.00	0.07	8.75	.01
	Coefficients							
	B	*SE B*	β	*t*	*p*			
1. Constant	13.32	7.20		1.85	.07			
BDI-II	0.16	0.19	0.13	0.83	.41			
STAI-S	1.14	0.25	0.70	4.63	.00			
2. Constant	30.79	8.79		3.50	.00			
BDI-II	- 0.21	0.21	- 0.17	-0.99	.33			
STAI-S	1.08	0.22	0.66	4.85	.00			
Group	-4.36	1.48	- 0.42	-2.96	.01			

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers

(Mahalanobis distance = 8.91, critical value = χ^2[3] = 16.27, p < .001). Tolerance values were all greater than 0.20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 63% of the variance in anxiety score. STAI-S scores made a unique and significant contribution to the prediction of anxiety score. The contribution of BDI-II scores to the prediction of anxiety was not significant. The addition of group in model 2 significantly increased the amount of anxiety variance explained. Both STAI-S scores and group made a unique and significant contribution to the prediction of anxiety score. After controlling for current depression and state anxiety, group membership still predicted significant portions of the variance in anxiety score.

N2: Angry Hostility.

For the regression of the clinical variables on the angry hostility facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 52.

Table 52

Correlations among the angry hostility facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	N2: Angry Hostility	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	- 0.53*	-		
BDI-II	0.62*	- 0.75*	-	
STAI-S	0.55*	- 0.58*	0.73*	-

Note: * p < .001

The independent variables all had significant correlations with angry hostility. A simple bivariate regression analysis was performed first to establish the amount of variance in angry hostility score that could be explained by group membership. A summary of the regression statistics is displayed in Table 53.

Table 53

Regression of group membership on angry hostility for the comparison of OCD and healthy control subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.53	0.29	14.34	1,36	.00
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	69.74	4.08		17.08	.00
Group	- 5.19	1.37	- 0.53	- 3.79	.00

When group was used as a single predictor for angry hostility, the direct model was significant and accounted for 29% of the variance in angry hostility score. Group made a unique and significant contribution to the prediction of angry hostility score. To evaluate whether group

membership still predicted significant portions of angry hostility after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 54.

Table 54

Hierarchical regression of group, BDI-II and STAI-S scores on the facet of angry hostility for the comparison of OCD and healthy control subjects

Model summary

	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.64	0.41	11.97	2,35	.00			
2. BDI-II, STAI-S, Group	0.64	0.41	8.02	3,34	.00	0.00	0.47	.50

Coefficients

	B	*SE B*	β	*t*	*p*
1. Constant	39.13	8.48		4.61	.00
BDI-II	0.56	0.22	0.48	2.52	.02
STAI-S	0.31	0.29	0.20	1.07	.30
2. Constant	44.45	11.53		3.85	.00
BDI-II	0.45	0.28	0.38	1.62	.11
STAI-S	0.29	0.29	0.19	1.00	.33
Group	-1.33	1.94	- 0.14	-0.69	.50

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.91, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than 0.20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 41% of the variance in angry hostility score. BDI-II scores made a unique and significant contribution to the prediction of angry hostility score. The contribution of STAI-S scores to the prediction of angry hostility was not significant. The addition of group in model 2 did not significantly increase the amount of angry hostility variance explained. None of the variables made a unique and significant contribution to the prediction of angry hostility score. After controlling for current depression and state anxiety, group membership did not predict significant portions of the variance in angry hostility score.

N3: Depression

For the regression of the clinical variables on the depression facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 55.

Table 55

Correlations among the depression facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	N3: Depression	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	- 0.78*	-		
BDI-II	0.73*	- 0.75*	-	
STAI-S	0.74*	- 0.58*	0.73*	-

Note: * $p < .001$

The independent variables all had significant correlations with depression. A simple bivariate regression analysis was performed first to establish the amount of variance in depression score that could be explained by group membership. A summary of the regression statistics is displayed in Table 56.

Table 56

Regression of group membership on the facet of depression for the comparison of OCD and healthy control subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.78	0.61	55.72	1,36	.00
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	79.31	3.39		23.42	.00
Group	-8.48	1.14	- 0.78	-7.47	.00

When group was used as a single predictor for depression, the direct model was significant and accounted for 61% of the variance in depression score. Group made a unique and significant contribution to the prediction of depression score. To evaluate whether group membership still predicted significant portions of depression after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 57.

Table 57

Hierarchical regression of group, BDI-II and STAI-S scores on the depression facet for the comparison of OCD and healthy control subjects

	Model summary							
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.79	0.63	29.32	2,35	.00			
2. BDI-II, STAI-S, Group	0.86	0.73	31.35	3,34	.00	0.10	13.86	.00

	Coefficients				
	B	*SE B*	β	*t*	*p*
1. Constant	24.48	7.53		3.25	.00
BDI-II	0.52	0.20	0.40	2.66	.01
STAI-S	0.78	0.26	0.45	3.02	.01
2. Constant	46.22	8.69		5.32	.00
BDI-II	0.07	0.21	0.05	0.33	.74
STAI-S	0.71	0.22	0.41	3.21	.00
Group	-5.43	1.46	- 0.50	-3.72	.00

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.91, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than 0.20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 63% of the variance in depression score. BDI-II and STAI-S scores made a unique and significant contribution to the prediction of depression score. The addition of group in model 2 did significantly increase the amount of depression variance explained. Both group and STAI-S scores made unique and significant contributions to the prediction of depression score. After controlling for current depression and state anxiety, group membership still predicted significant portions of the variance in depression score.

N4: Self-consciousness

For the regression of the clinical variables on the self-consciousness facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 58.

Table 58

Correlations among the self-consciousness facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	N4: Self-consciousness	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	- 0.76*	-		
BDI-II	0.68*	- 0.75*	-	
STAI-S	0.67*	- 0.58*	0.73*	-

Note: * $p < .001$

The independent variables all had significant correlations with self-consciousness. A simple bivariate regression analysis was performed first to establish the amount of variance in self-consciousness score that could be explained by group membership. A summary of the regression statistics is displayed in Table 59.

Table 59

Regression of group membership on the self-consciousness facet for the comparison of OCD and healthy control subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.76	0.58	50.04	1,36	.00
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	74.52	3.43		21.74	.00
Group	-8.13	1.15	- 0.76	-7.07	.00

When group was used as a single predictor for self-consciousness, the direct model was significant and accounted for 58% of the variance in self-consciousness score. Group made a unique and significant contribution to the prediction of self-consciousness score. To evaluate whether group membership still predicted significant portions of self-consciousness after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 60.

Table 60

Hierarchical regression of group, BDI-II and STAI-S scores on the facet of self-consciousness for the comparison of OCD and healthy control subjects

	Model summary							
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.72	0.52	19.10	2,35	.00			
2. BDI-II, STAI-S, Group	0.81	0.66	21.67	3,34	.00	0.14	13.34	.01
	Coefficients							
	B	*SE B*	β	*t*	*p*			
1. Constant	25.83	8.35		3.09	.00			
BDI-II	0.52	0.22	0.41	2.39	.02			
STAI-S	0.63	0.29	0.37	2.19	.04			
2. Constant	49.61	9.69		5.12	.00			
BDI-II	0.03	0.23	0.02	0.11	.91			
STAI-S	0.55	0.25	0.33	2.24	.03			
Group	-5.94	1.63	- 0.56	-3.65	.00			

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.91, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 52% of the variance in self-consciousness score. BDI-II and STAI-S scores both made a unique and significant contribution to the prediction of self-consciousness score. The addition of group in model 2 significantly increased the amount of self-consciousness variance explained. Both group and STAI-S scores made unique and significant contributions to the prediction of self-consciousness score. After controlling for current depression and state anxiety, group membership still predicted significant portions of the variance in self-consciousness score.

N5: Impulsiveness

For the regression of the clinical variables on the impulsiveness facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 61.

Table 61

Correlations among the impulsiveness facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	N5: Impulsiveness	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	- 0.39*	-		
BDI-II	0.49*	- 0.75**	-	
STAI-S	0.43*	- 0.58**	0.73**	-

Note: * $p < .01$; ** $p < .001$

The independent variables were all significantly correlated with impulsiveness. A simple bivariate regression analysis was performed first to establish the amount of variance in impulsiveness score that could be explained by group membership. A summary of the regression statistics is displayed in Table 62.

Table 62

Regression of group membership on the facet of impulsiveness for the comparison of OCD and healthy control subjects

Model summary					
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.39	0.15	6.50	1,36	.02
Coefficients					
	B	*SE B*	β	*t*	*p*
Constant	57.88	3.69		15.68	.00
Group	-3.16	1.24	- 0.39	-2.55	.02

When group was used as a single predictor for impulsiveness, the direct model was significant and accounted for 15% of the variance in impulsiveness score. Group made a unique and significant contribution to the prediction of impulsiveness score. To evaluate whether group membership still predicted significant portions of impulsiveness after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S

scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics are displayed in Table 63.

Table 63

Hierarchical regression of group, BDI-II and STAI-S scores on the facet of impulsiveness for the comparison of OCD and healthy control subjects

	Model summary							
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.50	0.25	5.88	2,35	.01			
2. BDI-II, STAI-S, Group	0.50	0.25	3.82	3,34	.02	0.00	0.03	.86

	Coefficients				
	B	*SE B*	β	*t*	*p*
1. Constant	38.47	7.91		4.86	.00
BDI-II	0.36	0.21	0.38	1.77	.09
STAI-S	0.20	0.27	0.16	0.75	.46
2. Constant	39.81	10.83		3.68	.00
BDI-II	0.34	0.26	0.35	1.30	.20
STAI-S	0.20	0.28	0.16	0.72	.48
Group	- 0.33	1.82	- 0.04	-0.18	.86

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.91, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than 0.20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 25% of the variance in impulsiveness score. However, STAI-S scores did not make a unique and significant contribution to the prediction of impulsiveness score. The contribution of BDI-II score was approaching significance. The addition of group in model 2 did not significantly increase the amount of impulsiveness variance explained. None of the variables in model two made unique and significant contributions to the prediction of impulsiveness score. After controlling for current depression and state anxiety, group membership no longer predicted significant portions of the variance in impulsiveness score.

N6: Vulnerability

For the regression of the clinical variables on the vulnerability facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 64.

Table 64

Correlations among the vulnerability facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	N6: Vulnerability	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	- 0.76*	-		
BDI-II	0.68*	- 0.75*	-	
STAI-S	0.69*	- 0.58*	0.73*	-

Note: * $p < .001$

The independent variables were all significantly correlated with vulnerability. A simple bivariate regression analysis was performed first to establish the amount of variance in vulnerability score that could be explained by group membership. A summary of the regression statistics is displayed in Table 65.

Table 65

Regression of group membership on the facet of vulnerability for the comparison of OCD and healthy control subjects

Model summary					
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.76	0.57	48.27	1,36	.00
Coefficients					
	B	*SE B*	β	*t*	*p*
Constant	77.34	3.61		21.45	.00
Group	-8.40	1.21	- 0.76	-6.95	.00

When group was used as a single predictor for vulnerability, the direct model was significant and accounted for 57% of the variance in vulnerability score. Group made a unique and significant contribution to the prediction of vulnerability score. To evaluate whether group membership still predicted significant portions of vulnerability after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 66.

Table 66

Hierarchical regression of group, BDI-II and STAI-S scores on the vulnerability facet for the comparison of OCD and healthy control subjects

Model summary

	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.74	0.55	21.30	2,35	.00			
2. BDI-II, STAI-S, Group	0.82	0.67	22.92	3,34	.00	0.12	12.35	.00

Coefficients

	B	*SE B*	β	*t*	*p*
1. Constant	24.59	8.44		2.91	.01
BDI-II	0.51	0.22	0.38	2.32	.03
STAI-S	0.73	0.29	0.42	2.52	.02
2. Constant	47.96	9.90		4.84	.00
BDI-II	0.02	0.24	0.02	0.10	.92
STAI-S	0.65	0.25	0.37	2.60	.02
Group	-5.84	1.66	- 0.53	-3.51	.00

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.91, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 55% of the variance in vulnerability score. Both BDI-II and STAI-S scores made a unique and significant contribution to the prediction of vulnerability score. The addition of group in model 2 significantly increased the amount of vulnerability variance explained. In the new model, BDI-II scores did not make a significant contribution to the prediction of vulnerability score. However, STAI-S and group both made a unique and significant contribution to vulnerability scores. After controlling for current depression and state anxiety, group membership still predicted significant portions of the variance in vulnerability score.

11.5.2 OCD versus sub-clinical OC subjects

As the OCD patients reported higher levels of current depression and state anxiety compared to the sub-clinical OC subjects, analysis was undertaken to evaluate the degree to which BDI-II and STAI-S scores influenced differences on the Neuroticism facets of depression and vulnerability.

N3: Depression

For the regression of BDI-II score on the Neuroticism facet of depression, correlational analysis was undertaken to ensure the prerequisites for regression analysis were met. The correlation coefficients are displayed in Table 67.

Table 67

Correlations among the depression facet, BDI-II and STAI-S scores for the comparison of OCD and sub-clinical OC subjects

Variables	N3: Depression	Group	BDI-II	STAI-S
Group (OCD = 1, sub-clinical OC = 2)	- 0.46*	-		
BDI-II	0.64**	- 0.42*	-	
STAI-S	0.64**	- 0.28	0.61**	-

Note: * $p < .01$, ** $p < .001$

The independent variables all had significant correlations with depression. A simple bivariate regression analysis was performed first to establish the amount of variance in depression score that could be explained by group membership. A summary of the regression statistics is displayed in Table 68.

Table 68

Regression of group membership on the depression facet for the comparison of OCD and sub-clinical OC subjects

Model summary					
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, sub-clinical OC = 2)	0.46	0.21	9.81	1,36	.00
Coefficients					
	B	*SE B*	β	*t*	*p*
Constant	76.80	4.35		17.66	.00
Group	-5.97	1.91	- 0.46	-3.13	.00

When group was used as a single predictor for depression, the direct model was significant and accounted for 21% of the variance in depression score. Group made a unique and significant contribution to the prediction of depression score. To evaluate whether group membership still predicted significant portions of depression after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 69.

Table 69

Hierarchical regression of group, BDI-II and STAI-S scores on the depression facet for the comparison of OCD and sub-clinical OC subjects

Model summary

	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.71	0.51	18.07	2,35	.00			
2. BDI-II, STAI-S, Group	0.74	0.55	13.78	3,34	.00	0.04	3.06	.09

Coefficients

	B	*SE B*	β	*t*	*p*
1. Constant	38.63	5.64		6.85	.00
BDI-II	0.49	0.18	0.41	2.70	.01
STAI-S	0.47	0.18	0.39	2.59	.01
2. Constant	46.76	7.18		6.51	.00
BDI-II	0.39	0.19	0.32	2.07	.05
STAI-S	0.46	0.18	0.38	2.60	.01
Group	- 2.86	1.64	- 0.22	- 1.75	.09

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 9.78, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S score was significant and explained 51% of the variance in depression score. BDI-II and STAI-S scores both made a unique and significant contribution to the prediction of depression score. The addition of group in model 2 did not significantly increase the amount of depression variance explained. BDI-II and STAI-S scores made unique and significant contributions to the prediction of depression score. After controlling for current depression, group membership did not predict significant portions of the variance in depression score.

N6: Vulnerability

For the regression of BDI-II score on the Neuroticism facet of vulnerability, correlational analysis was undertaken to ensure the prerequisites for regression analysis were met. The correlation coefficients are displayed in Table 70.

Table 70

Correlations among the depression facet, BDI-II and STAI-S scores for the comparison of OCD and sub-clinical OC subjects

Variables	N6: Vulnerability	Group	BDI-II	STAI-S
Group (OCD = 1, sub-clinical OC = 2)	- 0.39*	-		
BDI-II	0.50*	- 0.42*	-	
STAI-S	0.49*	- 0.28	0.61**	-

Note: * $p < .01$, ** $p < .001$

The independent variables all had significant correlations with vulnerability. A simple bivariate regression analysis was performed first to establish the amount of variance in vulnerability score

that could be explained by group membership. A summary of the regression statistics is displayed in Table 71.

Table 71

Regression of group membership on the depression facet for the comparison of OCD and sub-clinical OC subjects

Model summary					
	R	R^2	*F*	*df*	*p*
Group	0.39	0.16	6.64	1,36	.01
(OCD = 1, sub-clinical OC = 2)					
Coefficients					
	B	*SE B*	β	*t*	*p*
Constant	74.14	4.61		16.10	.00
Group	-5.20	2.02	- 0.39	-2.58	.01

When group was used as a single predictor for vulnerability, the direct model was significant and accounted for 16% of the variance in vulnerability score. Group made a unique and significant contribution to the prediction of vulnerability score. To evaluate whether group membership still predicted significant portions of vulnerability after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 72.

Table 72

Hierarchical regression of group, BDI-II and STAI-S scores on the facet of vulnerability for the comparison of OCD and sub-clinical OC subjects

Model summary								
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.56	0.31	7.83	2,35	.00			
2. BDI-II, STAI-S, Group	0.59	0.35	6.01	3,34	.00	0.04	1.94	.17
Coefficients								
	B	*SE B*	β	*t*	*p*			
1. Constant	42.99	6.83		6.30	.00			
BDI-II	0.40	0.22	0.32	1.82	.08			
STAI-S	0.37	0.22	0.30	1.67	.10			
2. Constant	50.95	8.83		5.77	.00			
BDI-II	0.30	0.23	0.24	1.29	.21			
STAI-S	0.36	0.22	0.29	1.64	.11			
Group	- 2.81	2.01	- 0.21	- 1.39	.17			

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 9.78, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 31% of the variance in vulnerability score. BDI-II scores approached significance in the prediction of vulnerability score. The addition of group in model 2 did not significantly increase the amount of vulnerability variance explained. In the new model, none of the variables made a unique and significant contribution to the prediction of vulnerability score. After controlling for current depression and state anxiety, group membership did not predict significant portions of the variance in vulnerability score.

11.5.3 Summary

After controlling for state measures of depression and anxiety, the OCD patients and healthy control subjects still differed on the Neuroticism facets of anxiety, depression, self-consciousness and vulnerability. Group differences on the facets of angry hostility and impulsiveness disappeared after controlling for current depression and state anxiety. After controlling for state measures of depression and anxiety, the group differences between the OCD patients and sub-clinical OC subjects on the Neuroticism facets of depression and vulnerability were no longer significant.

11.6 Extraversion facets

11.6.1 Data screening

Prior to analysis, the Extraversion facet variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of MANOVA. Extraversion comprised six variables: warmth, gregariousness, assertiveness, activity, excitement-seeking, and positive emotions. These variables were inspected using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. Two OCD cases and one panic disorder case had missing values for Extraversion. There were no missing values for the sub-clinical OC or control cases. The OCD and panic disorder cases with the missing data were deleted from the analysis. A full description of the data screening procedure is included as Appendix P.

11.6.2 Results

To test the hypotheses regarding the Extraversion facets and OCD patients in comparison to the healthy controls, panic disorder and sub-clinical OC subjects, a MANOVA was conducted using three planned contrasts. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. With two OCD cases and one panic disorder case with missing data excluded, and no cases excluded for assumption violations, there were 18 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. Mean Extraversion t scores for the four experimental groups are displayed in Table 73.

Table 73

Means and standard deviations of Extraversion facet T-scores for OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 18)		panic disorder (n =19)		sub-clinical OC (n = 20)		healthy controls (n = 20)				
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*Wilks' λ*	*F*	
									0.68	**1.55**	
E1 Warmth	42.11	10.48	44.26	12.90	47.25	13.87	53.60	10.24		3.35	*
E2 Gregariousness	42.11	8.06	38.95	9.72	45.89	14.26	52.20	9.90		5.42	**
E3 Assertiveness	44.00	10.53	46.00	12.94	45.95	12.85	52.80	7.83		2.30	
E4 Activity	45.06	10.22	50.37	13.13	48.32	12.35	50.90	9.24		1.01	
E5 Excitement-seeking	47.00	11.93	42.58	11.04	45.95	13.36	47.80	11.65		0.70	
E6 Positive Emotions	39.56	13.80	42.47	16.59	48.70	13.90	53.50	11.89		3.76	**

Note: * $p < .05$, ** $p < .01$

When comparing OCD, healthy control, panic disorder, and sub-clinical OC subjects on the facets of Extraversion, no overall multivariate effect was observed (Wilks' $\lambda = 0.68$, $F[18, 192.82] = 1.55$, $p = .08$). There were no differences between groups on the measures of assertiveness ($F[3, 73] = 2.30$, $p = .08$), activity ($F[3, 73] = 1.01$, $p = .39$) or excitement-seeking ($F[3, 73] = 0.70$, $p = .56$). The experimental groups did differ on measures of warmth ($F[3, 73] = 3.35$, $p < .05$), gregariousness ($F[3, 73] = 5.42$, $p < .01$) and positive emotions ($F[3, 73] = 3.76$, $p < .01$).

Planned comparisons between OCD patients and the healthy controls yielded an overall multivariate effect on the facets of Extraversion (Wilks' $\lambda = 0.80$, $F[6, 68] = 2.84$, $p < .05$). As predicted, the OCD patients scored lower than the healthy control subjects on the facet of assertiveness ($t[36] = - 2.41$, $p < .05$, $d = 0.95$, $P = 0.81$) and no differently on the facet of excitement-seeking ($t[36] = - 0.20$, $p = .84$). Contrary to the hypotheses, the OCD patients also scored significantly lower than healthy controls on the facets of warmth ($t[36] = - 2.95$, $p < .01$, $d = 1.11$, $P = 0.91$), gregariousness ($t[36] = - 2.87$, $p < .01$, $d = 1.12$, $P = 0.92$), and positive emotions ($t[36] = - 3.04$, $p < .01$, $d = 1.08$, $P = 0.90$), but no differently on the facet of activity ($t[36] = - 1.59$, $p = .12$).

Planned comparisons between OCD patients and the panic disorder group did not yield an overall multivariate effect on the facets of Extraversion (Wilks' $\lambda = 0.93$, $F[6, 68] = 0.82$, $p = .56$). As predicted, the OCD patients scored no differently to the panic disorder patients on the facets of warmth ($t[35] = - 0.55$, $p = .59$), gregariousness ($t[35] = 0.89$, $p = .38$), assertiveness ($t[35] = - 0.54$, $p = .59$), activity ($t[35] = - 1.42$, $p = .16$), excitement-seeking ($t[35] = 1.12$, $p = .27$), or positive emotions ($t[35] = - 0.63$, $p = .53$).

Planned comparisons between OCD patients and the sub-clinical OC subjects did not yield an overall multivariate effect on the facets of Extraversion (Wilks' $\lambda = 0.93$, $F[6, 68] = 0.83$, $p = .55$). As predicted, the OCD patients scored no differently to the panic disorder patients on the facets

of warmth (t[36] = - 1.32, p = .19), gregariousness (t[36] = - 1.08, p = .28), assertiveness (t[36] = - 0.53, p = .59), activity (t[36] = - 0.88, p = .38), and excitement-seeking (t[36] = 0.27, p = .79). Contrary to the hypothesis, the OCD patients did score significantly lower on the facet of positive emotions than the sub-clinical OC group (t[36] = - 1.99, p < .05, d = 0.66, P = 0.51) with a moderate effect size.

Post-hoc Tukey unequal N HSD tests were conducted to identify any significant differences between the healthy controls, panic disorder and sub-clinical OC subjects on the facets of Extraversion. The results indicated that the healthy control subjects scored significantly higher on the Extraversion facet of gregariousness compared to the panic disorder patients (p < .01).

11.6.3 Summary

In the present thesis, OCD patients scored significantly lower on measures of warmth, gregariousness, assertiveness and positive emotions compared to healthy controls. The OCD and panic disorder patients were not differentiated by any of the Extraversion facets. The OCD patients reported significantly lower scores on a measure of positive emotions compared to sub-clinical OC subjects.

11.7 The influence of depression and anxiety on Extraversion facets

11.7.1 OCD versus healthy controls.

As the OCD patients reported higher scores on the clinical measures of current depression and state anxiety, analysis was undertaken to evaluate the degree to which BDI-II and STAI-S scores influenced differences on the Extraversion facets of warmth, gregariousness, assertiveness and positive emotions. Separate analyses were conducted with each of the Extraversion facets as the dependent variables, and group, BDI-II, and STAI-S scores as the independent variables.

E1: Warmth

For the regression of the clinical variables on the warmth facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 74.

Table 74

Correlations among the warmth facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	E1: warmth	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	0.50*	-		
BDI-II	- 0.50*	- 0.75**	-	
STAI-S	- 0.21	- 0.58**	0.73*	-

Note: * p < .01, ** p < .001

Group and BDI-II score both had significant correlations with warmth. STAI-S did not correlate with warmth and was, therefore, not included in the regression analysis. A simple bivariate regression analysis was performed first to establish the amount of variance in warmth score that could be explained by group membership. A summary of the regression statistics is displayed in Table 75.

Table 75

Regression of group membership on the warmth facet for the comparison of OCD and healthy control subject subjects

Model summary					
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.50	0.25	11.67	1,36	.00
Coefficients					
	B	*SE B*	β	*t*	*p*
Constant	38.28	3.34		11.45	.00
Group	3.83	1.12	0.50	3.42	.00

When group was used as a single predictor for warmth, the direct model was significant and accounted for 25% of the variance in warmth score. Group made a unique and significant contribution to the prediction of warmth score. To evaluate whether group membership still predicted significant portions of warmth after controlling for current depression, a hierarchical regression was performed with BDI-II scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 76.

Table 76

Hierarchical regression of group and BDI-II scores on the warmth facet for the comparison of OCD and healthy control subjects

Model summary								
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II	0.50	0.25	12.24	1,36	.00			
2. BDI-II, Group	0.53	0.28	6.98	2,37	.00	0.03	1.53	.23
Coefficients								
	B	*SE B*	β	*t*	*p*			
1. Constant	53.75	2.31		23.27	.00			
BDI-II	- 0.47	0.13	- 0.50	-3.50	.00			
2. Constant	46.19	6.53		7.07	.00			
BDI-II	-2.28	0.20	- 0.30	-1.40	.17			
Group	2.07	1.67	0.27	1.24	.23			

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.82, critical value = $\chi^2[2] = 13.82$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II was significant and explained 25 of the variance in warmth score. BDI-II scores made a unique and significant contribution to the prediction of warmth score. The addition of group in model 2 did not significantly increase the amount of warmth variance explained. In the new model, neither BDI-II nor group made a unique and significant contribution to the prediction of warmth score. After controlling for current depression, group membership did not predict significant portions of the variance in warmth score.

E2: Gregariousness

For the regression of the clinical variables on the gregariousness facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 77.

Table 77

Correlations among the gregariousness facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	E2: Gregariousness	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	0.50*	-		
BDI-II	- 0.42*	- 0.75**	-	
STAI-S	- 0.27	- 0.58**	0.73**	-

Note: * $p < .01$, ** $p < .001$

Group and BDI-II both had significant correlations with gregariousness. STAI-S did not correlate with gregariousness and was, therefore, excluded from the analysis. A simple bivariate regression analysis was performed first to establish the amount of variance in gregariousness score that could be explained by group membership. A summary of the regression statistics is displayed in Table 78.

Table 78

Regression of group membership on the gregariousness facet for the comparison of OCD and healthy control subjects

Model summary					
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.50	0.25	11.71	1,36	.00
Coefficients					
	B	*SE B*	β	*t*	*p*
Constant	38.75	2.93		13.22	.00
Group	3.36	0.98	0.50	3.42	.00

When group was used as a single predictor for gregariousness, the direct model was significant and accounted for 25% of the variance in gregariousness score. Group made a unique and significant contribution to the prediction of gregariousness score. To evaluate whether group membership still predicted significant portions of gregariousness after controlling for current depression, a hierarchical regression was performed with BDI-II score 'forced' into step one and

group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 79.

Table 79

Hierarchical regression of group and BDI-II scores on the facet of gregariousness for the comparison of OCD and healthy control subjects

	Model summary							
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II	0.42	0.18	7.89	1,36	.01			
2. BDI-II, Group	0.50	0.25	5.89	2,35	.01	0.07	3.36	.08

	Coefficients				
	B	*SE B*	β	*t*	*p*
1. Constant	51.54	2.12		24.27	.00
BDI-II	- 0.35	0.12	- 0.42	- 2.81	.01
2. Constant	41.48	5.86		7.08	.00
BDI-II	- 0.10	0.18	- 0.12	- 0.54	.59
Group	2.75	1.50	0.41	1.83	.08

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.82, critical value = $\chi^2[2] = 13.82$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II score was significant and explained 18% of the variance in gregariousness score. BDI-II score made a unique and significant contribution to the prediction of gregariousness score. The addition of group in model 2 did not significantly increase the amount of gregariousness variance explained, although it was approaching significance. None of the variables made a unique and significant contribution to the prediction of gregariousness score. After controlling for current depression, group membership did not predict significant portions of the variance in gregariousness score.

E3: Assertiveness

For the regression of the clinical variables on the assertiveness facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 80.

Table 80

Correlations among the assertiveness facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	E3: Assertiveness	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	0.44*	-		
BDI-II	- 0.28	- 0.75**	-	
STAI-S	- 0.46*	- 0.58**	0.73**	-

Note: * $p < .01$, ** $p < .001$

Group and STAI-S both had significant correlations with assertiveness. BDI-II did not correlate significantly with assertiveness and was excluded from the analysis. A simple bivariate regression analysis was performed first to establish the amount of variance in assertiveness score that could be explained by group membership. A summary of the regression statistics is displayed in Table 81.

Table 81

Regression of group membership on the assertiveness facet for the comparison of OCD and healthy control subjects

Model summary					
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.44	0.19	8.66	1,36	.01
Coefficients					
	B	*SE B*	β	*t*	*p*
Constant	41.07	2.97		13.82	.00
Group	2.93	0.10	0.44	2.94	.01

When group was used as a single predictor for assertiveness, the direct model was significant and accounted for 19% of the variance in assertiveness score. Group made a unique and significant contribution to the prediction of assertiveness score. To evaluate whether group membership still predicted significant portions of assertiveness after controlling for state anxiety, a hierarchical regression was performed with STAI-S score 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 82.

