Circadian Rest/activity Rhythms as Predictors of Mood in a Small Sample of Outpatients with Bipolar Disorder

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Abstract

Circadian rhythm disturbance is believed to play a role in the pathogenesis of bipolar disorder. The aim of the current pilot study was to investigate the clinically significant hypothesis that the circadian activity rhythm may be associated with daily mood in bipolar disorder. It was hypothesized that decreased amplitude of the circadian activity rhythm would be associated with lower ed mood. Six outpatients diagnosed with bipolar disorder were followed prospectively for between 63 and 177 consecutive days. The 24-hour rest/activity rhythm was measured continuously using actigraphy and participants rated their mood daily via a validated software interface (ChronoRecord). Concomitant time series analysis between input (amplitude of the rest/activity rhythm) and output (mood) series’ using the Box-Jenkins ARIMA methodology found predicted positive associations between the two series’ in each case, although the association reached significance in only one time series. The clinical significance of this trend is discussed.

Bipolar disorder (BD) is a chronic mental illness characterized by recurrent episodes of mania and depression. Twelve month community prevalence rates are reported to be approximately 1% (Goodwin & Jamison, 2007), although this figure may be higher depending on the diagnostic criteria used (e.g., Merikangas et al., 2007). BD ranks 6th amongst the leading 10 causes of disability in young people (15 - 44 years old) worldwide (Kleinman, Lowin, Flood, Gandhi, Edgell & Revicki, 2003) and is a significant financial burden, with yearly costs to Australian society approaching $5 billion (Fisher, Goldney, Grande, Taylor, & Hawthorne, 2007).

The genetic contribution to BD-vulnerability is strong (Goodwin & Jamison, 2007). However, the complexities of gene-to-gene interactions involved in BD pathophysiology are such that precise determination of genetic liability and chromosomal loci has proven elusive. These inherent complexities associated with BD genotyping have led necessarily to the search for biological traits that ‘mediate the gap’ between genotypic vulnerability and phenotypic manifestation of disorder states. One such trait that has received considerable research attention as a vulnerability marker for BD is a dysfunctional circadian system.

Circadian rhythms originate from the suprachiasmatic nuclei (SCN) in mammals (Reppert & Weaver, 2002) and can be observed in hundreds of biological and behavioural processes. Mood disorders appear to be particularly strongly associated with disturbed circadian rhythmicity (McClung, 2007).

There are strong reasons to suspect that circadian dysfunction plays a key role in vulnerability to BD. Firstly, dysfunctional neurobiological mechanisms assumed to underlie BD pathophysiology (e.g., the hypothalamic-pituitary-adrenal axis and the serotonergic system) are functionally connected to the endogenous circadian system (Mistlberger, Antle, Glass, & Miller, 2000). Secondly, mania and depression are associated with sleep/wake cycle disruptions (Lamont, Legault-Coutu, Cermakian, & Boivin, 2007), and diurnal variation of mood is a common feature of mood episodes (Feldman-Naim, Turner, & Leibenluft, 1997). Finally, many efficacious treatments for mania and depression typically improve circadian rhythm stabilization (McClung, 2007). While the evidence for a role for circadian disturbance is clear, the precise mechanism of disturbance is unknown.

Four hypotheses have been proposed to describe the mechanism of circadian disturbance in BD (Goodwin & Jamison, 2007); i) Desynchrony between the endogenous circadian rhythm and the sleep/wake process, possibly caused by a fast-running (<24-hour) internal clock, ii) Phase advance of the endogenous rhythm relative to the sleep/wake pattern, iii) Phase instability across days, iv) Reduced amplitude of the circadian oscillator. On balance, the amplitude
The higher vulnerability group exhibited... conclusion the final common pathway to mania (Wehr & Wirz-Justice, 1982). Following this reasoning, treatment guidelines encourage self-monitoring of activity and sleep as critical in relapse prevention (Miklowitz, Goodwin, Bauer, & Geddes, 2008). The present study was designed as a pilot investigation of the novel prediction that clinically significant information can be derived from the 24-h rhythm in locomotor activity, an automated measure of sleep/wake and circadian function that does not rely on patient insight.