Table 82

Hierarchical regression of group and STAI-S scores on the facet of assertiveness for the comparison of OCD and healthy control subjects

Model summary								
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. STAI-S	0.46	0.21	9.79	1,36	.00			
2. STAI-S, Group	0.51	0.26	6.09	2,35	.01	0.05	2.10	.16
Coefficients								
	B	*SE B*	β	*t*	*p*			
1. Constant	65.34	5.54		11.79	.00			
STAI-S	- 0.49	0.16	- 0.46	- 3.13	.00			
2. Constant	55.45	8.75		6.34	.00			
STAI-S	- 0.33	0.19	- 0.31	- 1.74	.09			
Group	1.73	1.19	0.26	1.45	.16			

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 6.52, critical value = $\chi^2[2] = 13.82$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including STAI-S score was significant and explained 21% of the variance in assertiveness score. STAI-S score made a unique and significant contribution to the prediction of assertiveness score. The addition of group in model 2 did not significantly increase the amount of assertiveness variance explained. Group did not make a unique and significant contribution to the prediction of assertiveness. The contribution of STAI-S score to the prediction of assertiveness score approached significance. After controlling for state anxiety, group membership did not predict significant portions of the variance in assertiveness score.

E6: Positive Emotions

For the regression of the clinical variables on the positive emotions facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 83.

Table 83

Correlations among the positive emotions facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	E6: Positive Emotions	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	0.49*	-		
BDI-II	- 0.71**	- 0.75**	-	
STAI-S	- 0.52**	- 0.58**	0.73**	-

Note: * $p < .01$, ** $p < .001$

The independent variables all had substantial correlations with positive emotions. A simple bivariate regression analysis was performed first to establish the amount of variance in positive emotions score that could be explained by group membership. A summary of the regression statistics is displayed in Table 84.

Table 84

Regression of group membership on the facet of positive emotions for the comparison of OCD and healthy control subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.49	0.24	11.20	1,36	.00
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	34.91	4.14		8.43	.00
Group	4.65	1.39	0.49	3.35	.00

When group was used as a single predictor for positive emotions, the direct model was significant and accounted for 24% of the variance in positive emotions score. Group made a unique and significant contribution to the prediction of positive emotions score. To evaluate whether group membership still predicted significant portions of positive emotions after

controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 85.

Table 85

Hierarchical regression of group, BDI-II and STAI-S scores on the facet of positive emotions for the comparison of OCD and healthy control subjects

Model summary

	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.71	0.50	17.79	2,35	.00			
2. BDI-II, STAI-S, Group	0.71	0.50	11.75	3,34	.00	0.00	0.34	.56

Coefficients

	B	*SE B*	β	*t*	*p*
1. Constant	57.35	7.61		7.54	.00
BDI-II	- 0.80	0.20	- 0.70	- 4.03	.00
STAI-S	- 0.03	0.26	- 0.02	- 0.10	.92
2. Constant	61.41	10.37		5.92	.00
BDI-II	- 0.88	0.25	- 0.77	- 3.58	.00
STAI-S	- 0.04	0.26	- 0.03	- 0.15	.88
Group	- 1.01	1.74	- 0.11	- 0.58	.56

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.91, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 50% of the variance in positive emotions score. BDI-II score made a unique and significant contribution to the prediction of positive emotions score. STAI-S score did not predict a significant proportion of the variance in positive emotions score. The addition of group in model 2 did not significantly increase the amount of positive emotions variance explained. In the new model, only BDI-II score made unique and significant contributions to the prediction of positive emotions score. After controlling for current depression and state anxiety, group membership did not predict significant portions of the variance in positive emotions score.

11.7.2 OCD versus sub-clinical OC subjects

As the OCD patients reported higher levels of current depression and state anxiety compared to the sub-clinical OC subjects, analysis was undertaken to evaluate the degree to which BDI-II and STAI-S scores mediated differences on the Extraversion facet of positive emotions.

E6: Positive emotions

For the regression of the clinical variables on the positive emotions facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 86.

Table 86

Correlations among the positive emotions facet, BDI-II and STAI-S scores for the comparison of OCD and sub-clinical OC subjects

Variables	E6: Positive emotions	Group	BDI-II	STAI-S
Group (OCD = 1, sub-clinical OC = 2)	0.32*	-		
BDI-II	- 0.66***	- 0.43**	-	
STAI-S	- 0.58***	- 0.28	0.61***	-

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

The independent variables were all significantly correlated with positive emotions. A simple bivariate regression analysis was performed first to establish the amount of variance in positive emotions score that could be explained by group membership. A summary of the regression statistics are displayed in Table 87.

Table 87

Regression of group membership on the positive emotions facet for the comparison of OCD and sub-clinical OC subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, sub-clinical OC = 2)	0.32	0.10	4.13	1,36	.05
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	34.98	5.14		6.81	.00
Group	4.57	2.25	0.32	2.03	.05

When group was used as a single predictor for positive emotions, the direct model was significant and accounted for 10% of the variance in positive emotions score. Group made a unique and significant contribution to the prediction of positive emotions score. To evaluate whether group membership still predicted significant portions of positive emotions after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 88.

Table 88

Hierarchical regression of group, BDI-II and STAI-S scores on the facet of positive emotions for the comparison of OCD and sub-clinical OC subjects

Model summary

	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.70	0.48	16.42	2,35	.00			
2. BDI-II, STAI-S, Group	0.70	0.48	10.71	3,34	.00	0.00	.11	.74

Coefficients

	B	*SE B*	β	*t*	*p*
1. Constant	69.74	6.38		10.93	.00
BDI-II	- 0.65	0.21	- 0.48	- 3.14	.00
STAI-S	- 0.39	0.21	- 0.29	- 1.87	.07
2. Constant	67.90	8.48		8.01	.00
BDI-II	- 0.62	0.22	- 0.46	- 2.82	.01
STAI-S	- 0.38	0.21	- 0.29	- 1.84	.08
Group	0.65	1.93	0.05	0.34	.74

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 9.78, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 48% of the variance in positive emotions score. BDI-II score made a unique and significant contribution to the prediction of positive emotions score. The contribution of STAI-S to the prediction of positive emotions score was approaching significance. The addition of group in model 2 did not significantly increase the amount of positive emotions variance explained. In the new model, only BDI-II score made unique and significant contributions to the prediction of positive emotions score. After controlling for current depression, group membership did not predict significant portions of the variance in positive emotions score.

11.7.3 Summary

For the comparison of OCD patients and healthy control subjects, the differences on the Extraversion facets of warmth, gregariousness, assertiveness and positive emotions were no longer significant after controlling for current depression and state anxiety.

For the comparison of OCD and sub-clinical OC subjects, the differences on the Extraversion facet of positive emotions were also no longer significant after controlling for current depression and state anxiety.

11.8 Openness facets

11.8.1 Data screening

Prior to analysis, the Openness facet variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of MANOVA. Openness facets comprised six variables: fantasy, aesthetics, feelings, actions, ideas and values. These variables were inspected using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing value analysis was undertaken using the SPSS MVA procedure. Two OCD cases and one panic disorder case had missing values for Openness. There were no missing values for the sub-clinical OC or control cases. The OCD and panic disorder cases with the missing data were deleted from the analysis. For a description of the data screening procedure employed, refer to Appendix Q.

11.8.2 Results

To test the hypotheses regarding the Openness facets and OCD patients in comparison to the healthy controls, panic disorder and sub-clinical OC subjects, a MANOVA was conducted using three planned contrasts. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. To measure the effect size of any significant group differences, Cohen's *d* was calculated using the effect size generator for windows: version 2.2 (Devilly, 2004). With two OCD cases and one panic disorder case with missing data excluded, and no cases excluded for assumption violations, there were 18 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. Mean Openness T-scores for the four experimental groups are displayed in Table 89.

Table 89

Means and standard deviations of Openness facet T-scores for OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 18)		panic disorder (n =19)		sub-clinical OC (n = 20)		Controls (n = 20)				
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	Wilks' λ	*F*	
									0.61	**2.04**	*
O1 Fantasy	55.06	9.50	59.53	11.27	55.25	11.70	58.50	8.46		.92	
O2 Aesthetics	54.11	8.49	51.68	13.23	52.55	12.43	52.85	7.41		.16	
O3 Feelings	57.44	7.36	58.16	12.45	56.80	12.24	53.75	8.92		.67	
O4 Actions	39.33	12.11	50.05	13.58	43.85	10.63	56.90	9.74		8.36	**
O5 Ideas	49.44	10.22	51.26	15.91	49.79	10.78	56.30	9.16		1.42	
O6 Values	52.50	10.33	57.53	11.78	55.75	10.13	59.55	9.64		1.53	

Note: * $p < .01$, ** $p < .001$

When comparing OCD, healthy control, panic disorder, and sub-clinical OC subjects on the facets of Openness, an overall multivariate effect was observed (Wilks' $\lambda = 0.61$, $F[18, 192.82] = 2.04$, $p < .01$). The experimental groups differed on the facet of actions ($F[3, 73] = 8.36$,

$p < .01$). The experimental groups did not differ on the Openness facets of fantasy ($F[3, 73] = 0.92$, $p = .43$), aesthetics ($F[3, 73] = 0.16$, $p = .92$), feelings ($F[3, 73] = 0.67$, $p = .57$), ideas ($F[3, 73] = 1.42$, $p = .24$), or values ($F[3, 73] = 1.53$, $p = .21$).

Planned comparisons between the OCD patients and healthy controls yielded an overall multivariate effect on the facets of Openness (Wilks' $\lambda = 0.67$, $F[6, 68] = 5.53$, $p < .001$). As predicted, the OCD patients did score significantly lower on the facet of actions ($t[36] = - 2.82$, $p < .01$, $d = 1.60$, $P = 0.98$). As predicted, the OCD patients also scored no differently on the facets of aesthetics ($t[36] = 0.36$, $p = .72$) and ideas ($t[36] = - 1.79$, $p = .08$). However, contrary to the hypothesis, the OCD patients did not score higher than the healthy control subjects on the facets of fantasy ($t[36] = - 1.03$, $p = .31$) or feelings ($t[36] = 1.08$, $p = .28$). Contrary to the hypothesis, the OCD patients also scored lower on the facet of values ($t[36] = - 2.07$, $p = .04$, $d = 0.71$, $P = 0.57$).

Planned comparisons between OCD patients and the panic disorder group yielded an overall multivariate effect on the facets of Openness (Wilks' $\lambda = 0.82$, $F[6, 68] = 2.53$, $p < .05$). As predicted, the OCD patients scored lower on the facet of actions compared to the panic disorder patients ($t[35] = - 2.82$, $p < .01$, $d = 0.83$, $P = 0.70$). However, contrary to the hypothesis, the OCD patients did not score significantly higher on the facets of fantasy ($t[35] = - 1.32$, $p = .19$) or feelings ($t[35] = - 0.21$, $p = .84$). As predicted, the OCD patients also scored no differently to the panic disorder patients on the facets of aesthetics ($t[35] = 0.69$, $p = .49$), ideas ($t[35] = - 0.47$, $p = .64$), and values ($t[35] = - 1.46$, $p = .15$).

Planned comparisons between OCD patients and the sub-clinical OC group did not yield an overall multivariate effect on the facets of Openness (Wilks' $\lambda = 0.95$, $F[6, 68] = 0.95$, $p = .75$). As predicted, the OCD patients scored no differently to the sub-clinical OC subjects on the facets of fantasy ($t[36] = - 0.06$, $p = .95$), aesthetics ($t[36] = 0.45$, $p = .65$), feelings ($t[36] = 0.19$, $p = .85$), actions ($t[36] = - 1.20$, $p = .23$), ideas ($t[36] = - 0.09$, $p = .93$) and values ($t[36] = - 0.95$, $p = .34$).

Post-hoc Tukey unequal N HSD tests were conducted to identify any significant differences between the healthy controls, panic disorder and sub-clinical OC subjects on the facets of Openness. The results indicated that the healthy control subjects scored significantly higher on the Openness facet of actions compared to the sub-clinical OC subjects ($p < .01$).

11.8.3 Summary

In the current thesis, the OCD patients reported significantly lower levels of Openness to actions and values when compared to a healthy control group. The OCD patients also reported significantly lower scores on Openness to actions when compared to the panic disorder

patients. There were no differences between OCD and sub-clinical OC subjects on the facets of Openness.

11.9 The influence of depression and anxiety on Openness facets

11.9.1 OCD versus healthy control subjects

As the OCD patients reported higher scores on the clinical measures of current depression and state anxiety analysis was undertaken to evaluate the degree to which BDI-II and STAI-S scores influenced differences on the Openness facets of actions and values. Separate analyses were conducted with each of the Openness facets as the dependent variables and group, BDI-II, and STAI-S scores as the independent variables.

O4: Actions

For the regression of the clinical variables on the actions facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 90.

Table 90
Correlations among the actions facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	O4: actions	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	0 .64*	-		
BDI-II	- 0.61*	- 0.75*	-	
STAI-S	- 0.55*	- 0.58*	0.73*	-

Note: * p < .001

The independent variables all had significant correlations with warmth. A simple bivariate regression analysis was performed first to establish the amount of variance in actions score that could be explained by group membership. A summary of the regression statistics are displayed in Table 91.

Table 91
Regression of group membership on the facet of actions for the comparison of OCD and healthy control subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.64	0.41	24.49	1,36	.00
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	33.48	3.53		9.49	.00
Group	5.86	1.18	0.64	4.95	.00

When group was used as a single predictor for actions, the direct model was significant and accounted for 41% of the variance in actions score. Group made a unique and significant

contribution to the prediction of actions score. To evaluate whether group membership still predicted significant portions of actions after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 92.

Table 92

Hierarchical regression of group, BDI-II and STAI-S scores on the facet of actions for the comparison of OCD and healthy control subjects

Model summary

	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II	0.63	0.40	11.57	2,35	.00			
2. BDI-II, STAI-S, Group	0.68	0.46	9.81	3,34	.00	0.06	4.18	.05

Coefficients

	B	*SE B*	β	*t*	*p*
1. Constant	65.83	8.09		8.14	.00
BDI-II	- 0.49	0.21	- 0.45	- 2.34	.03
STAI-S	- 0.33	0.28	- 0.23	- 1.20	.24
2. Constant	51.47	10.45		4.93	.00
BDI-II	- 0.20	0.25	- 0.18	- 0.78	.44
STAI-S	- 0.29	0.27	- 0.20	- 1.08	.29
Group	3.59	1.75	0.39	2.05	.05

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.91, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S was significant and explained 40% of the variance in actions score. BDI-II scores made a unique and significant contribution to the prediction of actions score. STAI-S scores did not predict significant portions of the variance in actions score. The addition of group in model 2 significantly increased the amount of actions variance explained. In the new model, neither BDI-II nor STAI-S made a unique and significant contribution to the prediction of actions score. After controlling for current depression and state anxiety, group membership still predicted significant portions of the variance in actions score.

O6: Values.

For the regression of the clinical variables on the values facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 93.

Table 93

Correlations among the values facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	O6: values	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	0.34*	-		
BDI-II	- 0.41**	- 0.75***	-	
STAI-S	- 0.42**	- 0.58***	0.73***	-

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

The independent variables were all significantly correlated with values. A simple bivariate regression analysis was performed first to establish the amount of variance in values score that could be explained by group membership. A summary of the regression statistics is displayed in Table 94.

Table 94

Regression of group membership on the facet of values for the comparison of OCD and healthy control subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.34	0.12	4.73	1,36	.04
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	50.15	3.22		15.57	.00
Group	2.35	1.08	0.34	2.18	.04

When group was used as a single predictor for values, the direct model was significant and accounted for 12% of the variance in values score. Group made a unique and significant contribution to the prediction of values score. To evaluate whether group membership still predicted significant portions of values after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 95.

Table 95

Hierarchical regression of group, BDI-II and STAI-S scores on the facet of values for the comparison of OCD and healthy control subjects

Model summary

	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II	0.45	0.20	4.47	2,35	.02			
2. BDI-II, STAI-S, Group	0.45	0.20	2.91	3,34	.05	0.00	0.04	.84

Coefficients

	B	*SE B*	β	*t*	*p*
1. Constant	68.13	6.97		9.78	.00
BDI-II	- 0.19	0.18	- 0.23	- 1.04	.31
STAI-S	- 0.28	0.24	- 0.26	- 1.18	.25
2. Constant	66.84	9.54		7.01	.00
BDI-II	- 0.16	0.23	- 0.19	- 0.71	.48
STAI-S	- 0.28	0.24	- 0.26	- 1.14	.26
Group	0.32	1.60	0.05	0.20	.84

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.91, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S was significant and explained 20% of the variance in values score. However, neither BDI-II nor STAI-S scores made a unique and significant contribution to the prediction of values score. The addition of group in model 2 did not significantly increase the amount of values variance explained. In the new model, none of the variables made a unique and significant contribution to the prediction of values score. After controlling for current depression and state anxiety, group membership did not predict significant portions of the variance in values score.

11.9.2 Summary

For the comparison of OCD patients and healthy control subjects, differences on the Openness facet of actions remained significant after controlling for current depression and state anxiety. Differences between the groups on the facet of values were no longer significant after controlling for state measures of depression and anxiety.

11.10 Agreeableness facets

11.10.1 Data screening

Prior to analysis, the Agreeableness facet variables were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of MANOVA. Agreeableness comprised six variables: trust, straightforwardness, altruism, compliance, modesty and tendermindedness. These variables were inspected using the Statistica descriptives procedure. All variables were within range, and means and standard deviations

were plausible. Missing Value analysis was undertaken using the SPSS MVA procedure. Two OCD cases and one panic disorder case had missing values for Agreeableness. There were no missing values for the sub-clinical OC or control cases. The OCD and panic disorder cases with the missing data were deleted from the analysis. A full description of the data screening procedure is included as Appendix R.

11.10.2 Results

To test the hypotheses regarding the Agreeableness facets and OCD patients in comparison to the healthy controls, panic disorder and sub-clinical OC subjects, a MANOVA was conducted using three planned contrasts. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. To measure the effect size of any significant group differences, Cohen's *d* was calculated using the Effect Size Generator for Windows: version 2.2 (Devilly, 2004). With two OCD cases and one panic disorder case with missing data excluded, and no cases excluded for assumption violations, there were 18 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. Mean Agreeableness T-scores for the four experimental groups are displayed in Table 96.

Table 96

Means and standard deviations of Agreeableness facet T-scores for OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 18)		panic disorder (n =19)		sub-clinical OC (n = 20)		healthy controls (n = 20)				
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	Wilks' λ	*F*	
									0.68	**1.59**	
A1 Trust	43.28	14.36	38.11	14.83	45.50	12.20	50.25	11.04		2.85	*
A2 Straightforwardness	51.11	9.46	47.16	11.23	44.00	11.87	50.95	9.02		2.06	
A3 Altruism	45.94	12.86	46.53	13.65	47.95	13.21	52.45	10.11		1.08	
A4 Compliance	43.56	13.98	45.42	17.51	46.95	11.39	45.40	12.69		0.19	
A5 Modesty	56.67	12.26	51.68	17.44	48.10	10.59	50.55	10.96		1.43	
A6 Tendermindedness	55.22	7.73	56.53	13.70	52.30	12.54	53.30	9.49		0.56	

Note: p * < .05

When comparing OCD, panic disorder, sub-clinical OC and healthy control subjects on the facets of Agreeableness, no overall multivariate effect was observed (Wilks' $\lambda = 0.68$, $F[18, 192.82] = 1.59$, $p = .07$). The experimental groups did not differ on the Agreeableness facets of straightforwardness ($F[3, 73] = 2.06$, $p = .11$), altruism ($F[3, 73] = 1.08$, $p = .36$), compliance ($F[3, 73] = 0.19$, $p = .91$), modesty ($F[3, 73] = 1.43$, $p = .24$) and tendermindedness ($F[3, 73] = 0.56$, $p = .64$). There was, however, a significant difference between the experimental groups on the facet of trust ($F[3, 73] = 2.85$, $p < .05$).

Planned comparisons between the OCD patients and healthy controls did not yield an overall multivariate effect on the facets of Agreeableness (Wilks' $\lambda = 0.90$, $F[6, 68] = 1.31$, $p = .27$). The OCD patients scored no differently to the control subjects on the facets of trust ($t[36] = - 1.63$, p

= .11), straightforwardness (*t*[36] = 0.05, *p* = .96), altruism (*t*[36] = - 1.60, *p* = .11), compliance (*t*[36] = - 0.40, *p* = .69), modesty (*t*[36] = 1.44, *p* = .15) and tendermindedness (*t*[36] = 0.53, *p* = .60). These results do not support the hypothesis that the OCD patients would report significantly higher scores on the facets of straightforwardness, modesty and tendermindedness.

Planned comparisons between OCD patients and the panic disorder patients did not yield an overall multivariate effect on the facets of Agreeableness (Wilks' λ = 0.93, *F*[6, 68] = 0.87, *p* = .52). Contrary to the hypothesis, the OCD patients did not score significantly higher than the panic disorder patients on the facets of trust (*t*[35] = 1.20, *p* = .24), straightforwardness (*t*[35] = 1.15, *p* = .26), compliance (*t*[35] = - 0.40, *p* = .69), modesty (*t*[35] = 1.16, *p* = .25) and tendermindedness (*t*[35] = - 0.36, *p* = .72). There was also no difference between the OCD patients and the panic disorder patients on the facet of altruism (*t*[35] = - 0.14, *p* = .89).

Planned comparisons between OCD patients and the sub-clinical OC subjects did not yield an overall multivariate effect on the facets of Agreeableness (Wilks' λ = 0.86, *F*[6, 68] = 1.85, *p* = .10). As predicted, the OCD patients scored no differently to the sub-clinical OC subjects on the facets of trust (*t*[36] = - 0.50, *p* = .62), altruism (*t*[36] = - 0.49, *p* = .62), compliance (*t*[36] = - 0.74, *p* = .46) and tendermindedness (*t*[36] = 0.81, *p* = .42). However, contrary to the hypothesis, the OCD patients did report higher levels of straightforwardness (*t*[36] = 2.09, *p* < .05, *d* = 0.66, *P* = 0.51) and modesty (*t*[36] = 2.02, *p* < .05, *d* = 0.75, *P* = 0.61].

Post-hoc Tukey unequal N HSD tests were conducted to identify any significant differences between the healthy controls, panic disorder and sub-clinical OC subjects on the facets of Agreeableness. The results indicated that the healthy control subjects scored significantly higher on the facet of trust compared to the panic disorder patients (*p* < .05).

11.10.3 Summary

The results indicated that OCD patients reported no differences to the healthy control subjects on any of the facets of Agreeableness. There were also no differences between the OCD patients and the panic disorder patients on the Agreeableness facets. Compared to a sub-clinical OC group, the OCD patients reported significantly higher levels of straightforwardness and modesty.

11.11 The influence of depression and anxiety on Agreeableness facets

11.11.1 OCD versus sub-clinical OC subjects

As the OCD patients reported higher levels of current depression and state anxiety compared to the sub-clinical OC subjects, analysis was undertaken to evaluate the degree to which BDI-II

and STAI-S scores mediated differences on the Agreeableness facets of straightforwardness and modesty.

A2: Straightforwardness

For the regression of BDI-II and STAI-S score on the straightforwardness facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 97.

Table 97

Correlations among the straightforwardness facet, BDI-II and STAI-S scores for the comparison of OCD and sub-clinical OC subjects

Variables	A2: Straightforwardness	Group	BDI-II	STAI-S
Group (OCD = 1, sub-clinical OC = 2)	- 0.32*	-		
BDI-II	- 0.09	- 0.43**	-	
STAI-S	0.14	- 0.28*	0.61***	-

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

The independent variable group was significantly correlated with straightforwardness but BDI-II and STAI-S scores were not. This indicates that current depression and state anxiety did not contribute to the difference between the two groups on the straightforwardness facet.

A5: Modesty

For the regression of BDI-II and STAI-S score on the modesty facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 98.

Table 98

Correlations among the modesty facet, BDI-II and STAI-S scores for the comparison of OCD and sub-clinical OC subjects

Variables	A5: Modesty	Group	BDI-II	STAI-S
Group (OCD = 1, sub-clinical OC = 2)	- 0.36*	-		
BDI-II	0.30*	- 0.43**	-	
STAI-S	- 0.36**	- 0.28*	0.61***	-

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

The independent variables were all significantly correlated with modesty. A simple bivariate regression analysis was performed first to establish the amount of variance in modesty score that could be explained by group membership. A summary of the regression statistics is displayed in Table 99.

Table 99

Regression of group membership on the facet of modesty for the comparison of OCD and sub-clinical OC subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group	0.36	0.13	5.34	1,36	.03
(OCD = 1, sub-clinical OC = 2)					
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	60.95	4.23		14.41	.00
Group	- 4.28	1.85	- 0.36	- 2.31	.03

When group was used as a single predictor for modesty, the direct model was significant and accounted for 13% of the variance in modesty score. Group made a unique and significant contribution to the prediction of modesty score. To evaluate whether group membership still predicted significant portions of modesty after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 100.

Table 100

Hierarchical regression of group, BDI-II and STAI-S scores on the facet of modesty for the comparison of OCD and sub-clinical OC subjects

	Model summary							
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.40	0.16	3.38	2,35	.05			
2. BDI-II, STAI-S, Group	0.47	0.22	3.27	3,34	.03	0.06	2.71	.11
	Coefficients							
	B	*SE B*	β	*t*	*p*			
1. Constant	36.22	6.80		5.33	.00			
BDI-II	0.10	0.22	0.09	0.45	.66			
STAI-S	0.38	0.22	0.34	1.75	.09			
2. Constant	45.49	8.70		5.23	.00			
BDI-II	- 0.02	0.23	- 0.02	- 0.10	.92			
STAI-S	0.37	0.21	0.33	1.73	.09			
Group	- 3.27	1.98	- 0.27	- 1.65	.11			

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 9.78, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 16% of the variance in modesty score. BDI-II score did not make a unique and significant contribution to the prediction of modesty score. The contribution of STAI-S to the prediction of modesty score was approaching significance. The addition of group in model 2 did not significantly increase

the amount of modesty variance explained. In the new model, none of the variables made unique and significant contributions to the prediction of modesty score. After controlling for current depression, group membership did not predict significant portions of the variance in modesty score.

11.11.2 Summary

For the comparison of OCD and sub-clinical OC subjects, current depression and state anxiety did not account for the differences observed on the Agreeableness facet of straightforwardness. This result supports previous research that the Agreeableness domain is largely independent of symptom severity in depression (Bagby et al., 1995). However, when current depression and state anxiety were controlled for, differences on the facet of modesty was no longer significant for the comparison of OCD patients and sub-clinical OC subjects.

11.12 Conscientiousness facets

11.12.1 Data screening

Prior to analysis, the Conscientiousness facets were examined for accuracy of data entry, missing values and fit between their distributions and the assumptions of MANOVA. Conscientiousness comprised six variables: competence, order, dutifulness, achievement striving, self-discipline and deliberation. These variables were inspected using the Statistica descriptives procedure. All variables were within range, and means and standard deviations were plausible. Missing Value analysis was undertaken using the SPSS MVA procedure. Two OCD cases and one panic disorder case had missing values for Conscientiousness. There were no missing values for the sub-clinical OC or healthy control groups. The OCD and panic disorder cases with the missing data were deleted from the analysis. A full description of the data screening procedure is included in Appendix S.

11.12.2 Results

To test the hypotheses regarding the Conscientiousness facets and OCD patients in comparison to the healthy controls, panic disorder and sub-clinical OC subjects, a MANOVA was conducted using three planned contrasts. The contrasts compared: (1) OCD versus healthy controls; (2) OCD versus panic disorder; and (3) OCD versus sub-clinical OC. To measure the effect size of any significant group differences, Cohen's *d* was calculated using the Effect Size Generator for Windows: version 2.2 (Devilly, 2004). With two OCD cases and one panic disorder case with missing data excluded, and no cases excluded for assumption violations, there were 18 cases in the OCD group, 19 cases in the panic disorder group and 20 cases in the sub-clinical OC and healthy control groups. Mean Conscientiousness t scores for the four experimental groups are displayed in Table 101.

Table 101

Means and standard deviations of Conscientiousness facet T-scores for OCD, panic disorder, sub-clinical OC and healthy control subjects

	OCD (n = 18)		panic disorder (n =19)		sub-clinical OC (n = 20)		healthy controls (n = 20)				
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	Wilks' λ	*F*	
									0.57	**2.36**	**
C1 Competence	42.00	9.16	42.84	11.87	47.15	11.28	52.00	11.43		3.36	*
C2 Order	48.06	10.43	43.74	12.67	53.70	11.54	43.10	11.94		3.47	*
C3 Dutifulness	45.89	10.40	50.63	10.48	48.75	11.07	49.75	10.68		0.67	
C4 Achievement striving	40.22	9.74	47.53	9.38	46.60	8.89	43.65	12.20		1.98	
C5 Self-discipline	33.11	8.58	38.21	15.38	44.10	13.58	45.35	13.31		3.56	*
C6 Deliberation	48.11	11.20	48.63	13.95	52.55	9.63	50.10	12.60		0.54	

Note: * $p < .05$, ** $p < .01$

When comparing OCD, healthy control, panic disorder, and sub-clinical OC subjects on the facets of Conscientiousness an overall multivariate effects was observed (Wilks' $\lambda = 0.57$, $F[18, 192.82] = 2.36$, $p < .01$). The experimental groups differed on the facets of competence ($F[3, 73] = 3.36$, $p < .05$), order ($F[3, 73] = 3.47$, $p < .05$) and self-discipline ($F[3, 73] = 3.56$, $p < .05$). The experimental groups did not differ on the Conscientiousness facets of dutifulness ($F[3, 73] = 0.67$, $p = .56$), achievement striving ($F[3, 73] = 1.98$, $p = .13$) or deliberation ($F[3, 73] = 0.54$, $p = .66$).

Planned comparisons between OCD patients and the healthy control group yielded an overall multivariate effect on the facets of Conscientiousness (Wilks' $\lambda = 0.74$, $F[6, 68] = 4.03$, $p < .01$). As predicted, the OCD patients scored no differently to the healthy control subjects on the facets of order ($t[36] = 1.30$, $p = .20$), dutifulness ($t[36] = -1.11$, $p = .27$), achievement striving ($t[36] = -1.04$, $p = .30$) and deliberation ($t[36] = -0.51$, $p = .61$). As predicted, the OCD patients did score lower than the healthy control subjects on the facet of competence ($t[36] = -2.79$, $p < .01$, $d = 0.97$, $P = 0.83$) and self-discipline ($t[36] = -2.89$, $p < .01$, $d = 1.09$, $P = 0.90$).

Planned comparisons between OCD patients and the panic disorder patients did not yield an overall multivariate effect on the facets of Conscientiousness (Wilks' $\lambda = 0.86$, $F[6, 68] = 1.80$, $p = .11$). As predicted, the OCD patients scored no differently to the panic disorder patients on the facets of competence ($t[35] = 0.23$, $p = .82$), order ($t[35] = 1.12$, $p = .27$), dutifulness ($t[35] = -1.35$, $p = .18$), self-discipline ($t[35] = -1.19$, $p = .24$) and deliberation ($t[35] = -0.13$, $p = .89$). However, contrary to the hypothesis, the OCD patients scored lower on the facet of achievement striving ($t[35] = -2.19$, $p < .05$, $d = 0.76$, $P = 0.61$).

Planned comparisons between OCD patients and the sub-clinical OC group did not yield an overall multivariate effect on the facets of Conscientiousness (Wilks' $\lambda = 0.89$, $F[6, 68] = 1.37$,

p = .24). As predicted, the OCD patients scored no differently to the sub-clinical OC subjects on the facets of competence (*t*[36] = - 1.44, *p* = .15), order (*t*[36] = - 1.49, *p* = .14), dutifulness (*t*[36] = - 0.83, *p* = .41), achievement striving (*t*[36] = - 1.93, *p* = .06) and deliberation (*t*[36] = - 1.14, *p* = .26). However, contrary to the hypothesis, the OCD patients did score lower than the sub-clinical OC subjects on the facet of self-discipline (*t*[36] = - 2.60, *p* < .01, *d* = 0.97, *P* = 0.82).

Post-hoc Tukey unequal N HSD tests were conducted to identify any significant differences between the healthy controls, panic disorder and sub-clinical OC subjects on the facets of Conscientiousness. The results indicated that the healthy control subjects scored significantly lower on the facet of order compared to the sub-clinical OC subjects (*p* < .05).

11.12.3 Summary

In the current thesis, OCD patients were differentiated from the healthy control subjects by their lower scores on competence and self-discipline. The OCD patients were also differentiated from the panic disorder patients by their lower scores on achievement striving. The OCD patients also scored lower on self-discipline when compared to sub-clinical OC subjects.

11.13 The influence of depression and anxiety on Conscientiousness facets

11.13.1 OCD versus healthy control subjects

As the OCD patients reported higher scores on the clinical measures of current depression and state anxiety, analysis was undertaken to evaluate the degree to which BDI-II and STAI-S scores influenced differences on the Conscientiousness facets of competence and self-discipline. Separate analyses were conducted with each of the Conscientiousness facets as the dependent variables, and group, BDI-II, and STAI-S scores as the independent variables.

C1: Competence

For the regression of the clinical variables on the competence facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 102.

Table 102

Correlations among the competence facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	C1: competence	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	0.44*	-		
BDI-II	- 0.47*	- 0.75**	-	
STAI-S	- 0.61**	- 0.58**	0.73**	-

Note: * p < .01, ** p < .001

The independent variables all had substantial correlations with competence. A simple bivariate regression analysis was performed first to establish the amount of variance in competence score that could be explained by group membership. A summary of the regression statistics is displayed in Table 103.

Table 103

Regression of group membership on the facet of competence for the comparison of OCD and healthy control subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.44	0.20	8.73	1,36	.01
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	38.67	3.37		11.49	.00
Group	3.33	1.13	0.44	2.95	.01

When group was used as a single predictor for competence, the direct model was significant and accounted for 20% of the variance in competence score. Group made a unique and significant contribution to the prediction of competence score. To evaluate whether group membership still predicted significant portions of competence score after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 104.

Table 104

Hierarchical regression of group, BDI-II and STAI-S scores on the competence facet for the comparison of OCD and healthy control subjects

	Model summary							
	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II	0.61	0.37	10.47	2,35	.00			
2. BDI-II, STAI-S, Group	0.62	0.38	7.11	3,34	.00	0.01	0.61	.44
	Coefficients							
	B	*SE B*	β	*t*	*p*			
1. Constant	71.29	6.76		10.54	.00			
BDI-II	- 0.05	0.18	- 0.05	- 0.27	.89			
STAI-S	- 0.68	0.23	- 0.57	- 2.95	.01			
2. Constant	66.47	9.18		7.24	.00			
BDI-II	0.05	0.22	0.06	0.24	.81			
STAI-S	- 0.67	0.23	- 0.56	- 2.86	.01			
Group	1.20	1.54	0.16	0.78	.44			

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.91, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S was significant and explained 37% of the variance in competence score. STAI-S scores made a unique and significant contribution to the prediction of competence score. BDI-II scores did not predict significant portions of the variance in competence score. The addition of group in model 2 did not significantly increase the amount of competence variance explained. In the new model, only STAI-S made a unique and significant contribution to the prediction of competence score. After controlling for current depression and state anxiety, group membership no longer predicted significant portions of the variance in competence score.

C5: Self-discipline

For the regression of the clinical variables on the self-discipline facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 105.

Table 105

Correlations among the self-discipline facet, BDI-II and STAI-S scores for the comparison of OCD and healthy control subjects

Variables	C5: self-discipline	Group	BDI-II	STAI-S
Group (OCD = 1, controls = 2)	0.49*	-		
BDI-II	- 0.45*	- 0.75**	-	
STAI-S	- 0.65**	- 0.58**	0.73**	-

Note: * p < .01, ** p < .001

The independent variables were all significantly correlated with self-discipline. A simple bivariate regression analysis was performed first to establish the amount of variance in self-discipline score that could be explained by group membership. A summary of the regression statistics is displayed in Table 106.

Table 106

Regression of group membership on the self-discipline facet for the comparison of OCD and healthy control subjects

		Model summary			
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, controls = 2)	0.49	0.24	11.06	1,36	.00
		Coefficients			
	B	*SE B*	β	*t*	*p*
Constant	29.03	3.66		7.94	.00
Group	4.08	1.23	0.49	3.33	.00

When group was used as a single predictor for self-discipline, the direct model was significant and accounted for 24% of the variance in self-discipline score. Group made a unique and significant contribution to the prediction of self-discipline score. To evaluate whether group membership still predicted significant portions of self-discipline after controlling for current

depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores 'forced' into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 107.

Table 107

Hierarchical regression of group, BDI-II and STAI-S scores on the self-discipline facet for the comparison of OCD and healthy control subjects

Model summary

	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II	0.65	0.42	12.73	2,35	.00			
2. BDI-II, STAI-S, Group	0.67	0.46	9.46	3,34	.00	0.04	2.11	.16

Coefficients

	B	*SE B*	β	*t*	*p*
1. Constant	70.03	7.25		9.66	.00
BDI-II	0.04	0.19	0.04	0.22	.83
STAI-S	- 0.90	0.25	- 0.68	- 3.63	.00
2. Constant	60.62	9.64		6.29	.00
BDI-II	0.24	0.23	0.24	1.03	.31
STAI-S	- 0.87	0.25	- 0.66	- 3.56	.00
Group	2.35	1.62	0.28	1.45	.16

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 8.91, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S was significant and explained 42% of the variance in self-discipline score. STAI-S scores made a unique and significant contribution to the prediction of self-discipline score but BDI-II did not. The addition of group in model 2 did not significantly increase the amount of self-discipline variance explained. In the new model, only STAI-S score made a unique and significant contribution to the prediction of self-discipline score. After controlling for current depression and state anxiety, group membership did not predict significant portions of the variance in self-discipline score.

11.13.2 OCD versus sub-clinical OC subjects

As the OCD patients reported higher levels of current depression and state anxiety compared to the sub-clinical OC subjects, analysis was undertaken to evaluate the degree to which BDI-II and STAI-S scores mediated differences on the Conscientiousness facet of self-discipline.

C5: Self-discipline

For the regression of BDI-II and STAI-S score on the self-discipline facet, correlational analysis was undertaken to ensure the prerequisites for multiple regression analysis were met. The correlation coefficients are displayed in Table 108.

Table 108

Correlations among the self-discipline facet, BDI-II and STAI-S scores for the comparison of OCD and sub-clinical OC subjects

Variables	C5: self-discipline	Group	BDI-II	STAI-S
Group (OCD = 1, sub-clinical OC = 2)	0.44**	-		
BDI-II	- 0.47**	- 0.42**	-	
STAI-S	- 0.45**	- 0.28*	0.61***	-

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

The independent variables were all significantly correlated with self-discipline. A simple bivariate regression analysis was performed first to establish the amount of variance in self-discipline score that could be explained by group membership. A summary of the regression statistics is displayed in Table 109.

Table 109

Regression of group membership on the self-discipline facet for the comparison of OCD and sub-clinical OC subjects

Model summary					
	R	R^2	*F*	*df*	*p*
Group (OCD = 1, sub-clinical OC = 2)	0.44	0.19	8.66	1,36	.01
Coefficients					
	B	*SE B*	β	*t*	*p*
Constant	27.62	4.26		6.48	.00
Group	5.49	1.87	0.44	2.94	.01

When group was used as a single predictor for self-discipline, the direct model was significant and accounted for 19% of the variance in self-discipline score. Group made a unique and significant contribution to the prediction of self-discipline score. To evaluate whether group membership still predicted significant portions of self-discipline after controlling for current depression and state anxiety, a hierarchical regression was performed with BDI-II and STAI-S scores ‘forced’ into step one and group membership entered into step two. A summary of the hierarchical regression statistics is displayed in Table 110.

Table 110

Hierarchical regression of group, BDI-II and STAI-S scores on the self-discipline facet for the comparison of OCD and sub-clinical OC subjects

Model summary

	R	R^2	*F*	*df*	*p*	ΔR^2	ΔF	*Sig* ΔF
1. BDI-II, STAI-S	0.51	0.26	6.29	2,35	.01			
2. BDI-II, STAI-S, Group	0.58	0.33	5.62	3,34	.00	0.07	3.41	.07

Coefficients

	B	*SE B*	β	*t*	*p*
1. Constant	56.33	6.67		8.44	.00
BDI-II	- 0.38	0.22	- 0.32	- 1.74	.09
STAI-S	- 0.30	0.22	- 0.25	- 1.38	.18
2. Constant	46.22	8.46		5.47	.00
BDI-II	- 0.24	0.22	- 0.21	- 1.11	.28
STAI-S	- 0.28	0.21	- 0.24	- 1.36	.18
Group	3.56	1.93	0.29	1.85	.07

SPSS regression statistics were investigated to ensure that no assumptions were violated. Normal probability plots and residual scatterplots confirmed no violations of the normality, linearity or homoscedasticity assumptions. There was no suggestion of multivariate outliers (Mahalanobis distance = 9.78, critical value = $\chi^2[3] = 16.27$, $p < .001$). Tolerance values were all greater than .20 and collinearity diagnostics confirmed no problems of multicollinearity.

The model including BDI-II and STAI-S scores was significant and explained 26% of the variance in self-discipline score. The contribution of BDI-II scores to the prediction of self-discipline score approached significance. The addition of group in model 2 did not significantly increase the amount of self-discipline variance explained. In the new model, none of the variables made a unique and significant contribution to the prediction of self-discipline score. After controlling for current depression and state anxiety, group membership approached significance in the amount of variance in self-discipline score that it explained.

11.13.3 Summary

For the comparison of OCD patients and healthy control subjects, differences on the Conscientiousness facets of competence and self-discipline were no longer significant after controlling for measures of current depression and state anxiety. Similarly, for the comparison of OCD patients and sub-clinical OC subjects, differences on the Conscientiousness facet of self-discipline was no longer significant after controlling for current depression and anxiety.

11.14 Summary of personality results

Table 111 contains a summary of the results from the direct comparison of OCD patients to healthy control subjects, panic disorder patients and sub-clinical OC subjects on the domains and facets of the NEO PI-R.

Table 111
Summary of personality results

	Comparison		
Measure	OCD v controls	OCD v panic disorder	OCD v sub-clinical OC
Neuroticism	**OCD sig. ↑**	**OCD =**	**OCD sig. ↑**
Anxiety	OCD sig. ↑	OCD =	OCD =
Angry hostility	OCD sig. ↑	OCD =	OCD =
Depression	OCD sig. ↑	OCD =	OCD sig. ↑
Self-consciousness	OCD sig. ↑	OCD =	OCD =
Impulsiveness	OCD sig. ↑	OCD =	OCD =
Vulnerability	OCD sig. ↑	OCD =	OCD sig. ↑
Extraversion	**OCD sig. ↓**	**OCD =**	**OCD =**
Warmth	OCD sig. ↓	OCD =	OCD =
Gregariousness	OCD sig. ↓	OCD =	OCD =
Assertiveness	OCD sig. ↓	OCD =	OCD =
Activity	OCD =	OCD =	OCD =
Excitement-seeking	OCD =	OCD =	OCD =
Positive emotions	OCD sig. ↓	OCD =	OCD sig. ↓
Openness	**OCD sig. ↓**	**OCD =**	**OCD =**
Fantasy	OCD =	OCD =	OCD =
Aesthetics	OCD =	OCD =	OCD =
Feelings	OCD =	OCD =	OCD =
Actions	OCD sig. ↓	OCD sig. ↓	OCD =
Ideas	OCD =	OCD =	OCD =
Values	OCD sig. ↓	OCD =	OCD =
Agreeableness	**OCD =**	**OCD =**	**OCD =**
Trust	OCD =	OCD =	OCD =
Straightforwardness	OCD =	OCD =	OCD sig. ↑
Altruism	OCD =	OCD =	OCD =
Compliance	OCD =	OCD =	OCD =
Modesty	OCD =	OCD =	OCD sig. ↑
Tendermindedness	OCD =	OCD =	OCD =
Conscientiousness	**OCD =**	**OCD =**	**OCD sig. ↓**
Competence	OCD sig. ↓	OCD =	OCD =
Order	OCD =	OCD =	OCD =
Dutifulness	OCD =	OCD =	OCD =
Achievement-striving	OCD =	OCD sig. ↓	OCD =
Self-discipline	OCD sig. ↓	OCD =	OCD sig. ↓
Deliberation	OCD =	OCD =	OCD =

11.15 Predicting the severity of OC symptoms from personality traits

To determine the relative contribution of personality measures to the severity of obsessive-compulsive symptoms in the OCD patients and sub-clinical OC subjects, regression analysis was undertaken within each group using personality traits as the independent variables and Yale-Brown Obsessive-Compulsive Scale (Y-BOCS) scores as the dependent variable.

11.15.1 OCD patients

Correlational analysis was conducted to establish which personality variables correlated with Y-BOCS scores in the OCD patients and should, therefore, be included in the regression equation. The only personality variables with significant correlations with Y-BOCS scores were the Neuroticism facets of anxiety, and the Extraversion facets of activity. The correlation coefficients are displayed in Table 112.

Table 112
Correlations among the anxiety and activity facets and Y-BOCS scores for the OCD patients

Variables	Y-BOCS score	Anxiety	Activity
Anxiety	0.57**	-	
Activity	- 0.64**	- 0.40*	-

Note: * $p < .05$, ** $p < .01$

To establish the amount of variance in Y-BOCS score that could be explained by the personality variables, a multiple regression analysis was performed with anxiety and activity as the independent variables, and Y-BOCS score as the dependent variable. A summary of the regression statistics is displayed in Table 113.

Table 113
Regression of the anxiety and activity facets on Y-BOCS scores for the OCD patients

	Model summary				
	R	R^2	*F*	*df*	*p*
Anxiety, Activity	0.73	0.52	8.36	2,15	.00
	Coefficients				
	B	*SE B*	β	*t*	*p*
Constant	15.30	9.74		1.57	.14
Anxiety	0.20	0.11	0.37	1.91	.08
Activity	- 0.26	0.10	- 0.49	- 2.55	.02

When anxiety and activity were used as predictors for Y-BOCS score, the regression model was significant and accounted for 52% of the variance in Y-BOCS score. Activity made a unique and significant contribution to the prediction of Y-BOCS score. The contribution of anxiety to the prediction of Y-BOCS score was approaching significance.

11.15.2 Sub-clinical OC subjects

Correlational analysis was conducted to establish which personality variables correlated with Y-BOCS scores in the sub-clinical OC group and should, therefore, be included in the regression equation. The personality variables with significant correlations with Y-BOCS are displayed in Table 114.

Table 114

Correlations among the Neuroticism and Agreeableness domains, the angry hostility, fantasy, values, trust, straightforwardness and dutifulness facets and Y-BOCS scores for the sub-clinical OC subjects

Variables	Y-BOCS score	N	A	N2	O1	O6	A1	A2	C3
Neuroticism	0.46*	-							
Agreeableness	- 0.49*	- 0.08	-						
Angry hostility	0.52**	0.64**	- 0.47*	-					
Fantasy	0.45*	0.21	0.03	0.15	-				
Values	0.49*	- 0.15	0.39*	- 0.28	- 0.12	-			
Trust	- 0.56**	- 0.25	0.67**	- 0.32	- 0.12	0 .31	-		
Straightforwardness	- 0.61**	- 0.08	0.77***	- 0.18	- 0.18	0.55**	0.54**	-	
Dutifulness	- 0.55**	- 0.48*	0.16	- 0.24	- 0.18	0. 61**	0.17	0.44*	-

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

A preliminary analysis indicated very low tolerance values for Agreeableness (0.12), angry hostility (0.23) and straightforwardness (0.17). To avoid violating the multicollinearity assumption these three variables were removed from the analysis. To establish the amount of variance in Y-BOCS score that could be explained by the personality variables, a multiple regression analysis was performed with Neuroticism, fantasy, values, trust and dutifulness as the independent variables, and Y-BOCS score as the dependant variable. A summary of the regression statistics is displayed in Table 115.

Table 115

Regression of the Neuroticism domain and the fantasy, values, trust and dutifulness facets on Y-BOCS scores for the sub-clinical OC subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
1.	0.80	0.65	5.11	5,14	.01
	Coefficients				
	B	*SE B*	β	*t*	*p*
1. Constant	19.84	14.50		1.37	.19
Neuroticism	0.10	0.13	0.14	0.75	.47
Fantasy	0.21	0.11	0.30	1.85	.09
Values	- 0.11	0.17	- 0.14	- 0.66	.52
Trust	- 0.26	0.11	- 0.40	- 2.30	.04
Dutifulness	- 0.20	0.17	- 0.28	- 1.20	.25

The regression model was significant and accounted for 65% of the variance in Y-BOCS score. Trust made a unique and significant contribution to the prediction of Y-BOCS score. The contribution of fantasy to the prediction of Y-BOCS score was approaching significance.

11.16 Predicting discomfort of OC symptoms from personality traits

To determine the relative contribution of personality measures to the discomfort caused by obsessive-compulsive symptoms in all four experimental groups, regression analysis was undertaken within each group using personality traits as the independent variables, and Padua Inventory (PI) scores as the dependant variable.

11.16.1 OCD patients

Correlational analysis was conducted to establish which personality variables correlated with PI scores for the OCD patients and should, therefore, be included in the regression equation. The only personality variables with significant correlations with PI scores were the Neuroticism facet of anxiety, the Extraversion facet of activity, the Openness facet of actions and the Conscientiousness facets of achievement-striving. The correlation coefficients for these variables are displayed in Table 116.

Table 116

Correlations among the anxiety, activity, actions and achievement striving facets and PI scores for the OCD patients

Variables	Padua Inventory Score (DV)	Anxiety	Activity	Actions	Achievement Striving
Anxiety	0.48*	-			
Activity	- 0.50*	- 0.40*	-		
Actions	- 0.47*	- 0.48*	0.41*	-	
Achievement Striving	- 0.49*	- 0.08	0.52*	0.05	-

Note: * $p < .05$

To establish the amount of variance in PI score that could be explained by the personality variables, a multiple regression analysis was performed with anxiety, activity, actions and achievement striving as the independent variables, and PI score as the dependent variable. A summary of the regression statistics is displayed in Table 117.

Table 117

Regression of the anxiety, activity, actions and achievement striving facets on PI scores for the OCD patients

	Model summary				
	R	R^2	*F*	*df*	*p*
1.	0.72	0.51	3.40	4,13	.04
	Coefficients				
	B	*SE B*	β	*t*	*p*
1. Constant	100.10	62.98		1.59	.14
Anxiety	0.82	0.65	0.29	1.26	.23
Activity	- 0.09	0.71	- 0.03	- 0.12	.90
Actions	- 0.68	0.53	- 0.30	- 1.29	.22
Achievement striving	- 1.24	0.66	- 0.44	- 1.88	.08

When anxiety, activity, actions and achievement striving were used as predictors for PI score, the regression model was significant and accounted for 51% of the variance in PI score. The contribution of achievement-striving to the prediction of PI score was approaching significance. None of the other variables predicted significant portions of the variance in PI score.

11.16.2 Sub-clinical OC subjects

Correlational analysis was conducted to establish which personality variables correlated with PI scores in the sub-clinical OC group and should, therefore, be included in the regression equation. The only personality variable with a significant correlation with PI score was the domain of Openness ($r = 0.45$, $p < .05$). The result indicated that Openness-to-experience was the only predictor of the disturbance of OC symptoms in the sub-clinical OC subjects.

11.16.3 Panic disorder patients

Correlational analysis was conducted to establish which personality variables correlated with PI scores in the panic disorder group and should, therefore, be included in the regression equation. Thirteen personality variables had a significant correlation with PI score: Neuroticism, Conscientiousness, anxiety, depression, self-consciousness, impulsiveness, vulnerability, fantasy, competence, dutifulness, self-discipline and deliberation. A preliminary analysis indicated very low tolerance values for Neuroticism (.06), Conscientiousness (.07), depression (.05), self-consciousness (.16), impulsiveness (.20), self-discipline (.15) and deliberation (.11). To avoid violating the multicollinearity assumption, these variables were removed from the analysis. The personality variables with significant correlations with PI, which were included in the regression analysis, are displayed in Table 118.

Table 118

Correlations among the anxiety, vulnerability, fantasy, competence and dutifulness facets and PI scores for the panic disorder patients

Variables	PI score	N1	N6	O1	C1	C3
Anxiety	0.55*	-				
Vulnerability	0.48*	0.48*	-			
Fantasy	0.55*	0.70***	0.47*	-		
Competence	- 0.70**	- 0.34	- 0.39*	- 0.26	-	
Dutifulness	- 0.69**	- 0.40*	- 0.57**	- 0.51*	0.55**	-

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

To establish the amount of variance in PI score that could be explained by the personality variables, a multiple regression analysis was performed with anxiety, vulnerability, fantasy, competence and dutifulness as the independent variables, and PI score as the dependent variable. A summary of the regression statistics is displayed in Table 119.

Table 119

Regression of the anxiety, vulnerability, fantasy, competence and dutifulness facets on PI scores for the panic disorder patients

	Model summary				
	R	R^2	*F*	*df*	*p*
1.	0.83	0.69	5.90	5,13	.01
	Coefficients				
	B	*SE B*	β	*t*	*p*
1. Constant	77.87	64.18		1.21	.25
anxiety	0.48	0.72	0.15	0.66	.52
vulnerability	- 0.08	0.45	- 0.03	-0.17	.87
fantasy	0.58	0.68	0.20	0.86	.41
competence	-1.23	0.52	- 0.45	-2.36	.04
dutifulness	- 0.92	0.69	- 0.30	-1.34	.20

The regression model was significant and accounted for 69% of the variance in PI score. Competence made a unique and significant contribution to the prediction of PI score. None of the other variables predicted significant portions of the variance in PI score.

11.16.4 Healthy control subjects

Correlational analysis was conducted to establish which personality variables correlated with PI scores in the healthy control group and should, therefore, be included in the regression equation. The only personality variables with significant correlations with PI scores were the Extraversion facet of positive emotions and the Agreeableness facet of modesty. The correlation coefficients for these variables are displayed in Table 120.

Table 120

Correlations among the positive emotions and modesty facets and PI scores for the healthy control subjects

Variables	Padua Inventory Score	Positive emotions	modesty
Positive emotions	- 0.48*	-	
Modesty	0.46*	- 0.22	-

Note: * $p < .05$

To establish the amount of variance in PI score that could be explained by the personality variables, a multiple regression analysis was performed with positive emotions and modesty as the independent variables, and PI score as the dependent variable. A summary of the regression statistics are displayed in Table 121.

Table 121

Regression of the positive emotions and modesty facets on PI scores for the healthy control subjects

	Model summary				
	R	R^2	*F*	*df*	*p*
1.	0.61	0.37	4.92	2,17	.02
	Coefficients				
	B	*SE B*	β	*t*	*p*
1. Constant	10.49	7.71		1.36	.19
Positive emotions	- 0.18	0.09	- 0.40	-2.04	.06
Modesty	0.19	0.10	0.37	1.88	.08

When positive emotions and modesty were used as predictors for PI score, the regression model was significant and accounted for 37% of the variance in PI score. The contribution of both positive emotions and modesty to the prediction of PI score approached significance.

11.16.5 Summary

The results indicated that different personality variables predicted the severity and discomfort of OC symptoms in the different experimental groups. However, given the small sample size, and the number of analyses performed, interpretation of the results should be made with caution.

CHAPTER 12: DISCUSSION

12.1 Introduction

This chapter begins with a summary of the main findings, followed by a discussion of the demographic and clinical characteristics of the sample. The results from each of the DMS and n-back tasks are discussed separately, followed by a summary of the cognitive results. The results from the domains of the Revised NEO Personality Inventory (NEO PI-R) are discussed, followed by a discussion of the facets of each domain. A summary of the personality results is then presented. The chapter concludes with a discussion about the limitations of the thesis and recommendations for future research.

12.2 Summary of the main findings

This thesis directly compared OCD patients to healthy controls, patients with panic disorder, and sub-clinical OC subjects on measures of working memory and the Five-Factor Model of personality (FFM).

The thesis investigated whether the use of verbal mediation aids the performance of OCD subjects on tests of working memory. The thesis also investigated whether the requirement to maintain visual representations of stimuli 'on line' leads to a decrement in performance. The thesis also investigated whether OCD patients were impaired on working memory tasks requiring the use of strategic processing, such as updating and temporal ordering of information. Subjects completed a series of delayed-matching-to-sample (DMS) tasks that assessed the ability to maintain representations of different types of information in working memory (easy-to-label objects, difficult-to-label objects and spatial locations). Subjects also completed a series of continuous performance working memory tasks (n-back tasks) that required both continual updating and memory for order of verbal and spatial stimuli. The results indicated that OCD patients were impaired on a task requiring the maintenance of representations of spatial stimuli in working memory. OCD patients were also impaired on tasks requiring the updating and temporal ordering of representations of verbal and spatial stimuli in working memory. The OCD patients were not impaired in their ability to maintain representations of object information in working memory. The deficits were not the result of demographic or clinical characteristics, or of medication status and were also not related to specific symptom subtypes.

The thesis also investigated the normal personality traits of OCD in comparison to healthy controls, patients with panic disorder and a sub-clinical OC sample. Subjects completed the NEO PI-R as a measure of the FFM. Compared to healthy control subjects, OCD patients reported being highly emotional and introverted, less open to new experiences, and lacking confidence in their own abilities. The OCD patients were similar to the panic disorder patients on most of the domains and facets of the NEO PI-R, however, they were distinguished by their lower openness to experiencing new places, and being less diligent and purposeful. Compared

to the sub-clinical OC subjects, OCD patients reported being more prone to feelings of depression, more vulnerable to stress, less likely to experience positive emotions, more humble and sincere and less able to carry tasks through to completion. The results also indicated that current depression and state anxiety accounted for some of the personality differences between the OCD patients and healthy control subjects. However, differences on Neuroticism (including the facets of anxiety, depression, self-consciousness and vulnerability), Extraversion, and openness-to-actions were not influenced by current mood. In contrast, the personality differences between the OCD patients and the sub-clinical OC subjects, on all measures except straightforwardness, were accounted for by current mood.

12.3 Demographic and clinical characteristics

In this thesis, the experimental groups were well-matched with respect to demographic characteristics. The experimental groups did not statistically differ on the demographic characteristics of age, gender, estimated IQ or handedness.

The clinical characteristics of the experimental groups appeared to accurately represent the defining characteristics of each group. As expected, OCD patients reported significantly higher levels of depression, state anxiety, trait anxiety and more disturbing obsessive-compulsive symptoms compared to the healthy control subjects. Compared to the panic disorder patients, the OCD patients reported equivalent levels of depression, state anxiety and trait anxiety but, as expected, the OCD patients reported significantly more disturbing obsessive-compulsive behaviours. Compared to the sub-clinical OC subjects, the OCD patients reported higher levels of current depression, state and trait anxiety, disturbance of obsessive-compulsive symptoms and severity of obsessive-compulsive symptoms. The sub-clinical OC subjects reported higher levels of anxiety, depression and obsessive-compulsive symptoms compared to the healthy control group. The differences observed between the experimental groups on the clinical measures were consistent with previous research using clinical and sub-clinical OC samples (Savage et al., 1999; Mataix-Cols, 2003; Fullana et al., 2004).

12.4 Cognitive tasks

The following sections discuss the accuracy and reaction time results from the comparison of OCD patients, healthy controls, patients with panic disorder, and sub-clinical OC subjects on the three DMS tasks and the two n-back tasks. An overall discussion of the cognitive results is also included.