The diurnal pattern in wrist activity is a robust marker of the sleep/wake cycle, from which circadian rhythm parameters can be inferred (Ancoli-Israel, Cole, Alessi, Chambers, Morcroft & Pollack, 2003). Moreover, a number of studies have shown that disruption to the circadian pattern in wrist activity may occur during manic and depressive states (e.g., Salvatore et al., 2008). These disruptions may continue during euthymic periods (e.g., Jones, Hare, & Evershed, 2005). Consistent with the attenuated amplitude hypothesis, reduced amplitude and greater variability in rest/activity rhythms were the strongest predictors of mood disorder in these studies. Similarly, Murray, Bullock, and Van Someren (in preparation) demonstrated significant differences in the rest/activity rhythms of two groups of university students separated on the basis of a validated self-report measure of BD vulnerability (Depue, Krauss, Spoon, & Arbisi, 1989). Specifically, the higher vulnerability group exhibited significantly reduced mean amplitude compared to the lower vulnerability group, providing a proof of concept for the present study.

Dysregulation of the circadian pattern in rest/activity rhythms appears to be associated with BD and related pathological mood states. The relationship between rest/activity rhythms and daily mood variation is less clearly defined. The aim of the current study was to investigate the longitudinal relationship between rest/activity rhythm amplitude and daily mood in a BD outpatient sample using time series analysis. It was expected that higher rest/activity rhythm amplitude would be associated with improved mood on the same day. Lag and lead relationships between predictor and dependent variables were also explored, but in the absence of direction from the literature no specific predictions were made.

Method

Participants
Six participants (two Male, four Female) were recruited through an outpatient health care group in regional Victoria. Eligibility to participate in the study was subject to the following minimum requirements, intended to limit measurement confounds:

- primary diagnosis of Bipolar I disorder with no significant comorbidity;
- not currently working shiftwork;
- absence of a physical disability that may interfere with recording of ambulatory wrist movement.

To ensure informed consent was adequately obtained participants were also required to be euthymic at the commencement of the study.

Participants were asked to commit to the study for a period of 12 months. They were paid $20 for participation in the screening phase and a further $20 upon completion of the baseline questionnaire if they were accepted into the study proper.

Materials

Longitudinal monitoring of the key dependent variable (Mood) was achieved using the ChronoRecord software package (Bauer et al., 2004), a retrospective log of 24-hour mood, sleep, life events, and medications entered daily by the user. Daily mood is recorded on a 100-unit VAS with user-defined extremes of mania and depression anchoring each end point. A score of 50 is considered homeostatic (‘usual’) mood. The software has demonstrated concurrent validity with the Hamilton Depression Rating Scale in a BD outpatient sample (Bauer, Grof, Gyulai, Rasgon, Glenn & Whybrow, 2004). Scores above 60 indicate mild-to-severe mania and scores below 40 indicate mild-to-severe depression. Clinical mood episodes can be identified using ChronoRecord. Seven consecutive days of mood ratings predominantly above 60 indicate mania, and 14 consecutive days of mood ratings predominantly below 40 indicate depression.

Actigraphy is a non-intrusive measure of the sleep/wake rhythm in humans (Ancoli-Israel et al., 2003). It is particularly useful for naturalistic studies where more data intensive sleep monitoring tools (e.g., polysomnography) are impractical. Actigraphy has been previously validated in a range of populations, including clinical and non-clinical samples (see Ancoli-Israel et al., 2003 for review). The actigraph employed in the present study was the Mini-Mitter Mitter
worn on participants’ non-dominant hand. Activity data was recorded in 1-minute epochs and analysed using the Actiware 5.0 software program.

**Procedure**

Investigators approached outpatient case managers to promote the study and to assist in disseminating study information to their clients. Case managed clients who were interested in participating contacted the investigators and invited to a screening interview. At the initial meeting, potential participants completed a validated diagnostic screening instrument, the Composite International Diagnostic Interview – participant version (CIDI-Auto; Robins et al., 1988), as well as the requisite consent forms. After consent was obtained, participants were trained in the use of ChronoRecord and the actigraph. Data was uploaded from the actiwatch fortnightly throughout the study. At the end of data collection, participants underwent a debriefing interview at which their views of the protocol were sought.