12.4.1 DMS tasks

Irregular object DMS task

There were no differences in overall mean accuracy between the OCD patients (75.32% correct) and the healthy control subjects (75.20%), the panic disorder patients (74.00%) or the

sub-clinical OC subjects (74.50%) on the irregular object DMS task. The results do not support previous research that OCD patients perform more poorly than control subjects on tasks that do not permit verbal rehearsal of task stimuli (Purcell et al., 1998a, 1998b; Zielinski et al., 1991).

The hypothesis that the accuracy of the OCD patients would be no different to the healthy controls, panic disorder patients or sub-clinical OC subjects on the low demand trials of the irregular object DMS task was supported. On the low demand trials, the OCD patients (81.89%) were as accurate as the healthy controls (81.85%), the panic disorder (80.95%) and the sub-clinical OC subjects (80.25%). As predicted, the accuracy of the OCD patients (68.95%) was also no different on the high demand trials of the irregular object DMS task compared to the sub-clinical OC subjects (68.80%). However, contrary to the hypothesis, the accuracy of the OCD patients was also no different to the healthy controls (68.20%) or the panic disorder patients (67.25%) on the high demand trials. The equivalent performance of the OCD group on the low and high demand trials demonstrates that even when the amount of irregular object information to be actively maintained in working memory increased, the OCD patients still performed as accurately as healthy controls, panic disorder patients and sub-clinical OC subjects. The results do not support previous research suggesting that OCD patients perform more poorly than controls as the demand of a task increases (Purcell et al., 1998a; Veale et al., 1996).

As predicted, the accuracy of the OCD patients (79.05%) was no different to the healthy controls (80.05%), the panic disorder patients (79.95%) or the sub-clinical OC subjects (78.75%) on the perception trials of the irregular object DMS task. The performance of the OCD patients on the perception trials (250 ms delay) demonstrated that they were able to accurately encode the irregular object stimuli. As predicted, the accuracy of the OCD patients (71.79%) was also no different to the sub-clinical OC subjects (70.30%) on the memory trials of the irregular object DMS task. Contrary to the hypothesis, the accuracy of the OCD patients was also no different to the healthy controls (70.15%) or the panic disorder patients (68.05%) on the memory trials. The performance of the OCD patients on the memory trials (3,000 ms delay) demonstrates that the OCD patients were able to accurately maintain representations of the irregular object stimuli in working memory.

Overall, the results indicated that OCD patients were not impaired on a task where they were required to actively maintain representations of difficult-to-label object stimuli. This result does not support previous research that OCD patients perform more poorly than control subjects on tasks that do not permit verbal rehearsal of task stimuli (Purcell et al., 1998a, 1998b; Zielinski et al., 1991). However, the results are consistent with previous research suggesting that OCD patients are able to process pattern or object information as well as healthy controls (Nielen & Den Boer, 2003; Purcell et al., 1998a, 1998b). For example, OCD patients have generally performed as well as healthy control subjects on tasks comprising pattern or object stimuli such

as the CANTAB Pattern Recognition and Delayed-Matching-to-Sample (DMS) tasks, the Rey Complex Figure Task (RCFT) copy trials and working memory for line drawings.

Spatial Locations DMS task

There were no differences in overall mean accuracy performance between the OCD patients (76.26%) and the healthy control subjects (80.35%), the panic disorder patients (77.65%) and the sub-clinical OC subjects (77.25%) on the spatial locations DMS task. The results do not support previous research that OCD patients are impaired on tasks where they cannot apply verbal labels to task stimuli and must rely on maintaining visual representations of stimuli to aid their performance (Zielinski et al., 1991; Purcell et al., 1998a, 1998b).

As predicted, the accuracy of the OCD patients (84.32%) on the low demand trials of the spatial locations DMS task was no different to the healthy controls (87.20%), the panic disorder patients (85.70%) or the sub-clinical OC subjects (85.75%). As predicted, the accuracy of the OCD patients (68.32%) was also no different to the sub-clinical OC subjects (68.65%) on the high demand trials of the spatial locations DMS task. Contrary to the hypothesis, the accuracy of the OCD patients was also no different to the healthy controls (73.25%) or the panic disorder patients (69.65%) on the high demand trials. The performance of the OCD group on the high demand trials demonstrates that even as the amount of spatial information to be maintained in working memory increased, the OCD patients were still able to perform as accurately as the control subjects. As with the results from the irregular object DMS task, these results do not support previous research regarding demand related deficits in OCD (Veale et al., 1996; Purcell et al., 1998a).

As predicted, the accuracy of the OCD patients (81.63%) on the perception trials of the spatial locations DMS task was no different to the healthy controls (83.15%), the panic disorder patients (82.15%) or the sub-clinical OC subjects (80.95%). The performance of the OCD group on the perception trials (250 ms delay) demonstrated that they were able to accurately encode the spatial locations stimuli. As predicted, the accuracy of the OCD patients (71.00%) on the memory trials of the spatial location DMS task was no different to the sub-clinical OC subjects (73.55%). Contrary to the hypothesis, the accuracy of the OCD patients on the memory trials was also no different to the panic disorder patients (73.15%). The hypothesis that the accuracy of the OCD patients would be poorer than the healthy control subjects (77.25%) on the memory trials of the spatial locations DMS task was supported. The performance of the OCD patients on the memory trials (3,000 ms delay) demonstrated that compared to panic disorder patients and sub-clinical OC subjects, OCD patients were able to accurately maintain representations of spatial locations stimuli in working memory. The ability of the OCD patients to accurately maintain representations of spatial stimuli in working memory was poorer in comparison to the healthy control subjects. This result supports previous research that OCD patients perform more poorly than healthy controls on tasks involving spatial working memory (Purcell et al.,

1998a,b). For example, OCD patients have demonstrated impairments on other task involving spatial working memory such as the Tower of Hanoi, the CANTAB Spatial Working Memory and CANTAB Spatial Recognition tasks and the Cube Test.

Geometric object DMS task

On the geometric object DMS task, there were no differences in overall mean accuracy between the OCD patients (79.37%), and the healthy control subjects (80.30%), the panic disorder patients (78.70%) or the sub-clinical OC subjects (79.40%). The results support previous research that OCD patients are not impaired on tasks where they can apply verbal labels to task stimuli to aid their performance (Zielinski et al., 1991; Purcell et al., 1998a, 1998).

On the low demand trials, the OCD patients (84.21%) were as accurate as the healthy controls (84.95%), the patients with panic disorder (83.80%) and the sub-clinical OC subjects (83.55%). Similarly, the OCD patients (74.58%) performed as accurately as the healthy controls (75.65%), panic disorder patients (73.75%) and sub-clinical OC subjects (75.25%) on the high demand trials. The performance of the OCD patients on the low and high demand trials of the geometric object DMS task supported the hypotheses that they would not differ from the healthy controls, panic disorder patients or sub-clinical OC subjects on this task. The results indicated that even as the amount of geometric object information to be maintained in working memory increased, the OCD patients were still able to perform as accurately as the comparison subjects.

The OCD patients (82.53%) were as accurate as the healthy controls (85.40%), the panic disorder patients (82.50%) and the sub-clinical OC subjects (84.60%) on the perception trials of the geometric object DMS task. The performance of the OCD patients on the perception trials (250 ms delay) indicated that these patients were able to accurately encode the geometric object stimuli. The OCD patients (76.16%) also demonstrated equivalent accuracy compared to the healthy controls (75.15%), panic disorder patients (74.95%) and sub-clinical OC subjects (74.15%) on the memory trials. Performance on the memory trials (3,000 ms delay) demonstrates that OCD patients were able to accurately maintain representations of the geometric stimuli in working memory. These results support the hypotheses, and are consistent with previous research reporting no deficit in the ability of OCD patients to process stimuli that is able to be verbally rehearsed (Zielinski et al., 1991; Purcell et al., 1998a, 1998). The results are also consistent with previous research that has found that OCD patients perform as well as control subjects on tasks using object or pattern stimuli (Nielen & Den Boer, 2003; Purcell et al., 1998a, 1998b). For example, OCD patients have typically demonstrated equivalent performance to healthy control subjects on tasks comprising pattern or object stimuli such as the CANTAB Pattern Recognition and DMS tasks, the RCFT copy trials and working memory for line drawings.

DMS task reaction times

The hypothesis that the reaction times of the OCD patients would be no different to the healthy controls, panic disorder patients or sub-clinical OC subjects on all three DMS tasks was supported. There were no differences in the speed of responses by the OCD patients on any of the DMS tasks. The results indicated that compared to healthy controls, patients with panic disorder and sub-clinical OC subjects, OCD patients perform as quickly on computer-paced tasks that assess the ability to maintain representations of object and spatial stimuli in working memory. This result supports previous research suggesting that OCD patients perform as quickly as control subjects on timed tasks (Martin et al., 1995).

Summary of DMS task performance

In terms of overall performance, the OCD patients were equivalent to the healthy controls, panic disorder patients and sub-clinical OC subjects on the irregular object and geometric object DMS tasks on measures of both accuracy and reaction time. In contrast, the OCD patients were less accurate than the healthy control subjects on the spatial locations DMS task. In the present thesis, sub-clinical OC subjects and panic disorder patients did not differ from the healthy control subjects on any of the DMS tasks.

The OCD patients performed as accurately as the panic disorder, healthy control and sub-clinical OC subjects on both the perception and memory trials of the irregular object and geometric object DMS tasks. The performance of the OCD patients on the perception trials (250 ms delay) demonstrated that they were not impaired in their ability to accurately encode different types of object stimuli. Performance on the memory trials (3,000 ms delay) demonstrated that OCD patients were not impaired in their ability to maintain representations of different types of object stimuli in visual working memory. In the present thesis, the ability to encode and maintain representations of different types of object stimuli in visual working memory for varying periods of time was not compromised in individuals with OCD. Compared to healthy controls, panic disorder and sub-clinical OC subjects, the OCD patients were equally able to encode and maintain difficult-to-label irregular objects and easy-to-label geometric objects.

The OCD patients performed as accurately as panic disorder patients and sub-clinical OC subjects on the perception and memory trials of the spatial DMS task. While the OCD patients performed as accurately as the healthy control subjects on the perception trials of the spatial DMS task, they performed more poorly on the memory trials. The result indicated that compared to healthy control subjects, OCD patients find it more difficult to maintain representations of spatial stimuli in working memory.

The OCD patients also performed as well as the healthy control subjects, patients with panic disorder and sub-clinical OC subjects on both the low demand and high demand versions of

each of the DMS tasks. The equivalent performance of the OCD group on the low and high demand trials demonstrated that even as the amount of information to be maintained in working memory increased, the OCD subjects were still able to perform as accurately as the control subjects. In this thesis, the ability to apply verbal labels to the task stimuli had no impact on the accuracy of the OCD or sub-clinical OC subjects, nor did the demand level of the task. This result does not support previous research suggesting, in OCD patients, performance on cognitive tasks is related to task demand. However, the high demand version of the DMS task may not have been difficult enough to differentiate the OCD patients from the other experimental groups. Future research could benefit from including another level of demand on the DMS task to establish whether this leads to a decrement in the performance of the OCD patients in comparison to healthy control subjects, patients with other anxiety disorders and sub-clinical OC subjects.

The results of the thesis indicated that the pathophysiology of OCD may selectively target structures necessary to recognise the spatial locations of objects, but not structures required to recognise the features of objects. While caution is required when linking neuropsychological findings to underlying neurocircuitry without concurrent neuroimaging data (Deckersbach et al., 2004), the DMS tasks used in the present thesis have been well validated in brain activations studies (Smith et al., 1995). These activation studies have indicated that object DMS tasks predominantly activate temporal and parietal regions in the left hemisphere – regions that have not typically been implicated in the pathophysiology of OCD. In this thesis, OCD patients were not impaired on the object DMS tasks. In contrast, spatial DMS tasks activate occipital, posterior parietal and dorsolateral prefrontal areas in the right hemisphere. Right hemisphere and prefrontal regions have consistently been implicated in the pathophysiology of OCD. In the present thesis, OCD patients were impaired on the memory trials of the spatial DMS task.

Additionally, the results of this thesis are similar to a finding by Postle et al. (1997), who employed similar spatial and irregular object DMS tasks in a study of early Parkinson's symptoms (EPS). Compared to healthy control subjects, EPS patients demonstrated a selective impairment in spatial working memory. Performance on the object working memory task was equivalent to the control group. As symptoms of OCD have been observed in both idiopathic (Cummings & Cunningham, 1992) and postencephalitic (Schilder, 1938) Parkinson's disease, the results suggest that OCD and Parkinson's disease may share a similar pathophysiology that disrupts spatial working memory but not object working memory.

Overall, the results of this thesis do not lend support to the theories of Purcell et al. (1998a, b) and Zielinski et al. (1991) that verbal mediation aids performance on cognitive tasks. However, the results do support the idea that there is a dissociation for pattern and spatial information in OCD. OCD patients demonstrated equivalent accuracy on the DMS tasks requiring the encoding and maintenance of object information in working memory, regardless of whether the

objects were easy- or difficult-to-label. In contrast, the OCD patients were impaired on a task requiring the maintenance of spatial locations in working memory. It may be that theories regarding verbal mediation and task load are too simplistic when attempting to account for the cognitive deficits present in OCD and sub-clinical OC. Alternatively, the DMS tasks used in this thesis may not have been sufficiently demanding enough to highlight poorer performance by OCD patients as a function of task difficulty. In addition, despite being difficult-to-label the irregular objects may have permitted some verbal rehearsal. Therefore, the theory that verbal representations facilitate memory processes in OCD cannot be completely discounted.

12.4.2 N-back tasks

Verbal n-back accuracy (0-back and 1-back trials)

The hypothesis that OCD patients would perform as accurately as the healthy control subjects, patients with panic disorder and sub-clinical OC subjects on the 0-back and 1-back versions of the verbal n-back task was supported.

On the 0-back trials of the verbal n-back task, the OCD patients (99.37% correct) were as accurate as the healthy control subjects (99.40%), panic disorder patients (99.32%) and sub-clinical OC subjects (98.15%) when matching the identity of a letter presented on the screen to the first letter presented in the 0-back sequence. Similarly, on the 1-back condition the OCD patients (93.32%) were as accurate as the healthy control subjects (95.55%), panic disorder patients (93.95%) and sub-clinical OC subjects (94.15%) when matching the identity of a letter presented on the screen to the letter presented immediately before it.

Thus, on the low working memory load versions of the verbal n-back task, where the subjects were required to encode and maintain representations of verbal stimuli, but not to update or temporally order this information in visual working memory, the accuracy of the OCD patients was equivalent to the other experimental groups.

These results are consistent with the results of the DMS tasks in this thesis and suggest that the ability to encode and maintain representations of non-spatial stimuli in working memory is unimpaired in patients with OCD. This result also supports previous research demonstrating that OCD patients perform as well as controls on tasks comprised of non-spatial stimuli (Martin et al., 1995; Purcell et al., 1998a, 1998b; Nielen & Den Boer, 2003). For example, OCD patients have typically demonstrated equivalent performance to healthy control subjects on tasks such as the CANTAB Pattern Recognition and DMS tasks, the RCFT copy trials and working memory for line drawings.

Verbal n-back accuracy (2-back and 3-back trials)

The hypothesis that the OCD patients would perform more poorly than the healthy control subjects on the verbal 2-back task was supported, as was the prediction that the OCD patients would show equivalent performance to the sub-clinical OC subjects on this task. However, the hypothesis that the OCD patients would perform more poorly than the panic disorder patients on the verbal 2-back task was not supported. On the verbal 2-back task, the OCD patients (76.42%) performed no differently to the panic disorder patients (80.53%) or the sub-clinical OC subjects (78.75%), however, their accuracy was significantly worse than the healthy control subjects (87.20%).

The hypothesis that the OCD patients would perform more poorly than the panic disorder and healthy control subjects on the verbal 3-back task was supported, but the prediction that the OCD patients would show equivalent performance to the sub-clinical OC subjects was not supported. On the verbal 3-back task the accuracy of the OCD patients (58.68%) was significantly worse than the healthy controls (76.55%), panic disorder patients (70.16%) and sub-clinical OC subjects (70.60%).

The results indicated that as the amount of verbal stimuli to be updated in working memory increased, the accuracy of the OCD patients compared to the other experimental groups subsequently decreased. The poorer accuracy of the OCD patients on the 2-back version of the verbal n-back task differentiated them from the healthy control group, while their poorer accuracy on the verbal 3-back task differentiated them from all three comparison groups. The results indicated that OCD patients have a deficit in their ability to update and temporally order verbal information in working memory, and that this deficit increases as the working memory load of the task increases. The results are consistent with previous research that has found OCD patients are impaired on verbal tasks requiring executive processing such as temporal ordering, memory for frequency and semantic clustering (Savage et al., 2000; Cabrera et al., 2001; Jurado et al., 2001; Jurado et al., 2002; Deckersbach et al., 2004). For example, OCD patients have demonstrated impairment on tasks such as a temporal ordering task, a frequency occurrence task, the California Verbal Learning Test, and a test of semantic clustering. All of these tasks require the use of strategic processing such as updating, ordering or manipulating information in working memory.

As predicted, the performance of the OCD patients on the verbal n-back tasks was not the result of demographic or clinical characteristics, or of medication status. This result is consistent with numerous other studies that have reported that cognitive deficits in OCD patients are not related to clinical state (Purcell et al., 1998b; Schmitdke et al., 1998; Nielen & Den Boer, 2003). Previous studies have also found similar neuropsychological performance in medicated and non-medicated OCD patients (Purcell et al., 1998b; Mataix-Cols, Alonso, Pifarre, Menchon, &

Vallejo, 2002). There was also no relationship between symptom subtypes and verbal working memory performance.

Spatial n-back accuracy (0-back and 1-back trials)

The hypothesis that OCD patients would perform as accurately as the healthy control subjects, panic disorder patients, and sub-clinical OC subjects on the 0-back and 1-back versions of the spatial n-back task was supported.

On the 0-back trials of the spatial n-back task, OCD patients (95.63%) were as accurate as healthy control subjects (98.75%), panic disorder patients (98.05%) and sub-clinical OC subjects (96.90%) when matching the location presented on the screen to the first location presented in the 0-back sequence. Similarly, on the 1-back condition OCD patients (93.05%) were as accurate as the healthy control subjects (97.85%), panic disorder patients (95.89%) and sub-clinical OC subjects (96.40%) when matching the location presented on the screen to the location presented immediately before it.

On the low working memory load version of the spatial n-back task, where the subjects were required to encode and maintain representations of spatial stimuli, but not to update and temporally order this information in visual working memory, the performance of the OCD patients was equivalent to the healthy control, panic disorder patients and sub-clinical OC subjects. However, the difference between the OCD patients and the healthy control subjects did approach significance on the 1-back trials of the spatial n-back task. The poorer performance of the OCD patients on this task is consistent with the results from the DMS task that indicated that OCD patients are impaired in their ability to maintain representations of spatial stimuli in visual working memory.

Spatial n-back accuracy (2-back and 3-back trials)

The hypothesis that the accuracy of the OCD patients would be poorer than the panic disorder patients and healthy control subjects on the spatial 2-back task was not supported. The prediction that the accuracy of the OCD patients would be no different to the sub-clinical OC subjects on this task was supported. On the spatial 2-back task, the accuracy of the OCD patients (76.37%) was no different to the panic disorder patients (78.37%), healthy control subjects (84.65%) or the sub-clinical OC subjects (82.60%).

The hypothesis that the OCD patients would be less accurate than the healthy control group on the spatial 3-back task was supported, as was the prediction that the accuracy of the OCD patients would be no different to the sub-clinical OC subjects on the spatial 3-back task. The hypothesis that the OCD patients would be less accurate than the panic disorder patients on the spatial 3-back task was not supported. On the spatial 3-back task, the OCD patients (64.53%) were less accurate than the healthy control subjects (77.80%) but not the panic disorder

patients (67.53%) or the sub-clinical OC subjects (70.50%). The poorer accuracy of the OCD patients in comparison to healthy controls on the 3-back version of the spatial n-back task is consistent with the findings of (van der Wee et al., 2003). As predicted, the performance of the OCD patients on the spatial n-back task was not the result of demographic or clinical characteristics, or of medication status. There was also no relationship between symptom subtypes and verbal working memory performance.

These results indicated that on the spatial n-back task, the accuracy of the OCD patients decreased as the amount of stimuli to be updated and temporally ordered increased. The accuracy of the OCD patients on the 2-back version of the spatial n-back did not differentiate them from any of the comparison groups, while their accuracy on the spatial 3-back task differentiated them from the healthy control subjects. This result is consistent with previous research that has found impaired performance by OCD patients on tasks where they are required to update, manipulate or organise spatial information in working memory (Purcell et al., 1998a, 1998b; Savage et al., 1999; Moritz et al., 2003; Singh et al., 2003; van der Wee et al., 2003). For example, OCD patients have demonstrated impairment on tasks such as CANTAB Spatial Working Memory, spatial n-back task, Cube Test, mental rotation test, Block Design and visuospatial transformation. These tests all involve the manipulation of spatial stimuli.

N-back task reaction times

The hypothesis that the OCD patients would record equivalent reaction times to the healthy control subjects, panic disorder patients and sub-clinical OC subjects on both n-back tasks was supported. There were no differences in the speed of responses of the OCD patients on either the verbal n-back task or the spatial n-back task. This result supports previous research that shows OCD patients perform as quickly as controls on timed tasks (Martin et al., 1995).

Summary of n-back results

In the present thesis, OCD patients were less accurate on the verbal 2-back, verbal 3-back and spatial 3-back tasks compared to healthy control subjects, and less accurate on the verbal 3-back task compared to panic disorder patients and sub-clinical OC subjects. The accuracy of the panic disorder patients and sub-clinical OC subjects did not differ from the healthy control subjects on any of the n-back tasks. The results indicated that OCD patients were impaired in their ability to update and temporally order spatial and verbal information in working memory. The results suggest that executive memory processes are compromised in OCD. The results are consistent with previous research findings that OCD patients are impaired on tasks requiring executive processing such as temporal ordering, memory for frequency, semantic clustering and the manipulation and organisation of spatial information in working memory.

The results also support theories of fronto-striatal dysfunction in OCD. Brain activations studies have found that, among the frontal regions of the brain, the bilateral superior frontal sulcus and

the dorsolateral prefrontal cortex show specialisation for continuous updating and temporal order memory (Smith & Jonides, 1999; Wager & Smith, 2003). In this thesis, OCD patients were impaired in their ability to update and temporally order spatial and verbal information in working memory.

12.4.3 Summary of cognitive results

The results from the DMS tasks suggest that the ability to encode and maintain representations of different types of object stimuli in working memory is unimpaired in patients with OCD. In the present thesis, the OCD patients demonstrated equivalent accuracy and reaction time performance on both of the object DMS tasks in comparison to healthy controls, panic disorder patients and sub-clinical OC subjects. The results suggest that OCD patients are able to encode and maintain representations of different types of object stimuli, regardless of whether the stimulus is easy- or difficult-to-verbally-label.

The results do suggest that individuals with OCD have a deficit in the ability to maintain representations of spatial stimuli in visual working memory. While the OCD patients demonstrated equivalent accuracy and reaction times on the spatial DMS task compared to the panic disorder patients and sub-clinical OC subjects, they were less accurate than the healthy control subjects on the memory trials of the spatial DMS task. The result could not be attributed to a sensory processing deficit as the OCD patients were as accurate as control subjects on the perception trials of the spatial DMS task.

On the 0-back and 1-back versions of the n-back tasks, the OCD patients demonstrated equivalent accuracy and reaction time performance in comparison to healthy controls, panic disorder and sub-clinical OC subjects. The results indicated that OCD patients were able to encode and maintain representations of both the identity and spatial location of the stimulus letters. Again, performance was not affected by whether the stimulus could be verbally rehearsed. In fact, OCD patients performed more poorly on the verbal version of the n-back task than the spatial version. The results of this thesis also suggest that OCD patients are impaired in their ability to organise and manipulate information in visual memory. As evidenced by their decreasing accuracy on the 2-back and 3-back trials, OCD patients also showed poorer performance as the amount of information to be manipulated in working memory increased.

Taken together, the performance of the OCD patients on the three DMS tasks and the two n-back tasks suggests a deficit in the ability to manipulate verbal and spatial information in working memory, a deficit in the ability to maintain spatial information in working memory, but no deficit in the ability to encode and maintain representations of object stimuli in working memory.

A deficit in working memory in OCD patients - particularly working memory that involves strategic processing - may explain a number of previous findings regarding cognitive impairment

in OCD. For example, OCD patients typically perform well on tasks that are free of sequencing or the use of mental images (Hymas et al., 1991). Alternatively, OCD patients demonstrate impairment on tasks the require updating and on-line maintenance (Moritz et al., 2001b), sequencing (Singh et al., 2003), temporal ordering (Jurado et al., 2001) and manipulating spatial information (Purcell et al., 1998a, 1998b; Savage et al., 1999). Thus, a deficit in working memory may be responsible for the deficits observed on tasks involving other cognitive processes such as alternation learning, verbal memory and problem solving.

What is unclear from the results of this thesis, is whether the deficits observed in the OCD patients are the result of capacity constraints being exceeded in working memory, or whether they are related to some other executive deficit. Research conducted by van der Wee et al. (2003) indicated that the ability to manipulate information in working memory was not compromised in OCD. van der Wee et al. (2003) conducted a functional magnetic resonance imaging (fMRI) study in conjunction with the spatial n-back task. Due to the excessive activity observed in the anterior cingulate cortex (ACC) in their study, van der Wee et al. (2003) suggested that the poorer performance of the OCD patients may be related to an increase in error monitoring as memory load increases. Veale et al. (1996) has also proposed that OCD patients may try too hard to monitor their responses to ensure they do not make a mistake. These proposals are consistent with imaging studies of OCD patients that have found excessive activity in the ACC (Rauch et al., 1994; Breiter & Rauch, 1996; Adler et al., 2000). These findings are also consistent with cognitive models of OCD which suggest that individuals with OCD try too hard to exercise control over normal mental processes (Steketee et al., 1998; Purdon, Rowa, & Antony, 2005). Further research is required to uncover the exact role of the ACC in the pathophysiology of OCD. For example, does the excessive activity in the ACC appear during the performance of all types of tasks or is it only on certain tasks? Additionally, is the excessive activity related to the complexity of the task, the type of stimulus being processed, or the demand being placed on working memory?

In terms of task demand, there were no demand-related deficits on the tasks requiring the maintenance of spatial and object information in working memory. However, demand-related deficits did emerge on the tasks requiring continual updating and maintaining of temporal order of verbal and spatial stimuli. This result suggested that demand-related deficits may only become apparent on tasks requiring executive, or strategic functioning. This result supports a previous finding by van der Wee et al. (2003) that OCD patients were impaired on the spatial n-back task, but only at the highest level of difficulty (3-back trials).

Given that the sub-clinical OC subjects did not differ from the healthy control group on any of the cognitive tasks, the results do not support the dimensional model of obsessive-compulsive phenomena which assumes a continuum between normal and abnormal obsessions and compulsions. However, the accuracy of the sub-clinical OC subjects was poorer than the

healthy control subjects on some of the cognitive measures but these differences may not have reached significance because of the sample size. For example, on the verbal 2-back task the sub-clinical OC subjects (78.75%) were less accurate than the healthy control subjects (87.20%). Similarly, on the verbal 3-back task the sub-clinical OC subjects (70.60%) were also less accurate than the healthy control subjects (76.55%). The sub-clinical OC subjects (70.50%) were also less accurate than the healthy control subjects (77.80%) on the spatial 3-back task. More studies, directly comparing OCD and sub-clinical OC subjects, are required to better understand the similarities and differences between individuals with clinical and sub-clinical OC symptoms on tests of working memory.

Without concurrent neuroimaging data, generating conclusions about the specific brain regions implicated in OCD based on behavioural data alone is purely speculative. However, the tasks used in the present thesis have been extensively validated in neuroimaging and lesion studies of working memory. The impaired working memory of the OCD patients in this thesis supports the biological model of OCD that implicates fronto-striatal pathways in the pathogenesis of OCD. The brain regions that are implicated in the mediation of the symptoms of OCD also play a role in working memory. Working memory is thought to be subserved by circuits linking the prefrontal cortex to the basal ganglia. It has been suggested that impairment in working memory arises when the gating mechanism of the basal ganglia is dysfunctional (Frank, Loughry, & O'Reilly, 2001). Further research, combining symptom provocation, cognitive working memory tasks and neuroimaging techniques, is required to investigate whether the neural mechanisms that underlie OC symptoms are the same as those that underlie 'executive' working memory processes.

The results of the present thesis indicated that patients with OCD were impaired on tasks that have executive and memory requirements. In terms of the clinical features of OCD, a deficit in working memory may be consistent with certain OC behaviours. For example, an impairment in the ability to organise information in working memory may be a significant contributor to the doubting and checking behaviours observed in OCD (Greisberg & McKay, 2003; Evans et al. 2004). Dysfunctional working memory may contribute to the reinforcement of both obsessive thoughts (obsessive doubting), and compulsive behaviour (checking rituals). This thesis specifically examined the relationship between working memory deficits and the clinical symptoms of OCD. Due to the small sample size, the relationship between the working memory deficits and different symptom subtypes of OCD was assessed using a dimensional approach. The results indicated that working memory deficits were not related to specific symptom subtypes. However, further research is required to identify whether working memory deficits in OCD are more prominent in patients with predominately checking behaviours, or whether patients with other OC symptoms also have the same deficit.

Overall, the results of the present thesis provide further evidence that OCD is associated with a deficit related to executive memory processes, such as updating, organising and maintaining the temporal order of information in working memory. The results of the present thesis also supported previous research that this executive deficit is not just confined to spatial information. Given the results from imaging studies - that the dorsolateral prefrontal cortex is activated during tasks that involve updating and ordering of stimuli - the results of this thesis also support theories of fronto-striatal dysfunction in OCD.

12.5 Personality

The following section discusses the results from the comparison of OCD patients, healthy control subjects, panic disorder patients and sub-clinical OC subjects on the domains and facets of the NEO PI-R. An overall discussion of the personality results is also included. Given the small sample size these results are very exploratory but will, hopefully, provide a guide for future research.

12.5.1 Neuroticism domain and facets

OCD versus healthy control subjects

The hypothesis that the OCD patients would score significantly higher on the Neuroticism domain compared to the healthy control subjects was supported. The mean Neuroticism domain T-score of the OCD group (T = 69.94) fell into the 'very high' range while the mean Neuroticism score of the healthy control group (T = 45.45) fell into the 'average' range. The mean Neuroticism score of the OCD group in the present thesis was almost identical to that reported by Rector et al. (2002) (T = 70.08), but slightly higher than that reported by Samuels et al. (2000) (T = 64.00) and Leong (2003) (T = 64.45). This result supports previous research by Samuels et al. (2000) and Leong (2003) that OCD patients score higher on the domain of Neuroticism compared to healthy control subjects. The results, consistent with clinical descriptions of OCD, indicate that OCD patients are more likely than average to experience negative affects such as fear, sadness, embarrassment, anger, guilt and disgust.

The hypothesis that the OCD patients would score higher on all facets of Neuroticism compared to the healthy control subjects was also supported. The mean facet T-scores of the OCD group fell into the 'very high' range for anxiety (T = 65.50), depression (T = 70.83), self-consciousness (T = 66.39) and vulnerability (T = 68.94). The mean facet score for angry hostility fell into the 'high' range (T = 64.56), while the mean facet T-score for impulsiveness fell into the 'average' range (T = 54.72). In contrast the mean facet scores of the healthy control group fell into the 'average' range for angry hostility (T = 49.00), depression (T = 45.40) and impulsiveness (T = 45.25), and the 'low' range for anxiety (T = 44.30), self-consciousness (T = 42.00) and vulnerability (T = 43.75). The result supports an earlier finding by Samuels et al. (2000) that

OCD patients score higher on all facets of Neuroticism compared to healthy controls. The only Neuroticism facet score reported in the Samuels et al. (2000) study for the OCD group was anxiety (T = 65.50). The T-score reported by Samuels et al. (2000) for the anxiety facet is identical to the mean anxiety T-score reported in the present thesis. Leong (2003) also reported that OCD patients score higher than controls on all but one of the facets of Neuroticism (impulsiveness). In comparison to healthy control subjects, OCD patients present as nervous, frustrated, guilty, and socially anxious individuals who are unable to resist their urges or deal with stressful situations.

In this thesis, the differences between the OCD and healthy control subjects on the domain of Neuroticism and the facets of anxiety, depression, self-consciousness and vulnerability remained significant after controlling for current depression and state anxiety. The results indicated that differences between the healthy controls and the OCD patients on these personality traits were independent of current mood. This result is consistent with a finding by Rector et al. (2002) that the facets of anxiety and depression are not influenced by current mood. However, group differences on the facets of angry hostility and impulsiveness disappeared after controlling for current depression and state anxiety. The best predictor of angry hostility and impulsiveness score was Beck Depression Inventory score (BDI-II), suggesting that current depression, rather than anxiety, accounted for differences between OCD and healthy control subjects on these personality traits.

OCD versus panic disorder patients

The hypothesis that the OCD patients would report similar scores on the domain of Neuroticism compared to the panic disorder patients was supported. As with the OCD patients, the mean domain score of the panic disorder patients (T = 66.95) fell into the 'very high' range. The mean T-score on the Neuroticism domain for the panic disorder patients was higher than the T-scores reported for the agoraphobia group (T = 55.80) and the panic disorder group (T = 56.50) in the Bienvenu et al. (2001) study. However, the differences between the two studies may be due to only half the panic disorder and agoraphobia subjects in the Bienvenu et al. (2001) study being symptomatic at the time of testing. The result of the current thesis support the finding of Bienvenu et al. (2001, 2004) that individuals with panic disorder report elevated scores on the domain of Neuroticism. In the present thesis, panic disorder patients also scored significantly higher than the healthy control subjects (T = 45.45) on the domain of Neuroticism.

As predicted, the OCD patients also did not differ from the panic disorder patients on any of the Neuroticism facets. In a pattern identical to the OCD group, the mean facet scores of the panic disorder group fell into the 'very high' range for anxiety (T = 66.47), depression (T = 68.95), self-consciousness (T = 65.37) and vulnerability (T = 66.11), the 'high' range (T = 58.79) for angry hostility, and the 'average' range (T = 50.37) for impulsiveness. The results support the findings of Bienvenu et al. (2001, 2004) that individuals with panic disorder tend to report mean T-scores

in the 'high' range on the facets of Neuroticism. In this thesis, the panic disorder patients were also significantly higher on the Neuroticism facets of anxiety, depression, self-consciousness and vulnerability compared to the healthy control subjects.

The results indicated that both OCD and panic disorder patients are prone to experience above-average levels of psychological distress and irrational ideas, are less likely to adopt adaptive coping measures, and cope more poorly with stress. This supports previous research that high neuroticism characterises a number of clinical disorders (Bagby et al., 1995, 1996, 1997; Bienvenu et al., 2001, 2004; Rector et al., 2002).

OCD versus sub-clinical OC subjects

The hypothesis that the OCD patients would report similar mean T-scores on the domain of Neuroticism compared to the sub-clinical OC subjects was not supported. The mean Neuroticism score for the sub-clinical OC group was in the 'high' range (T = 59.70) but was still significantly lower than the mean Neuroticism score of the OCD group (T = 69.94). While previous research suggests that sub-clinical OC subjects resemble clinical OCD patients in that they also report high levels of Neuroticism, the magnitude of the elevated Neuroticism levels may not be equivalent. Previous studies have reported that individuals with sub-clinical OC symptoms report higher levels of Neuroticism compared to healthy control subjects (Mataix-Cols et al., 2000; Fullana et al., 2004). In this thesis, the mean Neuroticism score of the sub-clinical OC group was also significantly higher than the healthy control group (T = 45.45). The result supports the dimensional theory of obsessions and compulsions, and indicates that while both OCD and sub-clinical OC subjects are prone to experience a greater than average level of negative affect, these traits are more pronounced in the OCD group.

The hypothesis that the OCD patients would report similar scores on the facets of Neuroticism compared to the sub-clinical OC subjects was partially supported. While the sub-clinical OC subjects reported similar mean scores on the facets of anxiety (T = 58.89), angry hostility (T = 56.63), self-consciousness (T = 61.11), and impulsiveness (T = 51.79), they scored significantly lower on the facets of depression (T = 58.90) and vulnerability (T = 58.55). This result suggests that OCD patients and sub-clinical OC subjects experience similar levels of worry and nervousness, frustration, social anxiety and the inability to resist their urges. In contrast, OCD patients are more likely than sub-clinical OC subjects to experience depressive affect and cope less well with stress.

In this thesis, the sub-clinical OC subjects also scored significantly higher than the healthy control subjects on the facets of anxiety, depression, self-consciousness and vulnerability. This result supports the dimensional theory of obsessions and compulsions. This result also supports previous research that sub-clinical OC subjects experience higher levels of depression and anxiety compared to healthy control subjects (Mataix-Cols, 2003; Fullana et al., 2004).

The results from this thesis indicated that being more prone to depression and more vulnerable to stress may be important traits for distinguishing between clinical and sub-clinical levels of OC behaviour. The results confirm the importance of direct comparison of OCD and sub-clinical OC subjects to better understand the distinction between clinical and sub-clinical OC symptoms.

In the present thesis, the differences between the OCD and sub-clinical OC subjects on the Neuroticism domain and the facets of depression and vulnerability disappeared after controlling for current depression and state anxiety. The best predictor of Neuroticism domain score was BDI-II score suggesting that differences between OCD and sub-clinical OC on Neuroticism are accounted for by depression severity. The best predictors of depression facet score were BDI-II score and STAI-S score suggesting that current depression and state anxiety account for differences between clinical and sub-clinical OC on the facet of depression. The best predictor of vulnerability facet score was STAI-S score, suggesting that the difference between the OCD and sub-clinical OC subjects on vulnerability to stress was accounted for by current levels of anxiety.

Summary of Neuroticism results

The results indicated that OCD patients report significantly higher levels of Neuroticism than the healthy control subjects, a finding that is consistent with previous studies using a measure of the Five Factor Model of personality (FFM) to examine personality in OCD (Leong, 2003; Samuels et al., 2000). However, the high Neuroticism reported by the OCD patients in this thesis would not appear to be unique to the disorder. The OCD patients were not differentiated from the panic disorder patients on the domain of Neuroticism or any of its facets. High Neuroticism has also previously been reported in panic disorder and other clinical disorders (Bagby et al., 1995, 1996, 1997; Bienvenu et al., 2001, 2004). The facets of depression and vulnerability differentiated the OCD patients from the sub-clinical OC subjects. The finding that the OCD patients reported higher levels of depression and vulnerability to stress compared to the sub-clinical OC subjects suggests that these traits may be important for differentiating clinical and sub-clinical levels of OC behaviour.

12.5.2 Extraversion domain and facets

OCD versus healthy controls

The hypothesis that the OCD patients would report significantly lower levels of Extraversion compared to the healthy control subjects was supported. The mean Extraversion domain score of the OCD group (T = 39.11) fell into the 'low' range while the mean Extraversion score of the healthy control group (T = 52.50) fell into the 'average' range. The mean Extraversion score of the OCD group in this thesis was almost identical to that reported by Rector et al. (2002) (T = 39.83) but substantially lower than that reported by Samuels et al. (2000) (T = 47.40) and Leong

(2003) (T = 45.11). These differences may be due to random differences in the samples used in each study. The results indicate that OCD patients experience low levels of energy, optimism and the need for social stimulation, and are more likely to be reserved and even-paced. In contrast, the healthy controls subjects tend to be more assertive, upbeat and energetic. This result supports an earlier finding by Samuels et al. (2000) and Fullana et al. (2004) that OCD patients report lower levels of Extraversion compared to healthy control subjects.

The hypothesis that the OCD patients would score significantly lower on the assertiveness facet of the Extraversion domain compared to the healthy control subjects was also supported. The mean facet scores of the OCD group fell into the 'low' range for assertiveness (T = 44.00) while for the healthy control group the mean assertiveness score fell into the 'average' range (T = 52.80). This result indicates that OCD patients are less forceful and dominant than healthy control subjects. This result also supports the finding of Samuels et al. (2000) that OCD patients score lower on the facet of assertiveness compared to healthy controls. Unlike Samuels et al. (2000), this thesis also found that OCD patients score lower on measures of warmth, gregariousness and positive emotions. In this thesis, the mean facet scores of the OCD group fell into the 'low' range for warmth (T = 42.11), gregariousness (T = 42.11) and positive emotions (T = 39.56). In comparison, the mean facet scores for the healthy control group fell into the 'average' range for warmth (T = 53.60), gregariousness (T = 52.20) and positive emotions (T = 53.50). This result indicates that OCD patients tend to be more reserved, less exuberant, and avoid social stimulation in comparison to healthy control subjects. These results are consistent with reports of anxious avoidance in OCD (Mavissakalian et al., 1990, 1993; Sciuto et al., 1991). The OCD patients did not differ from the healthy control subjects on the facets of activity or excitement seeking. The mean facet scores for both the OCD patients and the healthy controls were in the 'average' range on the facets of activity (OCD: T = 45.06; Controls: T = 50.90) and excitement seeking (OCD: T = 47.00; Controls: T = 47.80). These results indicate that OCD patients and healthy control subjects both experience average levels of energy and sensation-seeking.

After controlling for current depression and state anxiety, the difference between the OCD and healthy control subjects on the domain of Extraversion was still significant. This result indicates that differences on this domain are independent of current mood and supports a similar finding by Rector et al. (2002). However, differences on the facets of warmth and gregariousness disappeared after controlling for current depression, differences on assertiveness disappeared after controlling for current anxiety, and differences on positive emotions disappeared after controlling for state measures of depression and anxiety. The best predictor of gregariousness was still group membership, although it did not reach significance. The best predictor of warmth and positive emotions was BDI-II score, suggesting that the differences between the OCD and healthy control subjects on these facets can be accounted for by current depression severity. Rector et al. (2002) also found that differences on the facet of positive emotions were influenced

by depression severity when comparing OCD patients to patients with Major Depression. The best predictor of assertiveness was STAI-S score, suggesting that difference between the OCD and healthy control subjects on this facet was influenced by state anxiety.

OCD versus panic disorder

The hypothesis that the OCD patients would report similar mean Extraversion scores to the panic disorder patients was supported. The mean Extraversion domain score of the OCD group (T = 39.11) was in the 'low' range as was the mean Extraversion domain score of the panic disorder group (T = 40.53). The mean T-score of the panic disorder patients in the present thesis was slightly lower than the mean T-score reported by Bienvenu et al (2001) for panic disorder (T = 44.90), but similar to the T-score reported for agoraphobia (T = 41.90). In the present thesis, panic disorder with agoraphobia was not an exclusion criteria so it is difficult to make direct comparisons with the results from the Bienvenu study. However, in the Bienvenu study both panic disorder and agoraphobia subjects reported mean Extraversion T-scores in the 'low' range, and were significantly lower than a control group. In the present thesis, the panic disorder patients were also significantly lower on Extraversion compared to the healthy control patients (T = 52.50). The results indicate that both OCD and panic disorder patients experience less than average levels of assertiveness, activity, stimulation and optimism.

As predicted, the OCD patients reported similar mean T-scores to the panic disorder patients on each of the facets of Extraversion. In a similar pattern to the OCD patients, the mean facet T-scores of the panic disorder patients fell into the 'low' range for warmth (T = 42.58), gregariousness (T = 38.95) and positive emotions (T = 42.47), and the 'average' range for activity (T = 50.37). In a slightly different pattern to the OCD patients, the panic disorder patients recorded mean T-scores that fell in the 'average' range for assertiveness (T = 46.00). While the OCD patients fell in to the 'low' range on this facet, the mean T-score of the panic disorder patients was at the low end of the average range and was not statistically different from the OCD group. Unlike the OCD patients who recorded a mean T-score on excitement seeking that fell in to the 'average' range, the panic disorder patients fell into the 'low' range on this facet (T = 42.58). Again, the mean T-score of the panic disorder patients was at the high end of the low range and was not statistically different from the OCD score. The results support previous research by Bienvenu et al. (2001) who found that individuals with panic disorder and agoraphobia score lower on facets of Extraversion, particularly the facet of positive emotions. Bienvenu et al. (2004) also found that panic disorder patients scored lower on the facet of positive emotions, and subjects with agoraphobia scored lower on the facets of warmth, gregariousness and positive emotions. The present thesis found that both OCD (39.56) and panic disorder (42.47) subjects score in the 'low' range on the positive emotions facet. This thesis also found that the panic disorder patients (T = 38.95) were significantly lower than healthy controls (T = 52.20) on the gregariousness facet. The results indicated that both OCD

and panic disorder patients are reserved individuals who avoid social stimulation and are less likely than average to experience positive emotions.

OCD versus sub-clinical OC subjects

As predicted, the OCD patients did not differ from the sub-clinical OC subjects on mean Extraversion T-scores. The mean T-score of the sub-clinical OC group (T = 45.55) fell into the 'average' range. While the mean T-score of the OCD group (T = 39.11) fell into the 'low' range, the difference was not statistically significant. The result indicate that OCD patients and sub-clinical OC subjects have similar levels of sociability, assertiveness, sensation-seeking behaviour, and optimism.

The prediction that the OCD patients would report similar mean T-scores on each of the facets of Extraversion compared to the sub-clinical OC subjects was partially supported. The OCD group did not differ from the sub-clinical OC group on the facets of warmth, gregariousness, assertiveness, activity, and excitement seeking. The mean T scores of the sub-clinical OC group fell into the 'average' range for the facets of warmth (T = 47.25), gregariousness (T = 45.89), assertiveness (T = 45.95), activity (T = 48.32), and excitement seeking (T = 45.95). The OCD patients also reported mean T-scores in the 'average' range on the facets of activity and excitement seeking. While the mean T-scores of the OCD patients on the facets of warmth, gregariousness, and assertiveness fell into the 'low' range, the differences were not statistically significant. The results indicated that OCD patients experience similar levels of social stimulation, dominance, affection, energy and sensation-seeking behaviour compared to an analogue sub-clinical OC group. The prediction that the OCD patients would score significantly no differently on the facet of positive emotions compared to the sub-clinical OC group was not supported. The mean T-score of the sub-clinical OC group on this facet fell into the 'average' range (T = 48.70), and was significantly higher than the mean T-score of the OCD group who fell into the 'low' range (T = 39.56). This result indicated that the OCD patients experience significantly lower levels of positive emotions such as joy and happiness compared to sub-clinical OC subjects.

The differences between the OCD and sub-clinical OC subjects on the facet of positive emotions disappeared after controlling for measures of current mood. The best predictor of positive emotions was BDI-II score suggesting that differences between OCD and sub-clinical OC subjects on the facet of positive emotions were mediated by current levels of depression. Rector et al. (2002) also found that positive emotions was influenced by depression severity when comparing OCD and Major Depression.

Summary of Extraversion results

In this thesis, OCD patients reported significantly lower levels of Extraversion than the healthy control group, a finding that supports one previous study using the FFM to examine personality traits in OCD (Samuels et al., 2000). However, low Extraversion would not appear to be unique to OCD. In this thesis, OCD patients were not differentiated from panic disorder patients on the domain of Extraversion or any of its facets. Low Extraversion has also previously been reported in various other clinical disorders (Bienvenu et al., 2001, 2004). While the OCD and sub-clinical OC subjects reported similar levels of Extraversion, the facet of positive emotions did differentiate OCD patients from sub-clinical OC subjects. The OCD patients were significantly lower on this facet compared to the sub-clinical OC group, although the difference appeared to be accounted for by differences in the severity of current depression between the groups.

12.5.3 Openness domain and facets

OCD versus healthy control subjects

It was predicted that the OCD patients would record similar mean scores on the domain of Openness compared to the healthy control subjects. The hypothesis was not supported with the OCD patients reporting significantly lower mean T-scores (T = 52.33) than the healthy control group (T = 59.20). However, the mean T-score of the OCD group still fell into the 'average' range, so the difference between the two groups is more a reflection of the higher than average mean T-score of the healthy control group. The mean T-score of the OCD group in the present thesis was comparable to the score reported by Samuels et al. (2000) (T = 53.50), Rector et al. (2002) (T = 51.44) and Leong (2003) (T = 50.87). The result indicated that individuals with OCD experience average levels of intellectual curiosity, imagination, preference for variety and independence of judgement.

It was also hypothesised that the OCD patients would score higher on the facets of fantasy and feelings, and lower on the facet of actions compared to healthy controls. The hypothesis was partially supported. The mean T-score of the healthy control group on the facet of actions (T = 56.90) was significantly higher than the mean T-score of the OCD group (T = 39.33). This result supports a previous finding by Samuels et al. (2000) that OCD patients report significantly lower mean T-scores on the facet of actions compared to healthy control subjects. This result suggests that OCD patients are lower than average in their willingness to try new things or go new places. The result is consistent with the anxious avoidance and rigidity associated with OCD (Mavissakalian et al., 1990, 1993; Sciuto et al., 1991) and with previous reports of low sensation-seeking in OCD patients (Kusunoki et al., 2000; Lyoo et al., 2001).

The hypothesis that the OCD patients would score significantly higher on the facets of fantasy and feeling compared to healthy control subjects was not supported. The mean T-score of the OCD group on the fantasy facet (T = 55.06) was in the 'high' range as was the mean T-score of the healthy control group (T = 58.50). The hypothesis that the OCD group would score

significantly higher than the healthy control subjects on the facet of feelings was also not supported. Again, the mean t score of the OCD group was in the 'high' range on the facet of feelings (T = 57.44). While the mean t score of the healthy control group (T = 53.75) fell into the 'average' range, the difference between the two groups was not significant. While the present thesis did not replicate the findings of Samuels et al. (2000) that OCD patients report significantly higher mean t scores on the facets of fantasy and feelings, the OCD patients did score in the 'high' range for these two facets which is consistent with the findings of Samuels et al. The results indicated that OCD patients experience 'higher-than-average' levels of active imagination and fantasy and deeper and more differentiated emotional states. The elevated scores reported by the OCD patients on the fantasy facet may reflect obsessional worries and cognitive distortions (Leong, 2003).

In this thesis, OCD patients also reported significantly lower mean T-scores on the facet of values (T = 52.50) in comparison to healthy controls (T = 59.55). The T-score of the OCD group still fell into the 'average' range and the difference would appear to be a reflection of the 'above average' score of the healthy control group. The mean T-score of the OCD group is similar to the T-scores reported by Rector et al. (2002) (T = 51.70) and Leong (2003) (T = 50.67). The result indicated that compared to healthy control subjects, OCD patients are more conservative and dogmatic.

The differences between the OCD and healthy control subjects on the domain of Openness disappeared after controlling for current depression and state anxiety. The best predictor of Openness score was BDI-II score, suggesting that differences between OCD and healthy controls on the Openness domain were mediated by current levels of depression. Differences on the facet of actions remained significant after controlling for current depression and state anxiety suggesting that differences between OCD and healthy controls on this facet were independent of current mood. Differences on the facet of values disappeared after controlling for current depression and state anxiety. The best predictor of values scores was STAI-S score, suggesting that the differences between OCD and healthy controls on this facet were mediated by current anxiety symptoms.

OCD versus panic disorder patients

It was predicted that OCD patients would record similar mean T-scores on the domain of Openness compared to the panic disorder group. This hypothesis was supported. The mean T-score of the OCD group (T = 52.33) fell into the 'average' range for Openness. The mean T-score of the panic disorder group (T = 58.00) fell into the 'high' range, however, the difference between the two groups was not significant. The mean T-score of the panic disorder group on the Openness domain was approximately one standard deviation higher than the score reported for the panic disorder group in the Bienvenu et al. (2001) study (T = 48.10). The difference may be related to different inclusion criteria used in that study, with half of the subjects in the panic

disorder group being remitted at the time of the study. In this thesis, all of the subjects met criteria for a current diagnosis of panic disorder. The result indicated that OCD and panic disorder patients experience similar levels of imagination, preference for variety and intellectual curiosity.

As predicted, the OCD patients scored significantly lower on the facet of actions (T = 39.33) compared to the panic disorder patients (T = 50.05). This was one of the only facets on the NEO PI-R that differentiated OCD patients from panic disorder patients. The result indicated that the panic disorder patients experience 'average' levels of novelty-seeking and preference for variety while the OCD patients tend to find change difficult and prefer to stick with the familiar. This result is consistent with reports of anxious avoidance and rigidity in OCD (Mavissakalian et al., 1990, 1993; Sciuto et al., 1991). There are also a number of previous studies reporting low novelty-seeking in OCD (Kusunoki et al., 2000; Lyoo et al., 2001). Low novelty-seeking has also differentiated OCD from major depression (Kusunoki et al., 2000).

Contrary to the hypothesis, there was no difference between the OCD patients and the panic disorder patients on the facets of fantasy and feelings. Like the OCD patients, the panic disorder patients scored 'above average' on these two facets (fantasy: T = 59.53; feelings: T = 58.16). The similarity of the two groups on these facets may be reflective of the presence of some obsessive-compulsive symptoms in the panic disorder group. While the panic disorder patients were screened and excluded for co-morbid OCD, some of the panic disorder patients did endorse obsessive-compulsive symptoms as evidenced by the mean score of 41.20 on the Padua Inventory for these patients. The results indicated that OCD and panic disorder patients reported experiencing similar levels of imagination, and intensity of emotional states.

OCD versus sub-clinical OC subjects

The hypothesis that the OCD patients would score no differently to the sub-clinical OC subjects on the domain of Openness was supported. The mean T-score of the OCD group (T = 52.33) and the mean T-score of the sub-clinical OC group (T = 53.60) both fell into the 'average' range on the domain of Openness. The result suggests that OCD patients and sub-clinical OC subjects experience similar levels of imagination, preference for variety, intellectual stimulation and independence of judgement.

The hypothesis that the OCD patients would score no differently to the sub-clinical OC subjects on the facets of Openness was also supported. There were no significant differences between the OCD patients and the sub-clinical OC subjects on any of the Openness facets. The OCD patients showed a similar pattern of results to the sub-clinical OC group on the Openness measure, with both groups in the 'high' range for fantasy (OCD: T = 55.06; sub-clinical OC: T = 55.25), the 'average' range for aesthetics (OCD: T = 54.11; sub-clinical OC: T = 52.55), the 'high' range for feelings (OCD: T = 57.44; sub-clinical OC: T = 56.80), the 'low' range for actions

(OCD: T = 39.33; sub-clinical OC: T = 43.85), and the 'average' range for ideas (OCD: T = 49.44; sub-clinical OC: T = 49.79). While the OCD patients were in the 'average' range for values (T = 52.50) and the sub-clinical OC subjects were in the 'high' range (T = 55.75), the sub-clinical OC group were only marginally 'above average' and the difference was not significant.

In the present thesis, sub-clinical OC subjects scored significantly lower on the facet of actions compared to the healthy control subjects (T = 56.90). This result supports the dimensional hypothesis of obsessions and compulsions as the OCD patients were also lower than the controls on this facet, but were also significantly lower than the sub-clinical OC subjects. This result suggests that lower openness-to-actions is characteristic of both clinical and sub-clinical OC symptoms.

Summary of Openness results

In the present thesis, OCD patients reported significantly lower levels of Openness-to-experience than the healthy control subjects, a finding that is inconsistent with previous studies using the FFM to examine personality in OCD (Leong, 2003; Samuels et al., 2003). Despite being significantly lower than the score reported by the healthy control group, the Openness score reported by the OCD still fell into the 'average' range. The OCD patients also differed on the facets of actions and values compared to the healthy control subjects. In this thesis, OCD patients were not differentiated from the panic disorder patients on the domain of Openness but did report significantly lower scores on the facet of actions. This was one of the few facets on the NEO PI-R that differentiated OCD and panic disorder patients. Given the numerous reports of lower openness-to-actions and novelty seeking in OCD compared to controls and other psychiatric disorders, lower scores on openness-to-actions may represent a trait marker of OCD. The OCD patients and the sub-clinical OC subjects did not differ on the domain or facets of Openness, and like the OCD patients, the sub-clinical OC subjects were also significantly lower on the facet of actions compared to the healthy control subjects.

12.5.4 Agreeableness domain and facets

OCD versus healthy control subjects

The hypothesis that the OCD patients would score significantly higher than the healthy control subjects on the domain of Agreeableness was not supported. The mean T-score of the OCD group (T = 47.83) fell into the 'average' range as did the mean T-score of the healthy control group (T = 51.80). The mean T-score of the OCD group in the present thesis was similar to that reported by Samuels et al. (2000) (T = 48.90) and almost identical to the mean T-score reported by Rector et al. (2002) (T = 47.79). In all three studies, the mean T-score of the OCD patients fell into the 'average' range on the domain of Agreeableness. The result of the present thesis does not support the findings of Samuels et al. (2000) who found that OCD patients report

significantly higher scores on the domain of Agreeableness compared to healthy control subjects. However, the difference in that study may have been due to the control subjects reporting 'below-average' levels of Agreeableness. The results may also be due to random differences in the OCD samples used in each study. For example, Samuels et al. (2000) assessed the OC symptoms of their subjects retrospectively, therefore, some of the subjects may not have been symptomatic at the time of testing. The result from this thesis indicates that OCD patients and healthy control subjects experience similar levels of altruism, sympathy and eagerness to help others.

The hypothesis that the OCD patients would score higher than the healthy control subjects on the Agreeableness facets of straightforwardness, modesty and tendermindedness was not supported. The mean T-scores of the OCD group (T = 51.11) and the healthy control group (T = 50.95) were in the 'average' range for the facet of straightforwardness. On the modesty facet, the OCD group (T = 56.67) were in the 'high' range while the healthy control group (T = 50.55) were in the 'average' range. Similarly, on the facet of tendermindedness the OCD group (T = 55.22) were in the 'high' range while the healthy control group (T = 53.30) were in the 'average' range. Despite this, the two groups did not differ significantly on these facets. The results of the present thesis do not support the findings of Samuels et al. (2000) who found that OCD patients reported significantly higher scores on the facets of straightforwardness, modesty and tendermindedness compared to healthy controls. Again, the difference in that study may have been due to the control subjects reporting 'below-average' levels of Agreeableness, particularly given that the OCD patients were in the 'average' range on the domains and facets of Agreeableness. Additionally, the OCD patients in the Samuels et al. (2000) study were tested retrospectively and may not have been symptomatic at the time of testing.

In the present thesis, OCD patients also scored no differently to healthy control subjects on the facets of trust, altruism and compliance. On the trust facet, the mean T-score of the OCD patients (T = 43.28) was in the 'low' range while the mean T-score of the healthy control subjects (T = 50.25) was in the 'average' range. On the altruism facet, both the OCD patients (T = 45.94) and the healthy control subjects (T = 52.45) scored in the 'average' range. The mean T-score of the OCD patients (T = 43.56) for the compliance facet was in the 'low' range, while the mean T-score of the healthy control subjects (T = 45.40) was in the 'average' range. None of these differences were statistically significant.

The results of the present thesis indicated that OCD and healthy control subjects experience similar levels of belief in others intentions, sincerity, generosity, cooperation, modesty, and sympathy and concern for others.

OCD versus panic disorder

The hypothesis that the OCD patients would score higher on the domain of Agreeableness compared to the panic disorder patients was not supported. The mean T-score of the OCD group (T = 47.83) and the panic disorder patients (T = 46.79) both fell into the 'average' range. The mean T-score of the panic disorder patients in the present thesis was comparable to the mean T-scores of the panic disorder group (T = 47.80) and the agoraphobia group (T = 46.70) reported in the Bienvenu et al. (2001) study. The result indicated that compared to panic disorder patients, OCD patients experience similar interpersonal tendencies.