**Data Preparation and Analysis**

Actigraph records were screened for missing and spurious data. If sufficient data were deemed to be missing, the entire 24-hour period was excluded from the analysis, as recommended by Van Someren et al. (1999). Excluded periods were not replaced, and resulted in the shortening of the eligible data series for one participant.

The predictor variable of interest was the amplitude of the activity rhythm operationalised using Van Someren’s measure Relative Amplitude (RA; Van Someren, Swaab, Colenda, Cohen, McCall & Rosenquist, 1999). This non-parametric method of amplitude computation is simply the difference between the most active 10 hours of the 24-hour period and the least active 5 hours, relative to total activity.

ChronoRecord mood records were screened for missing data. Four participants had missing days in their mood records, ranging from 1.0% to 6.2% of total eligible days. To ensure a continuous data series for meaningful time-series analysis, missing data were replaced using the Maximum Likelihood Estimation technique.

ChronoRecord mood records and individual case files were also screened for manic episodes using criteria described by Bauer et al. (2004). There was no evidence of full-blown manic episodes in any participant’s data (i.e. no 7 day periods of scores above 60). Upwards movement of mood could therefore be assumed to represent improved mood in the euthymic, non-pathological range.

Autoregressive integrated moving average (ARIMA) analysis was used to ‘pre-whiten’ individual data series’ where this was deemed necessary. ‘Pre-whitening’ reduces the influence of serial dependency, trends, and random shocks (AR, I, and MA, respectively) that can produce spurious relationships in multivariate time series analysis (Box, Jenkins, & Reinsel, 1994). Inspection of the autocorrelation function correlogram revealed that all data series’ but one were white noise and required no ARIMA filtering. The RA data series for Participant F showed a spike at lag 4 in the autocorrelation function correlogram. An MA(4) filter produced white noise residuals for this series which were used for cross-correlation with the Mood series.

The Cross-Correlation Function (CCF) was used to assess the magnitude of lagged relationships between pre-whitened concomitant time series’ (RA was presumed to be the causal series, and Mood was presumed to be the effect series). In the CCF this was expected to be reflected in a significant synchronous association (lag 0) between the variables or at lags up to a maximum of 2 days.

**Results**

Long-term actigraphic recording was found to be acceptable to participants, with no reports of significant difficulty with the protocol. The length of time series for analysis after replacement of missing mood values was as follows: Participant A: 177 days, B: 111 days, C: 158 days, D: 129 days, E: 114 days, and F: 63 days. Descriptive statistics for individuals’ daily actigraph and ChronoRecord data are presented in Table 1.

Table 1 shows that the average activity level per minute varied substantially between participants, as did the average amplitude. Mean mood for the majority of participants is approximately 50, the euthymic midpoint. Mean mood for Participant F however was 39, indicating a mildly depressive mood course for this participant.

As shown in Table 2, positive associations were found between RA and Mood at zero lag for all participants, suggesting a trend for increased amplitude of the rest/activity rhythm to be associated with higher mood on that day. However, this association was only significant for one of six participants.

Table 2 also shows the lag at which the maximum cross-correlation occurred for each participant. For three of six participants, the maximum lag was significant. For one of these three (Participant A), changes in the rest/activity rhythm led mood by one day, for Participant B, the rest/activity rhythm followed mood and for Participant D the maximum correlation was at zero lag.
The aim of this pilot study was to test the novel hypothesis that actigraphy could provide clinically significant information about changes in circadian rhythms in a BD sample, specifically, that there would be an association between amplitude of circadian activity rhythm and daily mood. Long-term actigraphic measurement of circadian activity rhythm was found to be viable in the sample, a finding which is likely to generalize to the BD population. Across participants, the predicted zero-order relationship between mood scores and the amplitude of the rest/activity rhythm was in the expected direction, but weak. The direction of the zero-order correlation between the two series’ was positive for all participants, but statistically significant in only one case. Exploration of other lags and leads did not find a systematic pattern across participants – maximal cross-correlations were significant in three cases, one showing mood to precede circadian activity rhythm, one the inverse and one a zero-order maximal correlation.