The hypothesis that the OCD patients would score higher than the panic disorder patients on the Agreeableness facets of trust, straightforwardness, compliance, modesty and tendermindedness was not supported. Both groups reported mean T-scores in the 'low' range for trust (OCD: T = 43.28; panic disorder: T = 38.11), the 'average ' range for straightforwardness (OCD: T = 51.11; panic disorder: T = 47.16) and the 'high' range for tendermindedness (OCD: T = 55.22; panic disorder: T = 56.53). While the OCD patients were in the 'low' range for compliance (T = 43.56) and panic disorder patients were in the 'average' range (T = 45.42), and the OCD patients were in the 'high' range for modesty (T = 56.67) and the panic disorder patients were in the 'average' range (T = 51.68), the differences between the two groups were not significant. The results of the present thesis indicated that OCD and panic disorder patients experience similar levels of belief in others intentions, sincerity, generosity, cooperation, modesty, and sympathy and concern for others.

In this thesis, panic disorder patients (T = 38.11) scored significantly lower than healthy control subjects (T = 50.25) on the facet of trust. This result is consistent with previous studies that have found lower scores on this facet in panic disorder (Bienvenu et al., 2001) and agoraphobia (Bienvenu et al., 2001, 2004) compared to control subjects.

OCD versus sub-clinical OC subjects

The hypothesis that the OCD patients would record similar mean T-scores on the domain of Agreeableness compared to the sub-clinical OC subjects was supported. The mean T-score for the OCD patients (T = 47.83) was in the 'average' range for Agreeableness as was the mean T-score of the sub-clinical OC subjects (T = 45.85). The result indicated that OCD patients and sub-clinical OC subjects share similar interpersonal tendencies.

The hypothesis that the OCD patients would record similar scores on the Agreeableness facets compared to the sub-clinical OC subjects was partially supported. The OCD patients did not differ from the sub-clinical OC subjects on the facets of trust (OCD: T = 43.28; sub-clinical OC: T = 45.50), altruism (OCD: T = 45.94; sub-clinical OC: T = 47.95), compliance (OCD: T = 43.56; sub-clinical OC: T = 46.95) or tendermindedness (OCD: T = 55.22; sub-clinical OC: T = 52.30). The results indicated that OCD patients and sub-clinical OC subjects are similar in their beliefs

about others' intentions, similar in their generosity, show similar reactions to interpersonal conflict and show similar levels of concern and sympathy for others.

Contrary to the hypothesis, the OCD patients did report significantly higher levels of straightforwardness and modesty. The mean T-score for the OCD patients on the facet of straightforwardness (T = 51.11) was in the 'average' range, while the mean T-score for the sub-clinical OC subjects (T = 44.00) was in the 'low' range. The result indicated than compared to sub-clinical OC subjects, OCD patients tend to be more sincere and ingenuous. The mean T-score of the OCD patients on the facet of modesty (T = 56.67) was in the 'high' range while the mean T-score of the sub-clinical OC group (T = 48.10) was in the 'average' range. The result indicated that OCD patients tend to be more humble and self-effacing in comparison to sub-clinical OC subjects.

The difference between the OCD and sub-clinical OC subjects on the facet of straightforwardness was not affected by current mood, however, the difference between these groups on the facet of modesty disappeared after controlling for current depression and state anxiety. The best predictor of modesty score was STAI-S, suggesting that the difference between the OCD and sub-clinical OC subjects on the facet of modesty were accounted for by the presence of current anxiety. These results support previous research by (Bagby et al., 1995) and Rector et al. (2002) that Agreeableness is independent of depression severity.

Summary of Agreeableness results

OCD patients were no different to the healthy control subjects on the domain of Agreeableness, a finding that is inconsistent with a previous finding by Samuels et al. (2000) that OCD patients report higher scores on the Agreeableness domain compared to healthy controls. The OCD patients were also no different to the panic disorder patients on this domain. Despite previous research suggesting that panic disorder patients record low scores on the facets of trust and compliance (Bienvenu et al., 2001), and that OCD patients score higher on the facets of modesty, straightforwardness and tendermindedness (Samuels et al., 2000), there were no differences between the two groups on these facets. The OCD patients were higher on the facets of straightforwardness and modesty compared to the sub-clinical OC group suggesting that these facets may differentiate clinical and sub-clinical levels of OC symptoms.

12.5.5 Conscientiousness domain and facets

OCD versus healthy controls

As predicted, there was no difference between the OCD patients and the healthy control subjects on mean T-scores on the domain of Conscientiousness. The mean T-score of the OCD group (T = 40.17) was in the 'low' range while the mean T-score of the healthy control group (T = 45.85) was in the 'low average' range. The mean Conscientiousness T-score for the

OCD group in the present thesis was comparable to the mean T-score reported for the OCD patients in the Samuels et al. (2000) study (T = 43.30) and the Rector et al. (2002) study (T = 40.61) but lower than the mean T-score reported in the Leong (2003) study (T = 45.45). The result indicated that OCD patients and healthy control subjects show similar overall levels of planning, organisation and the ability to carry out tasks.

As predicted, the OCD patients did not differ from the healthy control subjects on the facets of order (OCD: T = 48.06; healthy controls: T = 43.10), dutifulness (OCD: T = 45.89; healthy controls: T = 49.75), achievement striving (OCD: T = 40.22; healthy controls: T = 43.65), or deliberation (OCD: T = 48.11; healthy controls: T = 50.10). The results indicated that OCD patients resembled healthy control subjects in terms of their organisational ability, adherence to ethical principles, diligence, and the degree to which they think before acting.

As predicted, the OCD patients did score significantly lower on the Conscientiousness facet of competence compared to the healthy control subjects. In this thesis OCD patients had a mean T-score in the 'low' range for competence (T = 42.00) compared to the healthy control group who scored in the 'high' range (T = 52.00). This result supports the finding of Samuels et al. (2000) who also found that OCD patients score lower on the facet of competence compared to healthy control subjects. This result indicated that, compared to healthy control subjects, OCD patients tend to have a lower opinion of their abilities and consider themselves to be inept. This result is consistent with the notion that unhealthy perfectionism, a feature of OCD, is associated with a lack of self-esteem (Stumpf & Parker, 2000).

As predicted, the OCD patients also scored significantly lower on the Conscientiousness facet of self-discipline compared to the healthy control subjects. The OCD patients scored in the 'very low' range for self-discipline (T = 33.11) while the healthy control subjects scored in the 'average' range for this facet (T = 45.35). This result supports previous research by Samuels et al. (2000) who also found that OCD patients score lower on the facet of self-discipline compared to healthy control subjects. The result indicated that, compared to healthy control subjects, OCD patients are less able to carry tasks through to completion. This result is also consistent with a finding by Lyoo et al. (2001) who found that OCD patients score lower on a measure of self-directedness compared to control subjects. Lyoo et al. (2001) suggests that OCD patients may be unable to carry tasks through to completion because when they initiate goal-directed behaviours, they are hindered by invasive obsessions and compulsions (Lyoo et al., 2001).

In the present thesis, the differences between the OCD and healthy control subjects on the facets of competence and self-discipline disappeared after controlling for current depression and state anxiety. The best predictor of competence and self-discipline scores was STAI-S. This result indicated that differences between OCD and healthy control subjects on these facets was mediated by levels of current anxiety. Rector et al. (2002) found that differences between

OCD and patients with Major Depression on Conscientiousness disappeared after controlling for depression severity.

OCD versus panic disorder

The prediction that the OCD patients would report similar mean T-scores on the domain of Conscientiousness compared to the panic disorder patients was supported. The mean T-scores of the OCD patients (T = 40.17) and the panic disorder patients (T = 43.00) were both in the 'low' range on the domain of Conscientiousness. The results indicated that both OCD and panic disorder patients in the present thesis had a 'lower-than-average' tendency towards planning, organising and carrying tasks through to completion.

As predicted, the OCD patients did not differ from the panic disorder patients on measures of competence (OCD: T = 42.00; panic disorder: T = 42.84), order (OCD: T = 48.06; panic disorder: T = 43.74), dutifulness (OCD: T = 45.89; panic disorder: T = 50.63), self-discipline (OCD: T = 33.11; panic disorder: T = 38.21) and deliberation (OCD: T = 48.11; panic disorder: T = 48.63). The results indicated that OCD patients and panic disorder patients resemble each other in terms of their opinion of their abilities, their organisational ability, their adherence to ethical principles, their ability to carry tasks through to completion and the degree to which they think before acting.

Contrary to expectation, the OCD patients (T = 40.22) did score lower on the facet of achievement-striving compared to the panic disorder patients (T = 47.53). The mean T-score of the panic disorder patients on this facet was almost identical to the mean T-score reported by the panic disorder patients in a study by Bienvenu et al (2002) (T = 47.30). This result indicated that compared to patients with panic disorder, OCD patients are less diligent and purposeful.

OCD versus sub-clinical OC subjects

The prediction that the OCD patients would report similar mean T-scores on the domain of Conscientiousness compared to the sub-clinical OC subjects was not supported. The OCD patients scored significantly lower on Conscientiousness compared to the sub-clinical OC subjects. The mean T-score on the domain of Conscientiousness for the OCD group (T = 40.17) was in the 'low' range while the mean T-score of the sub-clinical OC group (T = 48.30) was in the 'average' range. The result indicated that in comparison to sub-clinical OC subjects, OCD patients show lower levels of persistence, motivation and planning.

The prediction that the OCD patients would report similar Conscientiousness scores to the sub-clinical OC subjects was partially supported. The OCD and sub-clinical OC subjects did not differ on measures of competence (OCD: T = 42.00; sub-clinical OC: T = 47.15), order (OCD: T = 48.06; sub-clinical OC: T = 53.70), dutifulness (OCD: T = 45.89; sub-clinical OC: T = 48.75), achievement striving (OCD: T = 40.22; sub-clinical OC: T = 46.60) or deliberation (OCD: T =

48.11; sub-clinical OC: T = 52.55). The results indicated that OCD patients and sub-clinical OC subjects report a similar opinion of their abilities, similar levels of organisation, similar adherence to ethical principles, similar levels of aspiration and a similar tendency to think through things before acting.

Contrary to expectation, the OCD patients did score lower on the facet of self-discipline compared to the sub-clinical OC subjects. The mean T-score of the OCD patients (T = 33.11) on the facet of self-discipline was in the 'very low' range while the mean T-score for the sub-clinical OC subjects (T = 44.10) was just below 'average'. The result indicated that compared to sub-clinical OC subjects, OCD patients reported below average levels of persistence and motivation in goal-directed behaviours. If lower scores on measures of self-discipline are reflective of OCD patients being hindered by intrusive obsessions and compulsions when they initiate goal-directed behaviours (Lyoo et al., 2001), then self-discipline may be an important facet for differentiating between clinical and sub-clinical levels of obsessions and compulsions.

In the present thesis, the sub-clinical OC subjects scored significantly higher on the facet of order compared to the healthy control subjects. This result supports a finding by Gershuny et al. (2000) that sub-clinical OC subjects score higher on conscientiousness compared to non-clinical controls..

In the present thesis, the differences between the OCD and sub-clinical OC subjects on the domain of Conscientiousness and the facet of self-discipline disappeared after controlling for current depression and state anxiety. The best predictor of Conscientiousness was BDI-II suggesting that differences between the OCD and sub-clinical OC subjects on this domain are mediated by current levels of depression. This result supports a finding by Rector et al. (2002) that Conscientiousness is influenced by depression severity. The best predictor of self-discipline score was still group membership, although it did not reach significance.

Summary of Conscientiousness results

In this thesis, OCD patients were lower on competence and self-discipline compared to the healthy control subjects. This finding supports an earlier study by Samuels et al. (2000). The OCD patients were also lower on the facet of achievement-striving compared to the panic disorder patients. This was one of the few facets that differentiated these two groups. The OCD patients were also significantly lower than the sub-clinical OC subjects on the Conscientiousness domain and the facet of self-discipline. Differences in Conscientiousness may represent a fundamental difference between clinical and sub-clinical levels of obsessive-compulsive behaviour.

12.5.6 Predicting obsessive-compulsive symptoms from personality traits

Regression analysis was conducted as a preliminary investigation of which personality traits were the best predictors of the severity of OC symptoms (Y-BOCS scores) in the OCD and sub-clinical OC subjects. Due to the small sample size, these results are interpreted cautiously and require replication in a larger sample.

For the OCD patients, the best predictor of the severity of OC symptoms was the Extraversion facet of activity. Low scores on the facet of activity were associated with low scores on the Y-BOCS. The result indicated that for individuals with clinical OCD, being energetic and keeping busy is associated with less severe OC symptoms. The Neuroticism facet of anxiety was also approaching significance in its prediction of the severity of obsessive-compulsive symptoms in the OCD patients. High scores on the facet of anxiety were associated with high scores on the Y-BOCS. This result indicated that more anxious OCD patients experienced more severe obsessive-compulsive symptoms. Previous research has found that the best predictors of the severity of OC symptoms are harm avoidance and self-directedness from the Temperament and Character Inventory (Lyoo et al., 2001), and Psychoticism from the Eysenck Personality Questionnaire (Fullana et al., 2004). As there are no studies that have predicted the severity of OC symptoms using the NEO PI-R it is difficult to make comparisons with previous research.

For the sub-clinical OC subjects, the best predictor of OC symptom severity was the Agreeableness facet of trust. Low scores on the facet of trust were associated with high scores on the Y-BOCS. This result indicated that for individuals with sub-clinical levels of OC behaviour, being sceptical and suspicious of others intentions is related to more severe OC symptoms. As the trust facet is related to social anxiety and paranoid fears (Leong, 2003), these traits may be related to the severity of OC symptoms in sub-clinical OC samples. This result is inconsistent with previous research that reported the best predictor of severity of OC symptoms in sub-clinical OC subjects was Neuroticism (Fullana et al., 2004).

Regression analysis was also conducted as a preliminary investigation of which personality traits were the best predictors of the disturbance of OC symptoms (PI scores) in the OCD, sub-clinical OC, panic disorder and healthy control subjects. Due to the small sample size, these results are also interpreted cautiously

In the OCD group the best predictor of the disturbance of OC symptoms was the Conscientiousness facet of achievement striving, although it did not reach significance. Low scores on the facet of achievement striving were associated with high scores on the PI. This result indicates that OCD patients who lack diligence and direction tend to experience more disturbing obsessive-compulsive symptoms.

The Openness domain was the only predictor of the disturbance caused by obsessive-compulsive symptoms in the sub-clinical OC subjects. High scores on Openness were associated with high scores on the PI. This result indicated that for individuals with sub-clinical levels of obsessive-compulsive behaviour, those with more vivid imaginations and who experience more elaborate fantasies also experience more disturbing obsessive-compulsive behaviours. This finding is consistent with previous research suggesting that high scores on the Openness facet of fantasy may reflect being susceptible to obsessional worries and cognitive distortions (Leong, 2003).

For the panic disorder patients, the best predictor of the disturbance caused by OC symptoms was the Conscientiousness facet of competence. Low scores on this facet were associated with higher scores on the PI. The result suggests that, for individuals with panic disorder, a feeling of being unprepared or inept is associated with more disturbing OC symptoms.

For the healthy control subjects, the Extraversion facet of positive emotions was the best predictor of disturbance of obsessive-compulsive behaviour. Low scores on the positive emotions facet were associated with high scores on the PI. The result suggests that in a non-clinical population, individuals who are less likely to experience positive emotions, such as joy and happiness, tend to experience more disturbing obsessive-compulsive symptoms. This result supports previous research that found that induced depressed mood in non-clinical subjects leads to an increase in the frequency of intrusive cognitions (Reynolds & Salkovskis, 1992).

12.5.7 Summary of personality results

Overall, the personality results indicated that OCD patients were distinguished from healthy control subjects by higher scores on the domain of Neuroticism and lower scores on the domains of Extraversion and Openness. Compared to healthy controls, OCD patients were also higher on all facets of Neuroticism, lower on the Extraversion facets of warmth, gregariousness, assertiveness and positive emotions, lower on the Openness facets of actions and values and lower on the Conscientiousness facets of competence and self-discipline. The domains of the NEO PI-R did not differentiate OCD patients from panic disorder patients, although OCD patients were lower on the Openness facet of actions and lower on the Conscientiousness facet of achievement striving. Compared to sub-clinical OC subjects, OCD patients were higher on the domain of Neuroticism and lower on the domain of Conscientiousness. The OCD patients were also higher than the sub-clinical OC subjects on the Neuroticism facets of depression and vulnerability, lower on the Extraversion facet of positive emotions, higher on the Agreeableness facets of straightforwardness and modesty, and lower on the Conscientiousness facet of self-discipline.

The personality profile of the OCD patients would appear to fit with the clinical profile of the disorder, and is consistent with a number of previous studies that have used the NEO PI-R to assess personality traits in OCD. For example, high Neuroticism, low openness-to-action, low competence and low self-discipline have all been consistently reported in OCD patients (Samuels et al., 2000; Lyoo et al., 2001; Rector et al., 2002; Leong, 2003; Bienvenu et al., 2004; Fullana et al., 2004).

High Neuroticism is one of the most consistent finding in personality assessment of OCD (Samuels et al., 2000; Leong, 2003; Bienvenu et al., 2004; Fullana et al, 2004). However, Neuroticism is also associated with numerous other psychiatric conditions and is not, therefore, specifically related to OCD (Bagby et al., 1995, 1996, 1997; Bienvenu et al., 2001, 2004; Rector et al., 2002). In this thesis OCD patients and patients with panic disorder both scored in the 'very high' range on the domain of Neuroticism.

The results of this thesis also supported previous research that low openness-to-action may represent a possible trait marker of OCD. There are a number of reports of low-sensation seeking and low openness-to-actions in OCD (Kusunoki et al., 2000; Samuels et al., 2000; Lyoo et al., 2001). In this thesis, low openness-to-actions differentiated the OCD patients from the healthy control subjects and the panic disorder patients. The sub-clinical OC subjects were also significantly lower on this trait than the healthy control subjects. Previous research has also indicated that this trait differentiates OCD from major depression (Kusunoki et al., 2000).

Low competence and low self-discipline are also frequently reported in OCD. Samuels et al. (2000) suggested that worry and doubt may interfere with the productivity of individuals with OCD resulting in low self-reported competence. This is consistent with clinical descriptions of OCD which consider chronic doubting to be one of the defining characteristic of the disorder (Greisberg & McKay, 2003). This result is also consistent with a finding by Lyoo et al. (2001) who found that OCD patients score lower on a measure of self-directedness compared to control subjects. Lyoo et al. (2001) suggests that OCD patients may be unable to carry tasks through to completion because when they initiate goal-directed behaviours, they are hindered by invasive obsessions and compulsions (Lyoo et al., 2001). Alternatively, OCD is associated with unhealthy perfectionism which, in turn, is associated with a lack of self-esteem (Stumpf & Parker, 2000). Thus, the low competence score reported by the OCD patients in the present thesis may also be reflective of the low self-esteem associated with unhealthy perfectionism. As Rector et al. (2002) suggest, despite the desire for order and organisation, individuals with OCD are unable to achieve these tasks to their satisfaction. This inability of OCD patients to achieve their goals may then result in the development of a low opinion of themselves.

While a number of the personality traits associated with OCD may not be specific to the disorder, understanding the personality profile of individuals with OCD may have important

implications in clinical interventions. For example, Miller (1991) suggests that the FFM can provide important insight for clinicians regarding needs, feelings, motives and interpersonal style of individuals that present for clinical treatment. Miller (1991) suggests that Neuroticism can influence the intensity and duration of a patient's distress; Extraversion can influence how enthusiastic a patient is about treatment; Openness influences the reaction of the patient to treatment interventions suggested by the clinician; Agreeableness influences the nature of the patient's relationship with the clinician; and Conscientiousness influences the willingness of the patient to do the work of therapy. Miller (1991) suggests that the FFM can provide insight into a patient's clinical presentation and can also influence the outcome of therapy.

The personality profile reported by the OCD patients confirms the severe and disabling nature of the disorder. In this thesis, OCD patients reported high Neuroticism, low Extraversion, and low Conscientiousness. This configuration of personality traits has been referred to as the 'misery triad' (Miller, 1991, page 430), and indicates a low capacity for well-being.

This thesis also found that different personality traits, as measured by the NEO PI-R, predicted obsessive-compulsive symptoms in the OCD patients compared to the sub-clinical OC subjects, panic disorder patients and healthy control subjects. While the results are preliminary, and require replication in a larger sample, uncovering the personality traits that predict severity of obsessive-compulsive symptoms may provide important insights into OCD, and may also have implication for treatment. In this thesis, the best predictor of severity of OC symptoms in the OCD patients was the Extraversion facet of activity. In the sub-clinical OC subjects, the best predictor of severity of OC symptoms was the Agreeableness facet of trust.

Overall, this thesis demonstrated that OCD patients can be distinguished from healthy control subjects, panic disorder patients and sub-clinical OC subjects on a measure of normal personality traits.

12.6 Limitations

A number of factors limit some of the conclusions made in this thesis. Firstly, the sample size was relatively small which limits the generalizability of the results and, therefore, the conclusions that can be drawn from the results. It is possible that, as a result of lower statistical power, some significant differences may not have been observed even though they exist. Additionally, the number of analyses conducted may have increased the possibility of type I error. An alpha level of .05 was chosen to ensure that moderate effect sizes were detected, and to guard against the possibility of type II error. Setting the alpha level to .01, with an expected moderate effect size (Cohen's d = 0.50), would have required at least 96 participants per group to have an 80% chance of detecting a difference in two-tailed testing (Power = .80) (Devilly, 2004). A sample size of such magnitude was not achievable for this thesis, particularly given the clinical emphasis. The recruitment of a clinical sample is particularly difficult and the recruiting and

testing of the 40 clinical patients in this thesis took a number of years. Due to time constraints, further testing to increase the sample size was not considered feasible. The thesis did, however, report two-tailed statistics even though the hypotheses were directional. With this in mind, the results may be seen as relatively robust and should allow future studies testable hypotheses for replication.

Another limitation of this thesis was the criteria used for inclusion in the sub-clinical OC group. The cut-off score used in this thesis was fairly 'liberal' which may limit the extent to which comparisons can be generalised between the OCD patients and the sub-clinical OC subjects. However, the characteristics of the sub-clinical OC subjects in this thesis were similar to sub-clinical OC samples used in other studies (e.g. Wade et al., 1998). There is also evidence that a range of inclusion criteria can be used in sub-clinical OC research (Mataix-Cols et al., 2000). The significant differences observed between the sub-clinical OC subjects and the healthy control subjects on measures of depression, anxiety and OC symptoms were also consistent with previous studies (Mataix-Cols et al., 2000; Mataix-Cols, 2003; Fullana et al., 2004).

The presence of OC symptoms in the panic disorder patients may also have been a confounding factor in this thesis. Some of the panic disorder patients reported high scores on the Padua Inventory (PI). While no patients with panic disorder and co-morbid OCD were included in the thesis, and the mean PI score of the patients with panic disorder was significantly lower than the mean PI score of the OCD patients, the inclusion of some panic disorder patients with high self-report levels of OC behaviour may limit the interpretation of the results.

Other potentially confounding factors that were not controlled for in this thesis included: treatment status; co-morbid conditions; Axis II pathology; and heterogeneity of OCD symptoms. In this thesis, the clinical patients were recruited from a number of different clinics, were receiving different therapy (pharmacological and cognitive-behavioural), and were at different stages of treatment. However, previous research suggests that cognitive deficits in OCD persist even after clinical recovery (Nielen & Den Boer, 2003) and that medication status does not influence neuropsychological performance (Mataix-Cols et al., 2002). With regard to co-morbidity, Basso et al. (2001) have suggested that executive impairments are related to co-morbid depression. The present thesis investigated the relationship between depressive symptoms and working memory performance and personality assessment in the OCD patients using correlational analysis. However, the small sample size precluded investigating whether separating OCD subjects into two groups: those with co-morbid major depression and those without, would have uncovered differences on measures of working memory and personality assessment. The thesis also did not assess Axis II pathology. Given that a number of Axis II disorders can be conceptually linked to the NEO PI-R (Costa & McCrae, 1992), and that the majority of OCD patients have at least one personality disorder (Jenike & Baer, 1992), the

presence of Axis II disorders may have influenced the normal personality assessment in this thesis. Future research, employing larger sample sizes, would be improved by taking each of these limiting factors into account.

12.7 Recommendations for future research

This thesis demonstrated the utility of directly comparing OCD patients, panic disorder patients and sub-clinical OC subjects on measures of working memory and normal personality. However, additional studies, employing larger sample sizes, are required to clarify the characteristics that distinguish, or are common to, individuals with clinical and sub-clinical OC symptoms and individuals with other anxiety disorders. The results of these studies have implications for understanding the aetiology of OCD, the dimensional theory of obsessions and compulsions and the utility of using sub-clinical OC samples to investigate questions about OCD.

The results of this thesis indicated that OCD patients are impaired on working memory tasks that involve strategic processing. However, it is still unclear whether this deficit arises due to capacity constraints being exceeded in working memory systems or some other executive dysfunction such as excessive error monitoring. Future research combining neuroimaging techniques, cognitive tasks and symptom provocation is required to better understand the relationship between the neural mechanisms underlying the behavioural manifestation of OCD, and impaired performance on tests of working memory. In isolation, neuroimaging techniques and neuropsychology both have limitations. However, in combination the inferences that can be made using these techniques substantially increase. Investigations of working memory impairment in OCD could also benefit from employing cognitive tasks (like the DMS and n-back tasks used in this thesis) that have been extensively validated in imaging studies of working memory. The advantages of using these tasks in conjunction with neuroimaging techniques are: they have baseline conditions (perception trials in the DMS task and 0-back trials in the n-back task); the nature of the tasks can be manipulated (attending to the location or attending to the identity of the stimulus) without changing the sequence of trial events; and the demand of the tasks can also be manipulated without changing the sequence of trial events. Thus, these tasks allow for the comparison of specific cognitive processes and reveal brain activations that are due only to the processes of interest. These paradigms contrast with standard neuropsychological tasks that do not reveal individual cognitive processes (Smith & Jonides, 1999). Including sub-clinical OC subjects in neuroimaging studies would also allow comparison of the brain activation associated with clinical and sub-clinical levels of OC symptoms.

Further investigation of the five-factor model of personality in OCD and sub-clinical OC is also recommended. The results of the present thesis indicated that OCD patients and sub-clinical OC subjects share some personality traits but can be distinguished by others. However, replication of these results is required in a larger sample. Understanding the specific personality

traits related to OCD has implications for diagnosis, prognosis and treatment. Additionally, identifying the personality traits associated with sub-clinical OC may also help elucidate whether certain personality traits represent a specific vulnerability to OCD. Examination of personality variables with respect to different symptom subtypes is also a relatively unexplored area. Given that OCD can be differentiated by a number of different symptom clusters (Lochner & Stein, 2003), examination of the personality traits associated with these symptom subtypes in OCD may yield potentially important information.

Given the accumulating evidence that OCD is associated with a specific deficit in working memory, research is also required to explore the utility of using cognitive restructuring in OCD therapy. The aim of this therapy would be to train people to improve their ability to use working memory (Savage et al., 2000; Greisberg & McKay, 2003). Studies assessing the effectiveness of cognitive retraining approaches for OCD are needed to examine the relationship between working memory deficits and clinical symptoms in OCD. For example, teaching OCD patients to use more effective encoding and retrieval strategies may lead to an improvement in their obsessive (chronic doubt) and compulsive (checking) symptoms.

12.8 Summary

In conclusion, the findings of the present thesis suggested the existence of working memory deficits in OCD patients that were not observed in panic disorder patients or sub-clinical OC subjects. The working memory deficits were most apparent on tasks requiring strategic processing, such as continual updating and temporal ordering of stimuli, and supported the theory of fronto-striatal dysfunction in OCD. The results of this thesis also distinguished between OCD patients and healthy control subjects, patients with panic disorder, and sub-clinical OC subjects on a measure of normal personality traits. The thesis suggests that including other anxiety disorders and sub-clinical OC subjects as control groups in OCD research is important for identifying the specificity of cognitive deficits and personality traits in OCD.

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LIST OF APPENDICES

Appendix A

Testing procedure

DMS task instructions

These tasks are designed to test your ability to remember shapes, or the location of shapes for a short period of time. You will be presented with three types of tasks of varying degrees of difficulty. Each task requires you to remember different types of information. One task requires you to remember the shape of irregular objects, one task requires you to remember the shape of geometric objects and one task requires you to remember the spatial locations of irregular objects. You will be given a short practice on each of the tasks.

First, I will explain how the task should be performed, and we will go through a practice trial. Some of the tasks can be complicated, so feel free to ask any questions you may have.

While performing the tasks, answer quickly but make accuracy your first priority.

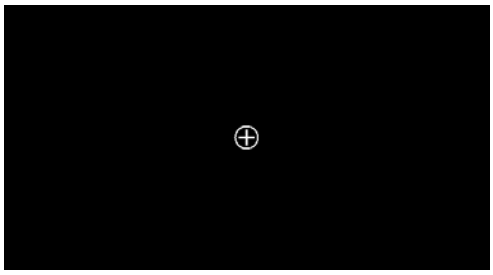
I will now explain each of the tasks.

Irregular Object DMS task

This task requires you to remember the shape of the objects that appear on the screen. Where they appear on the screen is not important, only what shape they are. The probe shape must appear exactly as it appeared as the target shape to be a match. It cannot be rotated or upside down, slightly longer or shorter. Remember, while performing the tasks, answer quickly but make accuracy your first priority.

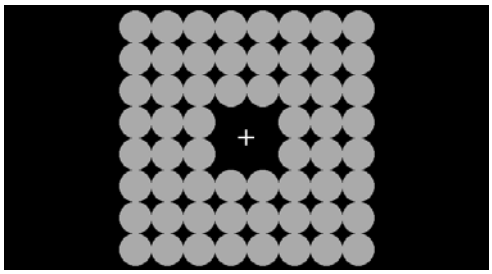
Go through computerised instructions (subjects were shown an example of a low demand trial and a high demand trial. The following example is a high demand trial).

Each trial begins with a cross inside a circle in the middle of the screen. This indicates the start of a new trial.

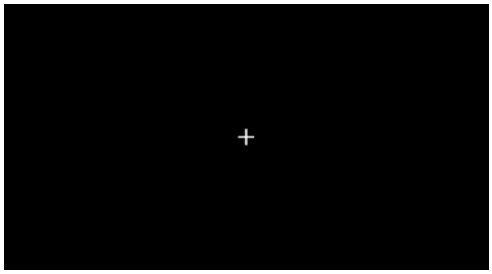


One or two target objects are then presented. These are the objects to be remembered.

The target objects are replaced by a visual mask that prevents an afterimage of the object from staying on the screen.



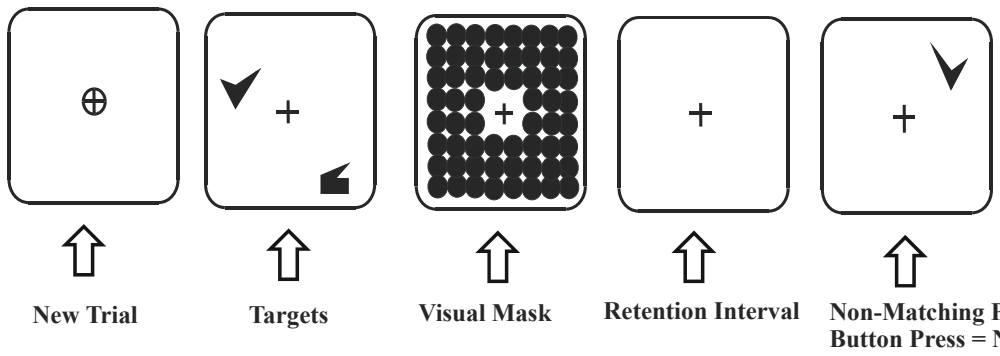
Following the visual mask a fixation cross appears in the centre of the screen. This is the retention interval where you are remembering the target objects. The retention interval will be very short for some trials and longer for others.



A single probe object then replaces the fixation cross. The probe object is the object that you respond to. If the probe object matches either of the target objects you respond YES by pressing the right button on the button box. If the probe object is different to both of the target objects you respond NO by pressing the LEFT button on the button box.

Remember that the probe shape must appear exactly as it appeared as the target shape to be a match. It cannot be rotated or upside down, slightly longer or shorter.

Show printed instructions to confirm



We will now do a practice trial of the irregular object DMS task.

Run practice trial

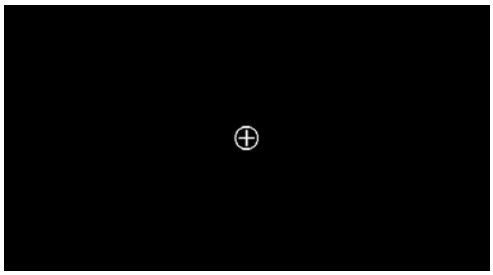
Do you have any questions about the irregular object DMS task?

Spatial Locations DMS task

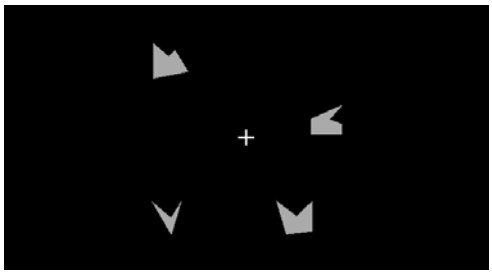
This task requires you to remember the location of where the shapes appear on the screen. What the shapes look like is not important, only where the shapes appear on the screen is important. The probe shape must appear exactly where it appeared as the target shape to be a match. It cannot be slightly above, below or to the left or right. It does not have to be the same shape that appears in the target location. Remember, while performing the tasks, answer quickly but make accuracy your first priority.

Go through computerised instructions

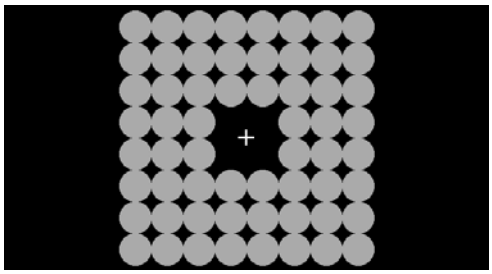
Each trial begins with a cross inside a circle in the middle of the screen. This indicates the start of a new trial.



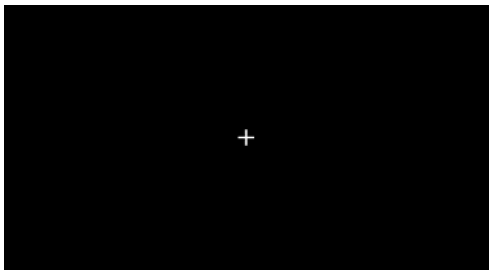
Two or four target locations are then presented. These are the locations to be remembered.



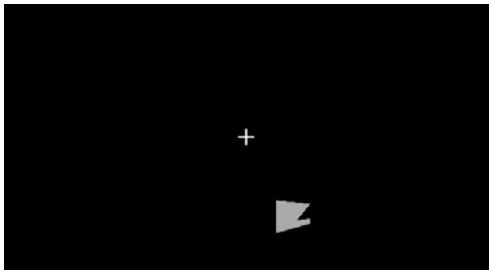
The target locations are replaced by a visual mask that prevents an afterimage of the locations from staying on the screen.



Following the visual mask a fixation cross appears in the centre of the screen. This is the retention interval where you are remembering the target locations. The retention interval will be very short for some trials and longer for others.

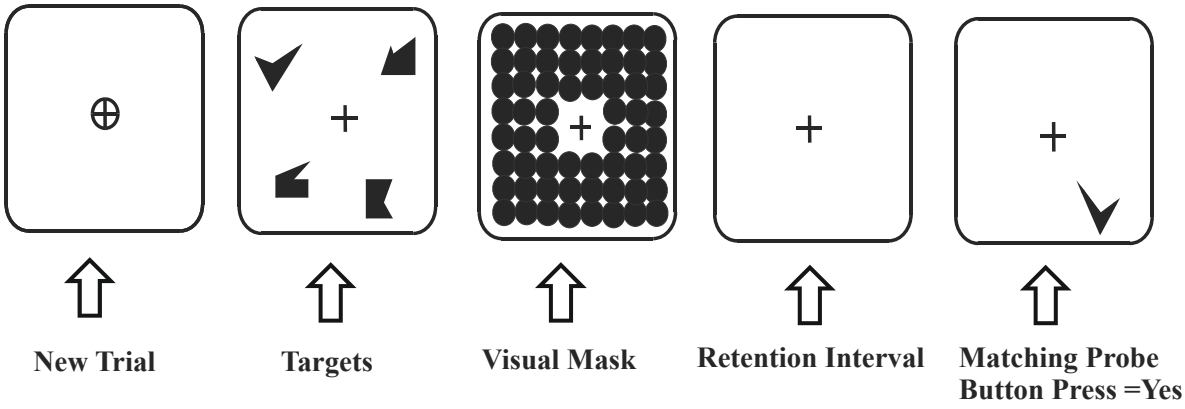


The fixation cross is then replaced by a single probe location. The probe location is the location that you respond to. If the probe location matches any of the target locations you respond YES by pressing the right button on the button box. If the probe location is different to both of the target locations you respond NO by pressing the LEFT button on the button box.



Remember that the probe location must appear exactly as it appeared as the target location to be a match. It cannot be slightly above, below or to the left or right of the target location.

Show printed instructions to confirm



We will now do a practice trial of the Spatial Locations DMS task

Run practice trial

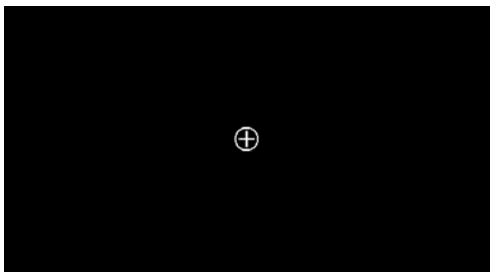
Do you have any questions about the Spatial Locations DMS task?

Geometric Object DMS task

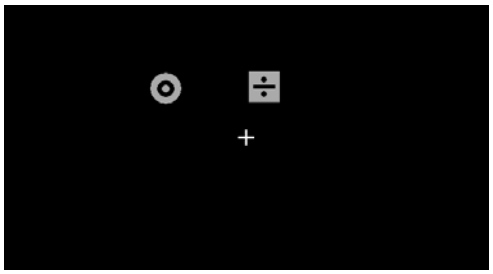
This task requires you to remember the shape of the objects that appear on the screen. Where they appear on the screen is not important, what is important is what shape they are. The probe shape must appear exactly as it appeared as the target shape to be a match. It cannot be rotated or upside down, slightly longer or shorter. Remember, while performing the tasks, answer quickly but make accuracy your first priority.

Go through computerised instructions.

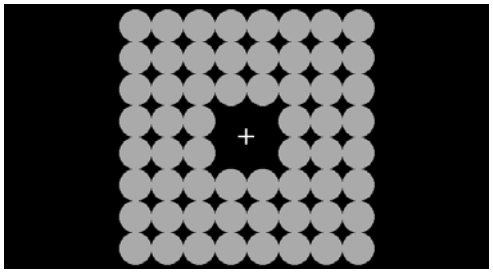
Each trial begins with a cross inside a circle in the middle of the screen. This indicates the start of a new trial.



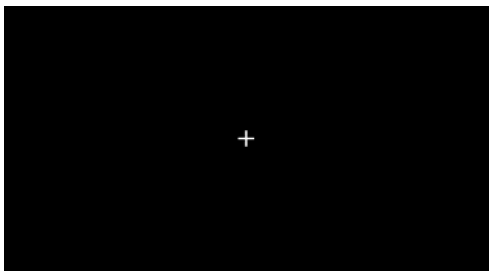
One or two target objects are then presented. These are the objects to be remembered.



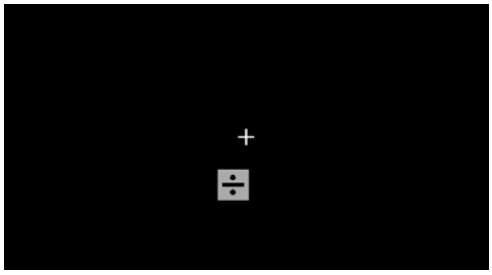
The target objects are replaced by a visual mask that prevents an afterimage of the object from staying on the screen.



Following the visual mask a fixation cross appears in the centre of the screen. This is the retention interval where you are remembering the target objects. The retention interval will be very short for some trials and longer for others.

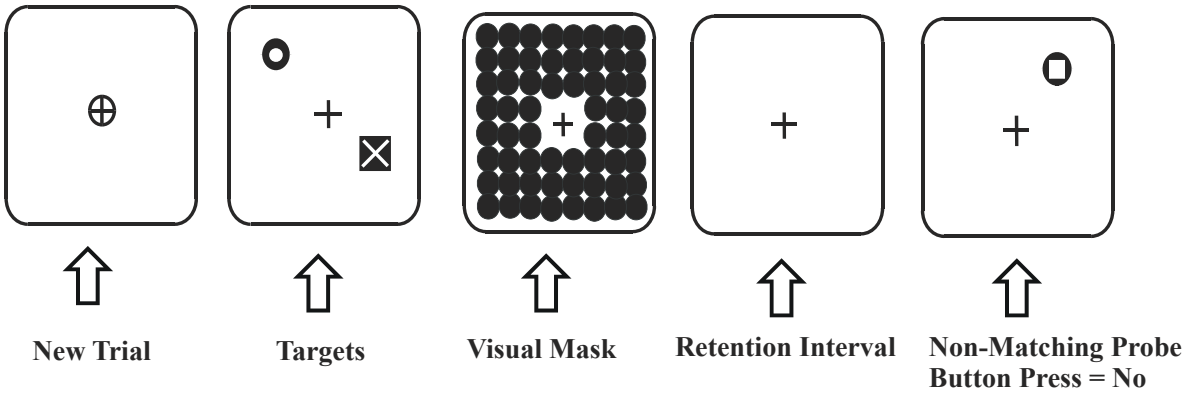


A single probe object then replaces the fixation cross. The probe object is the object that you respond to. If the probe object matches either of the target objects you respond YES by pressing the right button on the button box. If the probe object is different to both of the target objects you respond NO by pressing the LEFT button on the button box.



Remember that the probe shape must appear exactly as it appeared as the target shape to be a match. It cannot be rotated or upside down, slightly longer or shorter.

Show printed Instructions to confirm.



We will now do a practice trial of the Geometric Object DMS task.

Run practice trial

Do you have any questions about the Geometric Object DMS task?

Experimental trials of the DMS tasks

The experimental tasks are the same as the practice tasks, but they will appear in random order. Before each task, the instructions will be repeated and you will receive two short practice trials.

Each experimental trial lasts for approximately 5 minutes. There are two experimental trials per task.

While performing the tasks, answer quickly but make accuracy your first priority.

Do you have any questions before we start?

Run DMS task experimental trials

N-back task Instructions

The n-back task is designed to test your ability to remember a letter or the position of a letter for a short period of time. You will be presented with two types of task of varying degrees of difficulty. One task is referred to as a verbal task where you are required to remember letters for a short period of time. The other task is referred to as a spatial task where you are required to remember the position of the letters for a short period of time.

You will be given a short practice on each of the tasks.

Practice tasks

First, I will explain how the tasks should be performed, and we will go through a practice trial. Some of the tasks can be complicated, so feel free to ask any questions you may have.

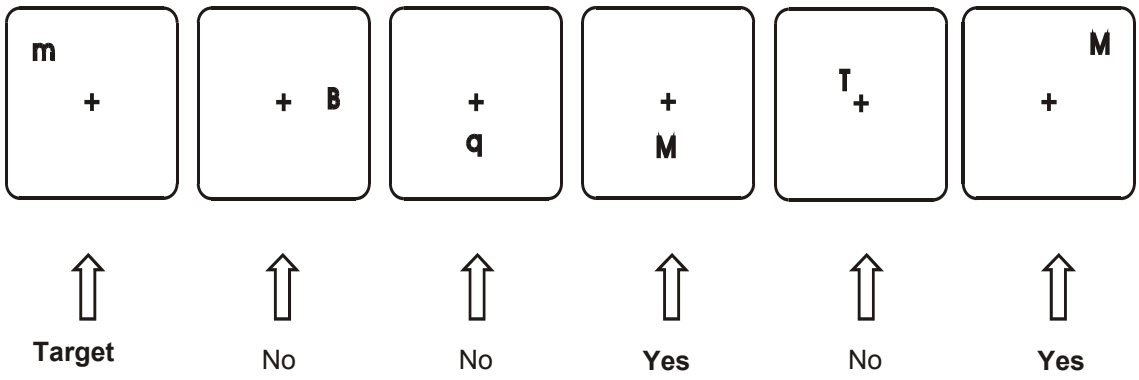
In all the tasks you will see a series of letters appear on the screen. Before each letter appears, you will see a small cross in the centre of the screen. While performing the tasks, answer quickly but make accuracy your first priority.

Verbal n-back tasks
The next four tasks require you to remember the identity of the letters that appear on the screen. Where they appear on the screen is not important, what is important is what letter they are. Remember, while performing the tasks, answer quickly but make accuracy your first priority.

We will now complete a practice trial for each of the verbal tasks.

<u>0-back task</u>
For the first task (the 0-back), the first letter that appears on the screen becomes the target letter for the rest of that series of letters. Each time that letter appears on the screen, (regardless of whether it is upper- or lower-case, or where it is on the screen), you need to press the button on the right-hand side of the button-box. If the letter on the screen does not match the target letter then you press the button on the left-hand side of the button-box.

Show printed instructions to confirm.



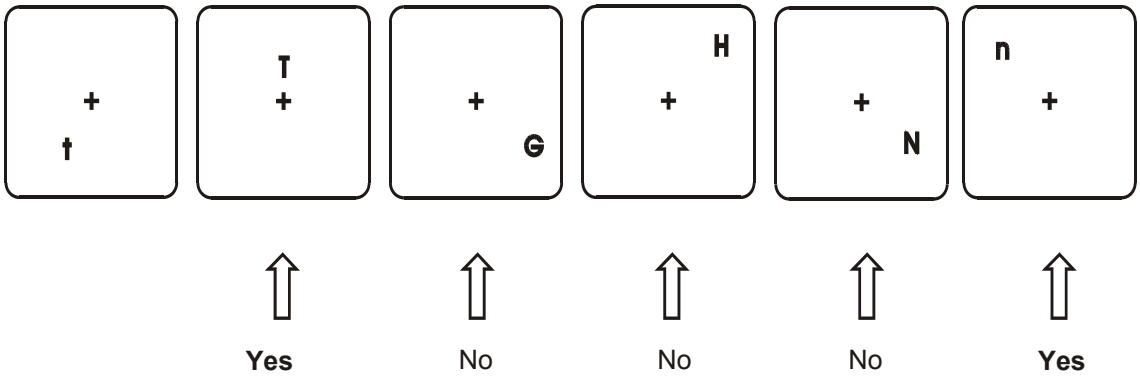
Do you have any questions about the 0-back task?

Run practice trial

1-back

For the second task (the 1-back), once again a series of letters will be presented on the screen. This time however, you are to press the button on the right-hand side of the button-box when the letter matches the one presented before it (regardless of whether it is upper- or lower-case). If the letter is different to the one before it then press the button on the left-hand side of the button-box.

Show printed instructions to confirm.



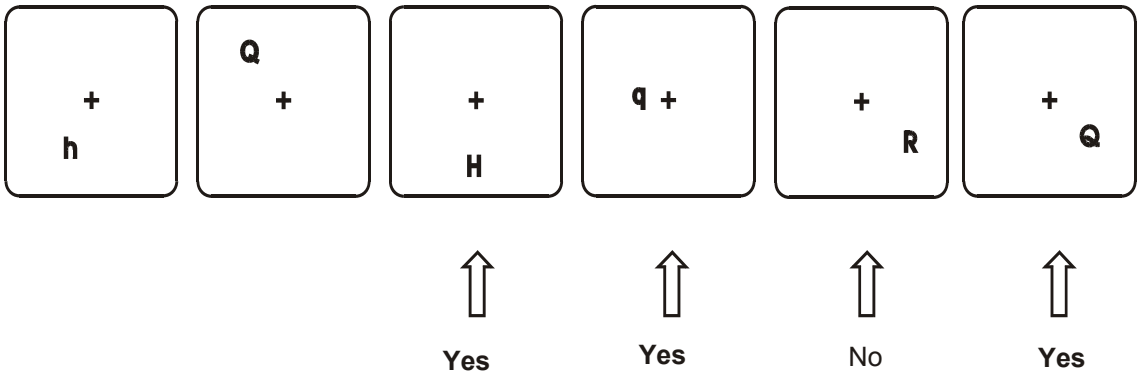
Do you have any questions about the 1-back task?

Run practice trial

2-back

For the next task (the 2-back), you are to press the button on the right when the letter on the screen matches the letter presented 2 previously (ie. 2-back). If it doesn't match the letter presented 2-back then press the button on the left.

Show printed instructions to confirm.

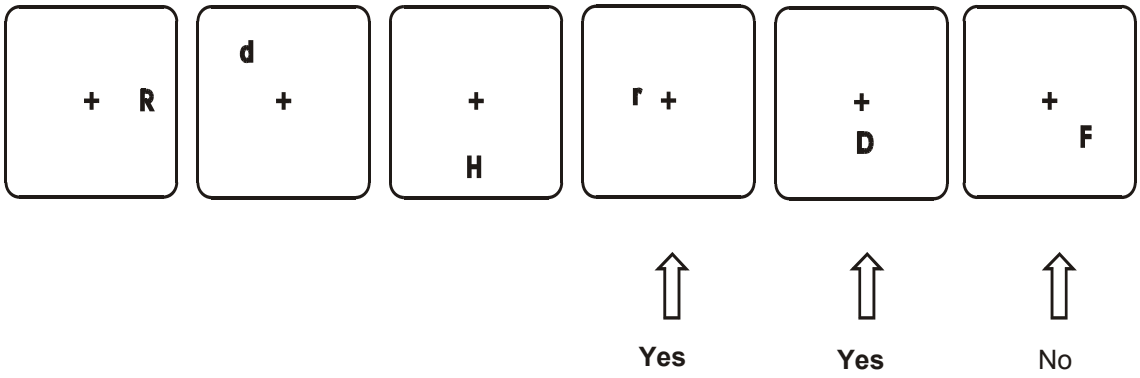


Do you have any questions about the 2-back task?

Run practice trial

3-back
For the final task (the 3-back), you are to press the button on the right when the letter on the screen matches the letter presented 3 letters previously (ie. 3-back). Once again, if it doesn't match the letter presented 3-back then press the button on the left.

Show printed instructions to confirm.



Do you have any questions about the 3-back task?

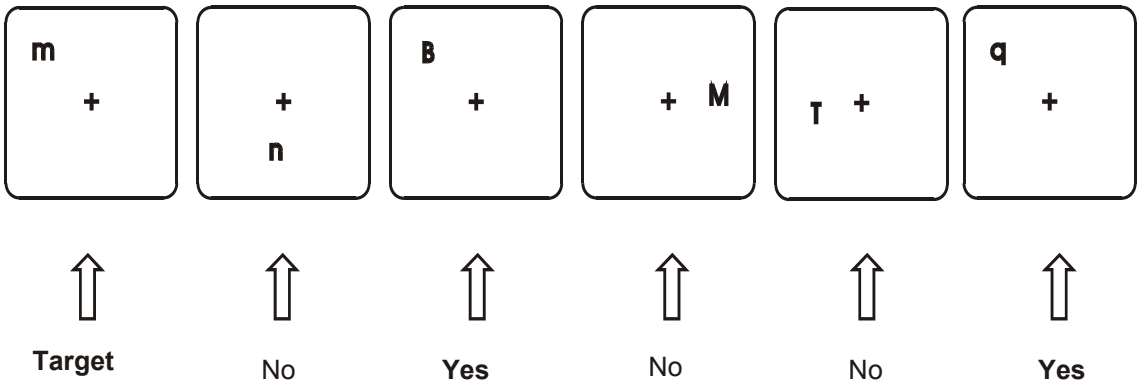
Run practice trial

Spatial n-back tasks
The next four tasks require you to remember where the letters appear on the screen.
The letters will always appear at least 2 positions away from each other. The identity of the letter is not important, only where the letters appear is important. Remember, while performing the tasks, answer quickly but make accuracy your first priority.

We will now complete a practice trial for each of the spatial tasks.

0-back
For the first task (the 0-back), the location the first letter that appears on the screen becomes the target location for the rest of the series. Each time a letter appears in that location on the screen, (regardless of what letter it is); you need to press the button on the right-hand side of the button-box. If the letter's location on the screen does not match the target position then you press the button on the left-hand side of the button-box.

Show printed instructions to confirm.



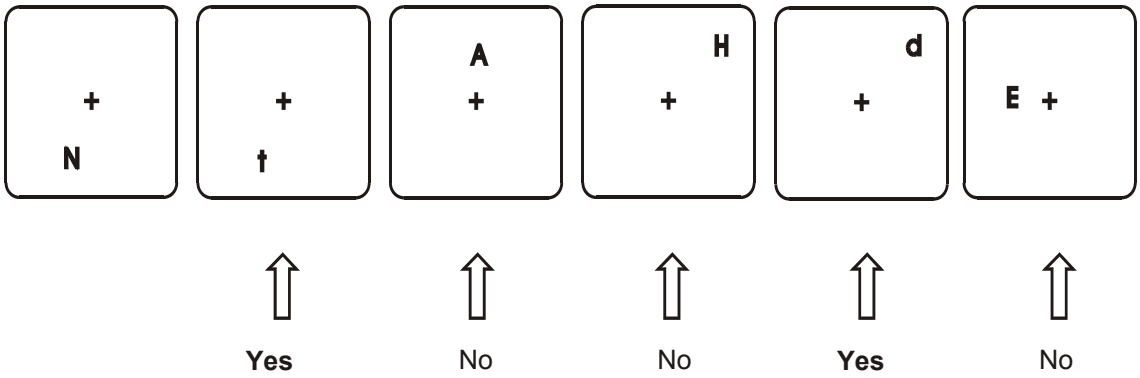
Do you have any questions about the 0-back task?

Run practice trial

1-back

For the second task (the 1-back), once again a series of letters will be presented in different locations on the screen. This time however, you are to press the button on the right-hand side of the button-box when the location of the letter matches the one presented before it (regardless of what letter it is). If the letter's location is different to the one before it then press the button on the left-hand side of the button-box.

Show printed instructions to confirm.



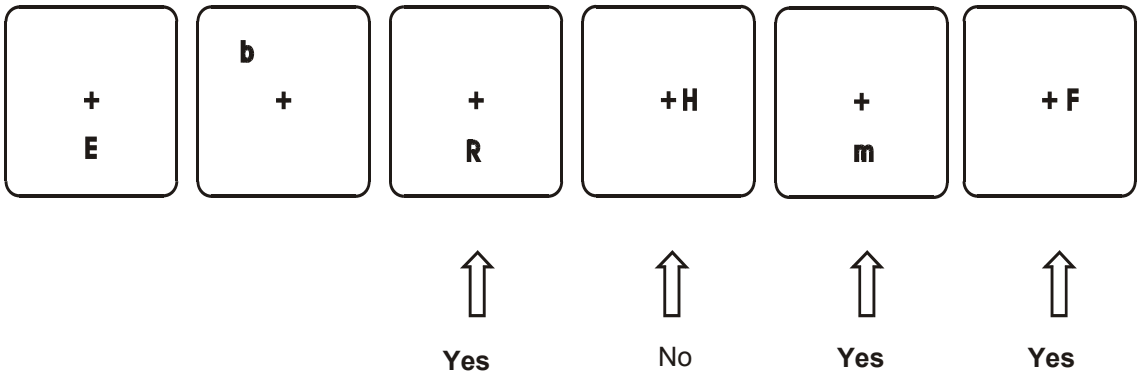
Do you have any questions about the 1-back task?

Run practice trial

2-back

For the next task (the 2-back), you are to press the button on the right when the letter's location on the screen matches the one presented 2 previously (ie. 2-back). If it doesn't match the letter's location presented 2-back then press the button on the left.

Show printed instructions to confirm.



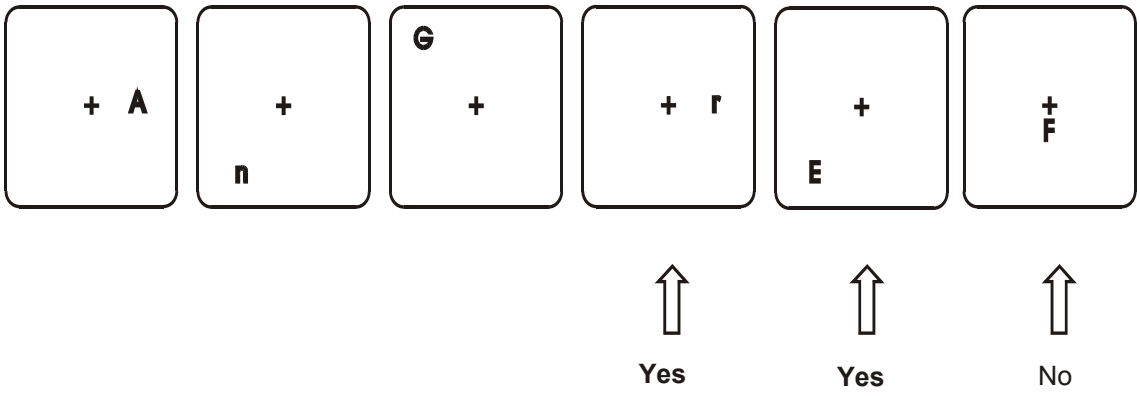
Do you have any questions about the 2-back task?

Run practice trial

3-back

For the final task (the 3-back), you are to press the button on the right when the letter's location on the screen matches the location of the letter presented 3 letters previously (i.e. 3-back). Once again, if it doesn't match the letter location presented 3-back then press the button on the left.

Show printed instructions to confirm.



Do you have any questions about the 3-back task?

Run practice trial

N-back experimental tasks

The experimental tasks are the same as the practice tasks, but they will appear in random order. Before each task, the instructions will be repeated. Once again, in all the tasks you will see a series of letters appear on the screen. Before each letter appears, you will see a small cross in the centre of the screen. Try and respond before the cross disappears and the next letter appears.

Each experimental task will last for approximately 3½ minutes.

While performing the tasks, answer quickly but make accuracy your first priority.

Do you have any questions?

Run n-back experimental trials

Appendix B

Data screening for demographic variables

Univariate outliers

To identify potential univariate outliers, Z scores were calculated for each demographic variable for the four experimental groups. None of the standardized scores exceed the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality

As the analysis involves grouped data, the central limit theorem assures us that the sampling distribution of the means are normally distributed, regardless of the distribution of the variables. If there are at least 20 degrees of freedom for errors, the F test is robust to violations of normality, provided there are no outliers (Tabachnick & Fidell, 2001). However, the distribution of the continuous demographic variables of age and IQ was still evaluated for skewness and kurtosis using Statistica distribution statistics and expected normal probability plots. Slight skewness and kurtosis was observed in some of the age and estimated IQ variable distributions, however, none of the statistics exceeded two standard errors of either skewness or kurtosis. Examination of the graphical representations of both variables confirmed that no serious departures from normality were present. The split on the dichotomous variable gender is less than 9:1 for all groups and is therefore considered appropriate for inclusion in the MANOVA (Tabachnick & Fidell, 2001). The spilt on the dichotomous variable handedness is poor, particularly for the OCD group (9:1), healthy control group (19:1), and sub-clinical OC group (9:1). Because of the poor split, handedness is not included in the MANOVA, and group differences on this variable are explored using non-parametric statistics.