The overarching aim of this pilot study was to investigate the possibility that a circadian parameter derived from actigraphy might provide useful clinical information for patients with BD – do the results support such a conclusion? A trend was found for increased amplitude of the circadian activity rhythm to be associated with improved mood at zero lag, and in one case the association was of moderate effect size. Similarly, in one of six participants a circadian activity rhythm significantly predicted daily mood (lag of -1). It can be concluded that there is not a strong relationship between the circadian rhythm in activity and daily mood in BD. The present data also suggest, however, that the relationship may be significant in a minority of patients. Given the potential clinical utility of such an association (even if it exists in only 16% of cases), we believe further investigation is warranted.

A larger sample and a longer duration of sampling is required to test whether a proportion of BD patients show the pattern found in one sixth of this pilot sample, and to identify predictors of this clinically useful covariation. The association between circadian activity rhythm and mood may also become stronger when clinically significant changes in mood (which were not seen here) are tracked.

Limitations

The study had a number of limitations. Firstly, the sample was small, and highlights the difficulties associated with recruiting and retaining participants with BD in longitudinal studies. Secondly, although SCN output partly determines the 24-h activity rhythm, the circadian component of the signal is impossible to separate from masking factors. The present data therefore do not constitute a test of the circadian amplitude hypothesis of BD, and monitoring of more direct circadian output parameters (e.g., core body temperature, melatonin) in parallel with actigraphy may help produce a more accurate estimate of the circadian output signal. Finally, pharmacological prophylaxis was not controlled in the present study. All participants were taking regular mood-stabilizing medications (e.g.,

### Table 1: Means and Standard Deviations for Daily Actigraph and ChronoRecord Data.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Activity</th>
<th>Amplitude</th>
<th>RA</th>
<th>Mood</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>149.45</td>
<td>263.75</td>
<td>0.94</td>
<td>45.24</td>
</tr>
<tr>
<td></td>
<td>(33.11)</td>
<td>(57.92)</td>
<td>(0.04)</td>
<td>(15.02)</td>
</tr>
<tr>
<td>B</td>
<td>294.96</td>
<td>519.91</td>
<td>0.93</td>
<td>52.52</td>
</tr>
<tr>
<td></td>
<td>(102.61)</td>
<td>(175.28)</td>
<td>(0.04)</td>
<td>(6.35)</td>
</tr>
<tr>
<td>C</td>
<td>136.33</td>
<td>263.12</td>
<td>0.94</td>
<td>46.34</td>
</tr>
<tr>
<td></td>
<td>(33.56)</td>
<td>(72.41)</td>
<td>(0.03)</td>
<td>(6.16)</td>
</tr>
<tr>
<td>D</td>
<td>133.26</td>
<td>236.67</td>
<td>0.90</td>
<td>49.53</td>
</tr>
<tr>
<td></td>
<td>(42.43)</td>
<td>(75.85)</td>
<td>(0.04)</td>
<td>(0.93)</td>
</tr>
<tr>
<td>E</td>
<td>274.96</td>
<td>470.96</td>
<td>0.94</td>
<td>50.71</td>
</tr>
<tr>
<td></td>
<td>(67.04)</td>
<td>(124.65)</td>
<td>(0.04)</td>
<td>(11.93)</td>
</tr>
<tr>
<td>F</td>
<td>86.60</td>
<td>143.76</td>
<td>0.93</td>
<td>39.00</td>
</tr>
<tr>
<td></td>
<td>(18.20)</td>
<td>(38.53)</td>
<td>(0.07)</td>
<td>(20.41)</td>
</tr>
</tbody>
</table>

Note. Activity = mean activity level per minute; Amplitude = raw (non-sinusoidal) amplitude; RA = relative amplitude; Mood = raw ChronoRecord mood rating. Standard deviations are presented in parentheses.

### Table 2: Cross-Correlation Coefficients between RA and Mood.

<table>
<thead>
<tr>
<th>Participant</th>
<th>RA x Mood</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zero-order</td>
</tr>
<tr>
<td>A</td>
<td>.15</td>
</tr>
<tr>
<td>B</td>
<td>.14</td>
</tr>
<tr>
<td>C</td>
<td>.06</td>
</tr>
<tr>
<td>D</td>
<td>.34*</td>
</tr>
<tr>
<td>E</td>
<td>.16</td>
</tr>
<tr>
<td>F</td>
<td>.07</td>
</tr>
</tbody>
</table>

Note. Mood = raw ChronoRecord mood rating; RA = relative amplitude of the rest/activity rhythm. *p < .05

### Discussion

The aim of this pilot study was to test the novel hypothesis that actigraphy could provide clinically significant information about changes in circadian rhythms in a BD sample, specifically, that there would be an association between amplitude of circadian activity rhythm and daily mood. Long-term actigraphic measurement of circadian activity rhythm was found to
lithium, valproate), some of which have demonstrated effects on the circadian system (McClung, 2007). Drug-free patients with BD are preferable in studies of the circadian system, although this is impractical and potentially unethical.

Conclusions and Future Directions

The findings of this pilot study suggest that actigraphy meets the requirement of a feasible long-term measure of the circadian activity rhythm in BD. However, compelling evidence for an association between rest/activity rhythm amplitude and daily mood in BD patients was not found. Nonetheless, it remains possible that the association is significant in a minority of patients, a prospect that warrants further investigation because of its clinical significance.

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References


What Makes a Happy Cop?
Longitudinal Predictors of Police Officer Well-being

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Abstract
There is a predominant belief within both scientific and lay populations that policing is a stressful occupation, by virtue of officers’ exposure to stressful and traumatic events. However, much of the research conducted with police personnel fails to consider the role of the organisation in facilitating and maintaining employee well-being. Furthermore, it is now widely argued that individual factors (e.g., personality) have a differential impact on responses to stressful and traumatising events. This paper presents an overview of changes in stress and coping as officers move from recruits to the completion of their probation (a period of 20 months), and is a small portion of data from a multi-method longitudinal study of police officer well-being. In the larger study changes in stress and satisfaction were charted and the implications of prior traumatic experience/s, personality and coping in response to occupational experiences were examined.

Predicting Police Officer Well-being
Policing has experienced many changes in the past two decades, and is increasingly coming to resemble a business more than just a law enforcement agency (Fielding, 2001; Watson, 2006). There has been an increased focus on quality of service and performance accountability similar to that seen in other public service professions (Noblet, Teo, McWilliams & Rodwell, 2005). As such, the role of police is now far more complex (Silva, 2005). Despite these role changes and increased job complexity, the structure of the police force still remains rigidly hierarchical, with employees who are readily identifiable, and whom often see human nature at its worst (Fielding, 2000).

Policing brings with it a unique set of stressors and has long been considered to be one of the most stressful professions which one can be involved in, and many studies attest to the ‘stressful’ nature of the profession (see Abdollahi, 2002 for an overview). However, much of the evidence of the stressful nature of the police profession has relied on examining the experiences officers face operationally, and their characterisation as exposures to stressful and/or traumatic events (e.g., Brown, Cooper & Kirkaldy, 1996; Kohan & Mazmanian, 2003).

While public perception of the occupational roles of the police and other emergency services professions imply that these employees are at higher risk of developing stress symptoms, such lay perceptions tend to neglect the fact that protective services professionals elect to enter their chosen profession. Furthermore, they tend to be motivated to do so to assist people in the very situations that lead lay persons to perceive their emergency work as ‘stressful’. (Dunning, 2003; Gist & Woodall, 2000).

The aim of the larger study was to examine how individual, organisational and operational factors interact to influence police officer well-being and psychological growth over a period of time from recruitment and academy training; through the first 2 years of these officers being placed on operational duties. The constructs examined ranged from individual coping mechanisms and personality, to the influence of police culture and climate on employee well-being, psychological growth and distress. Thus, the study examined both the positive and negative influences on subjective well-being for newly recruited police officers from an individual and organisational perspective. Hart and Cooper (2001) provide a conceptual model of Organisational Health that meets these criteria, and this study is based on examining the utility of the pathways presented in this model, and expanding it to include concepts such as response to traumatic exposure.