Multivariate outliers

To identify the presence of multivariate outliers, Statistical Package for the Social Sciences (SPSS) version 12.0.1 (SPSS, Inc., 2003) regression residuals statistics were calculated for each experimental group. The criterion for multivariate outliers is Mahalanobis Distance at $p < .001$. Mahalanobis Distance is evaluated as X^2 with degrees of freedom equal to the number of variables. As there are three variables any case with a Mahalanobis Distance greater than X^2 (3) = 16.27 would be considered a multivariate outlier. With maximum values of 6.72 (OCD), 10.52 (panic disorder), 6.53 (sub-clinical OC) and 9.67 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance

F_{max} (ratio of largest cell variance to smallest) in conjunction with sample size ratios is recommended to test for homogeneity of variance as the formal tests are generally considered to be too strict (Tabachnick & Fidell, 2001). If sample sizes are relatively equal (4:1 or less for largest to smallest cell size) an F_{max} less than 10 is generally acceptable. None of the demographic variables had an F_{max} in excess of 10. The conservative Levene's test for equality of variance confirmed no significant differences in the variance of age [$F(3,76) = 1.89$, $p = 0.14$], estimated IQ [$F(3,76) = 0.01$, $p = 1.00$], or gender [$F(3,76) = 1.16$, $p = .33$] between groups.

Homogeneity of variance-covariance matrices

As the sample sizes are equal robustness of the significance test is expected (Tabachnick & Fidell, 2001). The very conservative Box's M statistic was also not significant [X^2 (18) = 8.05, p = .98] confirming homogeneity of variance-covariance matrices.

Linearity

Using the Statistica descriptives procedure bivariate scatterplots of the two continuous variables were inspected for signs of non-linearity within each group. Inspection of these plots suggested no evidence of curvilinearity.

Multicollinearity

Multicollinearity of the demographic variables was assessed using SPSS regression collinearity diagnostics. The criteria for multicollinearity used in the present thesis was any dimension with a condition index greater than 30 associated with two variables with variance proportions greater than 0.50 (Belsley, Kuh, & Welsch, 1980). Although one dimension had a condition

index greater than 30 only one variable associated with it had a variance proportion greater than .50. Therefore the criteria for multicollinearity was not met.

Appendix C

Data screening for clinical variables

Univariate outliers

To identify potential univariate outliers Z scores were calculated for each demographic variable for the four experimental groups. None of the standardized scores exceed the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality

The distribution of the clinical variables was evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. Some skewness and kurtosis was evident in some of the BDI-II and STAI-S variable distributions. The STAI-S skewness statistic for the sub-clinical OC group and the BDI-II skewness statistic for the control group both exceeded two standard errors of skewness. Inspection of the graphical depictions confirmed some departures from normality for these variables. Before a decision was made to include the skewed variables in a MANOVA, identification of univariate outliers was undertaken and bivariate scatterplots were investigated to establish whether the skewness of the variables BDI-II and STAI-S produce a harmful departure from linearity.

Linearity

Bivariate scatterplots of all combinations of the clinical variables within each experimental group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of curvilinearity. Despite the skewness present in the BDI-II and STAI-S variables there was no evidence that this skewness produced a harmful departure from linearity.

Homogeneity of Variance

While F_{max} was less than 10 for the STAI-S and STAI-T variables, F_{max} exceeded 10 for the BDI-II and PI variables. As the homogeneity of variance assumption was violated for the BDI-II and PI variables they were not included in the MANOVA. These two variables were examined separately using non-parametric statistics.

Multivariate outliers

As there were two variables included in the final MANOVA any case with a Mahalanobis Distance greater than X^2 (2) = 13.82 would be considered a multivariate outlier. With maximum values of 6.57 (OCD), 6.23 (panic disorder), 8.81 (sub-clinical OC) and 7.05 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of variance-covariance matrices

As the sample sizes are equal the robustness of the significance test is expected (Tabachnick & Fidell, 2001). The very conservative Box's M statistic was also not significant [X^2 (9) = 22.88, p = .01] confirming homogeneity of the variance-covariance matrices.

Multicollinearity

Multicollinearity was assessed using SPSS regression collinearity diagnostics. None of the dimensions had a condition index greater than 30 so the criteria for multicollinearity was not met (Belsley et al., 1980).

Appendix D

Data screening for Irregular object DMS task accuracy variables

Univariate outliers

To identify potential univariate outliers Z scores were calculated for each irregular object DMS task accuracy variable for the four experimental groups. One outlier was identified in the panic disorder group on the low demand/memory variable, the standardized score exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001). This case was deleted from the analysis.

Normality

The distribution of the irregular object DMS variables were evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. Slight skewness and kurtosis was observed in some of the irregular object DMS task variable distributions. The low demand/memory variable for the OCD group, the low demand/perception variable for the panic disorder group and the high demand/memory variable for the control group all exceeded two standard errors of skewness and kurtosis. The low demand/memory variable for the sub-clinical OC group also exceeded two standard errors of skewness. Inspection of the graphical data indicated that the departures from normality for these variables were not severe. However, before a decision was made to include the skewed variables in the ANOVA, bivariate scatterplots were investigated to establish whether the skewness of the variables produce a harmful departure from linearity.

Linearity

Scatterplots among each irregular object DMS task accuracy variables within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity. Despite the skewness present in some of the irregular object DMS accuracy variables there was no evidence that this skewness produced a harmful departure from linearity.

Multivariate outliers

As there are four variables any case with a Mahalanobis Distance greater than X^2 (4) = 18.47 would be considered a multivariate outlier. With maximum values of 11.44 (OCD), 9.50 (panic disorder), 8.30 (sub-clinical OC) and 11.57 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance

F_{max} did not exceed 10 for any of the irregular object DMS accuracy variables. Levene's test for equality of variance confirms no significant differences in the variance of low demand/perception trials [F(3,74) = 0.91, p = 0.44], low demand/memory trials [F(3,74) = 1.15, p = 0.34], high demand/perception trials [F(3,74) = .38, p = .77] and high demand/memory trials [F(3,74) = 2.01, p = .12] between the experimental groups.

Homogeneity of variance-covariance matrices

As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M with a significance criterion of .001. This statistic was not significant [X^2 (30) = 51.52, p = .009] confirming homogeneity of variance-covariance matrices.

Appendix E

Data screening for Irregular object DMS task reaction time variables

Univariate outliers

To identify potential univariate outliers Z scores were calculated for each reaction time variable for the four experimental groups. None of the standardized scores exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality

The distribution of the irregular object DMS reaction time variables were evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The high demand/perception reaction time variable exceed two standard errors of skewness and kurtosis for the healthy control group. Inspection of the graphical data confirmed that there were no serious departures from normality for this variable. However, before a decision was made to include the skewed variables in the ANOVA, bivariate scatterplots were investigated to establish whether the skewness of the variables produce a harmful departure from linearity.

Linearity

Scatterplots among each irregular object DMS task reaction time variable within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity. Despite the skewness present in the high demand/perception reaction time variable in the healthy control group there was no evidence that this skewness produced a harmful departure from linearity.

Multivariate outliers

As there are four variables any case with a Mahalanobis Distance greater than X^2 (4) = 18.47 would be considered a multivariate outlier. With maximum values of 10.54 (OCD), 6.56 (panic disorder), 9.00 (sub-clinical OC) and 8.74 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance

F_{max} did not exceed 10 for any of the irregular object DMS task reaction time variables. Levene's test for equality of variance confirmed there were no significant differences between groups in the variance of low demand/perception [F(3,75) = 0.64, p = 0.59], low demand/memory [F(3,75) = .11, p = .95], high demand/perception [F(3,75) = 1.21, p = .31] or high demand/memory variables [F(3,75) = 1.00, p = .40].

Homogeneity of variance-covariance matrices

As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M with a significance criterion of .001. This statistic was not significant [X^2 (30) = 28.13, p = .56] confirming homogeneity of variance-covariance matrices.

Appendix F

Data screening for spatial DMS task accuracy variables

Univariate outliers

To identify potential univariate outliers Z scores were calculated for each accuracy variable for the four experimental groups. One case in the sub-clinical OC group had a standardized score on the high demand/perception accuracy variable that exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001). This case was deleted from the analysis.

Normality

The distribution of the spatial DMS task accuracy variables were evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. Slight skewness and kurtosis was observed in some of the spatial accuracy variables however only the low demand/memory variable in the OCD group exceeded two standard errors of skewness and kurtosis. Inspection of the graphical data did not suggest that there was a severe departures from normality for this variable. Before a decision was made to include the skewed variable in the ANOVA, bivariate scatterplots were investigated to establish whether the skewness of the low demand/perception variable produces a harmful departure from linearity.

Linearity

Scatterplots among all accuracy variables within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity. Despite the skewness present in the low demand/perception accuracy variable there was no evidence that this skewness produced a harmful departure from linearity and therefore this variable was included in the ANOVA.

Multivariate outliers

As there are four variables any case with a Mahalanobis Distance greater than X^2 (4) = 18.47 would be considered a multivariate outlier. With maximum values of 13.04 (OCD), 8.79 (panic disorder), 11.62 (sub-clinical OC) and 11.63 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance

F_{max} did not exceed 10 for any of the spatial DMS task accuracy variables. Levene's test for equality of variance confirms no significant differences in the variance of low demand/perception trials [F(3,74) = 0.68, p = 0.57], low demand/memory trials [F(3,74) = .96, p = 0.42], high demand/perception trials [F(3,74) = 1.66, p = .18] or high demand/memory trials, [F(3,74) = .24, p = .87] between the experimental groups.

Homogeneity of variance-covariance matrices

As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M with a significance criterion of .001. This statistic was not significant [X^2 (30) = 35.67, p = .22] confirming homogeneity of variance-covariance matrices.

Appendix G

Data screening for spatial locations DMS task reaction time variables.

Univariate outliers
To identify potential univariate outliers Z scores were calculated for each reaction time variable for the four experimental groups. None of the standardized scores exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality
The distribution of the spatial locations DMS task reaction time variables were evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The reaction time variables did not exceed two standard errors of skewness and kurtosis for any of the experimental groups. Inspection of the graphical data confirmed that there were no severe departures from normality for these variables.

Linearity
Scatterplots among each spatial locations DMS task reaction time variable within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of curvilinearity.

Multivariate outliers
As there are four variables any case with a Mahalanobis Distance greater than X^2 (4) = 18.47 would be considered a multivariate outlier. With maximum values of 8.11 (OCD), 10.33 (panic disorder), 6.44 (sub-clinical OC) and 8.63 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance
F_{max} did not exceed 10 for any of the spatial DMS task reaction time variables. Levene's test for equality of variance confirmed there were no significant differences between groups in the variance of the low demand/perception [F(3,75) = .69, *p* = .56], high demand/perception [F(3,75) = 1.65, p = .18], low demand/memory [F(3,75) = 2.10, p = .11] or high demand/memory [F(3,75) = .13, p = .94] variables.

Homogeneity of variance-covariance matrices
As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M with a significance criterion of .001. This statistic was not significant [X^2 (30) = 17.65, p = .96] confirming homogeneity of variance-covariance matrices.

Appendix H

Data screening for geometric object DMS task accuracy variables

Univariate outliers
To identify potential univariate outliers Z scores were calculated for each accuracy variable for the four experimental groups. There were no variables that exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality
The distribution of the spatial DMS task accuracy variables were evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. None of the variables exceeded two standard errors of skewness and kurtosis. Inspection of the graphical data did not suggest that there was a severe departures from normality for these variables.

Linearity
Scatterplots among all accuracy variables within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity.

Multivariate outliers
As there are four variables any case with a Mahalanobis Distance greater than X^2 (4) = 18.47 would be considered a multivariate outlier. With maximum values of 9.50 (OCD), 7.69 (panic disorder), 8.83 (sub-clinical OC) and 14.20 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance
F_{max} did not exceed 10 for any of the geometric object DMS task accuracy variables. Levene's test for equality of variance confirms that there were no significant differences in the variance of low demand/perception trials [F(3,75) = 1.86, p = 0.14], low demand/memory trials [F(3,75) = .74, p = 0.53], high demand/perception trials [F(3,75) = 1.19, p = .32] or high demand/memory trials [F(3,75) = .77, p = .41] between the experimental groups.

Homogeneity of variance-covariance matrices
As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M test with a significance criterion of .001. This statistic was not significant [X^2 (30) = 31.21, p = .41] confirming homogeneity of variance-covariance matrices.

Appendix I

Data screening for geometric object DMS task reaction time variables

Univariate outliers

To identify potential univariate outliers Z scores were calculated for overall reaction time for the four experimental groups. One of the panic disorder patients had a standardised score that exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001). This case was deleted from the analysis.

Normality

The distribution of the geometric object DMS task reaction time variables was evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The high demand/memory variable for the panic disorder group exceeded two standard errors of skewness and kurtosis and the high demand/perception variable exceeded two standard errors of skewness for the healthy control group. Inspection of the graphical data did not suggest that there were any severe departures from normality for these variables. However before a decision was made to include the skewed variables in the ANOVA bivariate scatterplots were investigated to establish whether the skewness produced a harmful departure from linearity.

Linearity

Scatterplots among all reaction time variables within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity. Despite the skewness present in the high demand/memory and the high/demand/perception variables there was no evidence that this skewness produced a harmful departure from linearity and therefore these variables were included in the ANOVA.

Multivariate outliers

As there are four variables any case with a Mahalanobis Distance greater than X^2 (4) = 18.47 would be considered a multivariate outlier. With maximum values of 8.04 (OCD), 8.74 (panic disorder), 7.63 (sub-clinical OC) and 14.20 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance

F_{max} did not exceed 10 for any of the geometric object DMS task reaction time variables. Levene's test for equality of variance confirmed there was no significant difference between groups in the variance of the low demand/perception [F(3,74) = 1.63, *p* = .19], low demand/memory [F(3,74) = .22, p = .88], high demand/perception [F(3,74) = .58, p = .63] or high demand/memory variables [F(3,74) = .21, p = .89].

Homogeneity of variance-covariance matrices

As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M with a significance criterion of .001. This statistic was not significant [X^2 (30) = 34.43, p = .26] confirming homogeneity of variance-covariance matrices.

Appendix J

Data screening for verbal n-back task variables (2-back and 3-back)

Univariate outliers

To identify potential univariate outliers Z scores were calculated for each accuracy variable for the four experimental groups. There were no variables that exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality

The distribution of the verbal n-back task accuracy variables was evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The verbal 2-back variable in the OCD group exceeded two standard errors of skewness while the verbal 2-back variable in the sub-clinical group and the verbal 3-back variable in the panic disorder group exceeded two standard errors of both skewness and kurtosis. Inspection of the graphical data did not suggest that departures from normality were severe for these variables. However, before a decision was made to include the skewed variable in a MANOVA, bivariate scatterplots were investigated to establish whether the skewness of the verbal n-back variables produced a harmful departure from linearity.

Linearity

Bivariate scatterplots among both n-back accuracy variables within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity.

Multivariate outliers

As there are two variables any case with a Mahalanobis Distance greater than X^2 (2) = 13.82 would be considered a multivariate outlier. With maximum values of 6.18 (OCD), 8.85 (panic disorder), 8.60 (sub-clinical OC) and 7.45 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance

F_{max} did not exceed 10 for either of the verbal n-back variables. Despite Levene's test for equality of variance reporting significant differences in the variance of the verbal 2-back variable [$F(3,74) = 3.09$, $p = 0.03$], and the verbal 3-back variable [$F(3,74) = 4.59$, $p = 0.005$] the assumption of homogeneity of variance is not considered to be violated.

Homogeneity of variance-covariance matrices

As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M test with a significance criterion of .001. This statistic was not significant [X^2 (9) = 17.52, p = .041] confirming homogeneity of variance-covariance matrices.

Multicollinearity

Multicollinearity was assessed using SPSS regression collinearity diagnostics. No dimension had a condition index greater than 30 so the criteria for multicollinearity was not met (Belsley et al., 1980).

Appendix K

Data screening for verbal n-back reaction time variable

Univariate outliers

To identify potential univariate outliers Z scores were calculated for overall reaction time for the four experimental groups. None of the standardized scores exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality

The distribution of the verbal n-back task reaction time variable was evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The reaction time variable marginally exceeded two standard errors of skewness in the panic disorder group. Inspection of the graphical data did not suggest that there were any severe departures from normality for this variable.

Homogeneity of Variance

F_{max} did not exceed 10 for the verbal n-back task reaction time variable. Levene's test for equality of variance confirmed there was no significant difference between groups in the variance of overall reaction time [$F(3,74) = .29$, $p = 0.83$]

Appendix L

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Data screening for spatial n-back task variables (2-back and 3-back)

Univariate outliers

To identify potential univariate outliers Z scores were calculated for each accuracy variable for the four experimental groups. There were no variables that exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality

The distribution of the spatial n-back accuracy variables was evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The spatial 2-back variables in the OCD, panic disorder and sub-clinical OC group exceeded two standard errors of skewness while the spatial 2-back variable in the sub-clinical group also exceeded two standard errors of kurtosis. Inspection of the graphical data did not suggest that there was a severe departures from normality for these variables. However, before a decision was made to include the skewed variable in a MANOVA, bivariate scatterplots were investigated to establish whether the skewness of the spatial n-back accuracy variables produced a harmful departure from linearity.

Linearity

Bivariate scatterplots among both spatial n-back accuracy variables within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity.

Multivariate outliers

As there are two variables any case with a Mahalanobis Distance greater than X^2 (2) = 13.82 would be considered a multivariate outlier. With maximum values of 5.63 (OCD), 7.31 (panic disorder), 11.22 (sub-clinical OC) and 11.48 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance

F_{max} did not exceed 10 for either of the spatial n-back accuracy variables. Despite Levene's test for equality of variance reporting no significant differences in the variance of spatial 2-back trials [F(3,74) = 1.41, p = 0.25] but significant differences in the variance of the spatial 3-back trials [F(3,74) = 5.57, p = 0.002] the assumption of homogeneity of variance is not considered to be violated.

Homogeneity of variance-covariance matrices

As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M test with a significance criterion of .001. This statistic was not significant [X^2 (9) = 25.10, p = .003] confirming homogeneity of variance-covariance matrices.

Multicollinearity

Multicollinearity was assessed using SPSS regression collinearity diagnostics. No dimension had a condition index greater than 30 so the criteria for multicollinearity was not met (Belsley et al., 1980).

Appendix M

Data screening for spatial n-back reaction time variable.

Univariate outliers

To identify potential univariate outliers Z scores were calculated for overall reaction time for the four experimental groups. None of the standardized scores exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality

The distribution of the spatial n-back task reaction time variable was evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The reaction time variable slightly exceeded two standard errors of skewness in the panic disorder group. Inspection of the graphical data did not suggest that there were any severe departures from normality for this variable.

Homogeneity of Variance

F_{max} did not exceed 10 for the spatial n-back task reaction time variable. Levene's test for equality of variance confirmed there was no significant difference between groups in the variance of overall reaction time [$F(3,74) = .10$, $p = 0.96$].

Appendix N

Data screening for NEO PI-R domain variables

Univariate outliers

To identify potential univariate outliers Z scores were calculated for each NEO PI-R variable for the four experimental groups. There were no variables that exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality

The distribution of the NEO PI-R domain variables were evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The Agreeableness variable in the sub-clinical OC group exceeded two standard errors of skewness and the Neuroticism variable in the healthy control group exceeded two standard errors of skewness and kurtosis. Inspection of the graphical data did not suggest that there was a severe departures from normality for these variables. However, before a decision was made to include the skewed variable in a MANOVA, bivariate scatterplots were investigated to establish whether the skewness of the two variables produced a harmful departure from linearity.

Linearity

Bivariate scatterplots among all the NEO PI-R domain variables within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity. Despite the skewness present in some of the NEO PI-R domain variables there was no evidence that this skewness produced a harmful departure from linearity.

Multivariate outliers

As there are five NEO PI-R domain variables any case with a Mahalanobis Distance greater than X^2 (5) = 20.52 would be considered a multivariate outlier. With maximum values of 10.87 (OCD), 9.43 (panic disorder), 10.40 (sub-clinical OC) and 10.91 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance

F_{max} did not exceed 10 for any of the NEO PI-R domain variables. Despite Levene's test for equality of variance reporting a significant differences in the variance of Extraversion [F(3,73) = 3.08, $p < .05$] and Openness [F(3,73) = 4.54, $p < .01$] the assumption of homogeneity of variance is not considered to be violated.

Homogeneity of variance-covariance matrices

As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M test with a significance criterion of .001. This statistic was not significant [X^2 (45) = 69.06, p = .012] confirming homogeneity of variance-covariance matrices.

Multicollinearity

Multicollinearity was assessed using SPSS regression collinearity diagnostics. One dimension had a condition index greater than 30 but only one variable associated with this dimension had a variance proportion greater than .50 so the criteria for multicollinearity was not met (Belsley et al., 1980).

Appendix O

Data screening for Neuroticism facet variables

Univariate outliers
To identify potential univariate outliers Z scores were calculated for each accuracy variable for the four experimental groups. There were no variables that exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality
The distribution of the Neuroticism variables were evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The depression variable in the OCD group and the anxiety variable in the panic disorder group both exceeded two standard errors of skewness and kurtosis. Inspection of the graphical data did not suggest that there was a severe departures from normality for these variables. However, before a decision was made to include the skewed variable in a MANOVA, bivariate scatterplots were investigated to establish whether the skewness of the two variables produced a harmful departure from linearity.

Linearity
Bivariate scatterplots among all Neuroticism variables within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity.

Multivariate outliers
As there are six Neuroticism variables any case with a Mahalanobis Distance greater than X^2 (6) = 22.46 would be considered a multivariate outlier. With maximum values of 12.84 (OCD), 12.17 (panic disorder), 10.79 (sub-clinical OC) and 12.53 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance
F_{max} did not exceed 10 for any of the Neuroticism variables. Despite Levene's test for equality of variance reporting a significant differences in the variance of angry hostility [F(3,73) = 2.85, p = 0.04] the assumption of homogeneity of variance is not considered to be violated.

Homogeneity of variance-covariance matrices
As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M test with a significance criterion of .001. This statistic was not significant [X^2 (63) = 92.67, p = .009] confirming homogeneity of variance-covariance matrices.

Multicollinearity
Multicollinearity was assessed using SPSS regression collinearity diagnostics. No dimension had a condition index greater than 30 so the criteria for multicollinearity was not met (Belsley et al., 1980).

Appendix P

Data screening for Extraversion facet variables

Univariate outliers
To identify potential univariate outliers Z scores were calculated for each accuracy variable for the four experimental groups. There were no variables that exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality
The distribution of the Extraversion variables was still evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The assertiveness variable in the control group was the only variable that exceeded two standard errors of skewness and kurtosis. Inspection of the graphical data did not suggest that there was a severe departures from normality for this variable. However, before a decision was made to include the skewed variable in a MANOVA, bivariate scatterplots were investigated to establish whether the skewness of the assertiveness variable produced a harmful departure from linearity.

Linearity
Bivariate scatterplots among all Extraversion variables within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity.

Multivariate outliers
As there are six Extraversion variables any case with a Mahalanobis Distance greater than X^2 (6) = 22.46 would be considered a multivariate outlier. With maximum values of 12.64 (OCD), 9.38 (panic disorder), 10.37 (sub-clinical OC) and 12.85 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance
F_{max} did not exceed 10 for any of the Extraversion variables. Levene's test for equality of variance confirmed no differences in the variance of warmth, [F(3,73) = 1.28, p = .29], gregariousness, [F(3,73) = 2.71, p = .05], assertiveness, [F(3,73) = 2.15, p = .10], activity, [F(3,73) = 1.17, p = .33], excitement seeking, [F (3,73) = .05, p = .98] and positive emotions, [F (3,73) = 1.06, p = .37].

Homogeneity of variance-covariance matrices
As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M test with a significance criterion of .001. This statistic was not significant [X^2 (63) = 82.83, p = .05] confirming homogeneity of variance-covariance matrices.

Multicollinearity
Multicollinearity was assessed using SPSS regression collinearity diagnostics. No dimension had a condition index greater than 30 so the criteria for multicollinearity was not met (Belsley et al., 1980).

Appendix Q

Data screening for Openness facet variables

Univariate outliers
To identify potential univariate outliers Z scores were calculated for each accuracy variable for the four experimental groups. There were no variables that exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality
The distribution of the Openness variables was evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The aesthetics variable in the OCD group and the feelings variable in the sub-clinical group exceeded two standard errors of skewness. The actions variable in the OCD group exceeded two standard errors of skewness and kurtosis. Inspection of the graphical data did not suggest that there was a severe departures from normality for this variable. However, before a decision was made to include the skewed variables in a MANOVA, bivariate scatterplots were investigated to establish whether the skewness of the Openness variables produced a harmful departure from linearity.

Linearity
Bivariate scatterplots among all Openness variables within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity.

Multivariate outliers
As there are six variables any case with a Mahalanobis Distance greater than X^2 (6) = 22.46 would be considered a multivariate outlier. With maximum values of 9.39 (OCD), 11.53 (panic disorder), 11.21 (sub-clinical OC) and 10.42 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance
F_{max} did not exceed 10 for any of the Openness variables. Levene's test for equality of variance confirmed no differences in the variance of fantasy [F(3,73) = 1.11, p = .35], feelings [F(3,73) = 2.28, p = .09], actions [F(3,73) = .84, p = .48], values [F(3,73) = .27, p = .85]. While Levene's test is significant for aesthetics [F (3,73) = 3.85, p = .013] and ideas [F (3,73) = 3.30, p = .025], this was not considered to be a violation of the assumption.

Homogeneity of variance-covariance matrices
As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M test with a significance criterion of .001. This statistic was not significant [X^2 (63) = 67.19, p = .34] confirming homogeneity of variance-covariance matrices.

Multicollinearity
Multicollinearity was assessed using SPSS regression collinearity diagnostics. No dimension had a condition index greater than 30 so the criteria for multicollinearity was not met (Belsley et al., 1980).

Appendix R

Data screening for Agreeableness facet variables

Univariate outliers
To identify potential univariate outliers Z scores were calculated for each accuracy variable for the four experimental groups. There were no variables that exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality
The distribution of the Agreeableness variables were evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The tendermindedness variable in the sub-clinical group exceeded two standard errors of skewness and kurtosis. Inspection of the graphical data did not suggest that there was a severe departures from normality for this variable. However, before a decision was made to include the skewed variable in a MANOVA, bivariate scatterplots were investigated to establish whether the skewness of the tendermindedness variable produced a harmful departure from linearity.

Linearity
Bivariate scatterplots among all Agreeableness variables within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity.

Multivariate outliers
As there are six variables any case with a Mahalanobis Distance greater than X^2 (6) = 22.46 would be considered a multivariate outlier. With maximum values of 9.72 (OCD), 11.09 (panic disorder), 13.16 (sub-clinical OC) and 11.31 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance
F_{max} did not exceed 10 for any of the Agreeableness variables. Levene's test for equality of variance confirmed no differences in the variance of trust [F(3,73) = 1.33, p = .27], straightforwardness [F(3,73) = .46, p = .71], altruism [F(3,73) = .97, p = .41], compliance [F(3,73) = 2.24, p = .09], modesty [F (3,73) = 1.62, p = .19] and tendermindedness [F (3,73) = 1.28, p = .29].

Homogeneity of variance-covariance matrices
As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M test with a significance criterion of .001. This statistic was not significant [X^2 (63) = 81.49, p = .06] confirming homogeneity of variance-covariance matrices.

Multicollinearity
Multicollinearity was assessed using SPSS regression collinearity diagnostics. No dimension had a condition index greater than 30 so the criteria for multicollinearity was not met (Belsley et al., 1980).

Appendix S

Data screening for Conscientiousness facet variables

Univariate outliers
To identify potential univariate outliers Z scores were calculated for each accuracy variable for the four experimental groups. There were no variables that exceeded the α = .001 criterion of 3.29 for a two-tailed test (Tabachnick & Fidell, 2001).

Normality
The distribution of the Conscientiousness variables was evaluated for skewness and kurtosis using distribution statistics and expected normal probability plots. The order variable in the OCD group and the deliberation variable in the sub-clinical group exceeded two standard errors of skewness and the order variable in the sub-clinical group exceeded two standard errors of skewness and kurtosis. Inspection of the graphical data did not suggest that there was a severe departure from normality for this variable. However, before a decision was made to include the skewed variables in a MANOVA, bivariate scatterplots were investigated to establish whether the skewness of the Conscientiousness variables produced a harmful departure from linearity.

Linearity
Scatterplots among all Conscientiousness variables within each group were inspected for signs of non-linearity. Inspection of these plots suggested no evidence of true curvilinearity.

Multivariate outliers
As there are six Conscientiousness variables any case with a Mahalanobis Distance greater than X^2 (6) = 22.46 would be considered a multivariate outlier. With maximum values of 10.52 (OCD), 10.40 (panic disorder), 10.76 (sub-clinical OC) and 11.17 (controls) all below the critical level there was no suggestion of the presence of any multivariate outliers.

Homogeneity of Variance
F_{max} did not exceed 10 for any of the Conscientiousness variables. Levene's test for equality of variance confirmed no differences in the variance of competence [F(3,73) = .34, p = .80], order [F(3,73) = .51, p = .68], dutifulness [F(3,73) = .03, p = .99], achievement striving [F(3,73) = 1.25, p = .30] and deliberation [F(3,73) = 1.55, p = .21]. While Levene's statistic was significant for self-discipline [F(3,73) = 3.64, p = .02], this was not considered to be a violation of the assumption.

Homogeneity of variance-covariance matrices
As there are unequal sample sizes homogeneity of variance-covariance was assessed using Box's M test with a significance criterion of .001. This statistic was not significant [X^2(63) = 69.53, p = .27] confirming homogeneity of variance-covariance matrices.

Multicollinearity
Multicollinearity was assessed using SPSS regression collinearity diagnostics. No dimension had a condition index greater than 30 so the criteria for multicollinearity was not met (Belsley et al., 1980).