This paper reports the longitudinal findings regarding changes in stress and coping after officers had been...
exposed to the profession for 20 months (inclusive of 8 months of training). Burke, Shakespeare – Finch, Paton & Ryan (2006) reported that these officers showed a decrease in stress upon the completion of training, and that officers were reporting high use of emotion focused (e.g., Acceptance, Positive Reinterpretation), but contextually adaptive coping mechanisms (see Carver, Scheier & Weintraub, 1999). There were no gender differences apparent in coping profiles upon the completion of academy training. Furthermore, the female officers in this study showed higher levels of neuroticism than their males counterparts, consistent with the differential patterns expected in the general population (Costa, Terraciano, & McCrae, 2001; Lynn & Martin, 1997). Gender comparisons of stress at the earlier study phases indicated females reported higher levels of general distress than males, consistent with their higher neuroticism scores, and that all officers were reporting higher levels of stress from performance difficulties when compared to general and somatic distress (Burke, 2008: Burke et al., 2006).

Hypotheses
1. As stress was observed to decrease once officers completed training, it was proposed that a decrease would also be apparent upon completion of probation. Thus stress was expected to show a continued decline over the course of the longitudinal investigation.
2. Given the visible nature of the occupation, and the increased exposure officers had with the public upon graduation, it was expected that officers would continue to report higher levels from performance difficulties (evaluative pressure) than somatic or general distress complaints.
3. It was expected that females would continue to show higher levels of general distress than males across the longitudinal study, as a function of their higher neuroticism scores.
4. It was predicted that officers would continue to report using contextually adaptive coping strategies at a higher level than maladaptive coping.
5. As no gender differences in coping were found upon the completion of training, it was predicted that while there would be a decrease in reported coping use corresponding to the decrease in stress, there would be no interaction between gender and study phase for coping.

Method

Participants
Seventy-Eight Police Constables, who comprised the first 4 training groups in the baseline and post-training phases of this research project, were surveyed after their first 12 months of operational duties – representing a time point of 20 months since the initial baseline survey point at the police academy. Responses were received from 58 constables, giving a total response rate of 75% of the original recruit group. The response rate at this stage also reflected 92% from the post-train phase (n = 63 for these 4 groups post-training), two of these non-respondents had since resigned from the police, and one had been formally dismissed. Two of the individuals no longer with the service commented informally to the investigator about their reasons for leaving, but formal exit interviews were declined. The two remaining non-responders no longer wished to take part in the study. Of the 58 officers who participated in the longitudinal study, 57% (n = 33) were male, which is consistent with gender representations at the police academy during this time (Burke et al., 2006). The mean age of the constables was 29.66 (SD = 9.11) with ages ranging from 18 to 52, maintaining the original age distribution.

Materials
The COPE Inventory (Carver, et al., 1989) was used to examine the type and frequency of coping mechanisms reportedly used by the recruits when faced with stressful experiences. The COPE has 52 items, comprising 14 subscales, including both adaptive and maladaptive strategies. Participants were asked to indicate what they generally do and feel when involved with a stressful incident on a 5-point scale in which 1 = I don’t do this at all and 5 = I do this all the time. The Hopkins Symptom Checklist–21 (HSCl-21; Green, Walkey, McCormick, & Taylor, 1998) was used to ascertain the current level of stress of participants at point of entry to the academy. The instrument asked participants to report how distressed they had been within the past 7 days according to a 4-point scale, in which 1 = Not at all and 4 = Extremely.

Procedure
All constables were emailed by the researcher approximately 3-4 weeks prior to the 12 month anniversary of their graduation from the police academy. Approximately 2 weeks after this contact, test booklets were mailed out to each individual Constable. The package contained a cover letter which reintroduced the study and provided the officers with more information about the current phase and instructions for the completion of the booklet and its return to the University. Officers were given a period of 6 weeks in which to respond with standard reminder letters sent at 3, 5 and 6 weeks respectively after the mail out had their survey package not been returned. Consent was deemed to have been obtained upon voluntary return of the completed booklet.
Results

Stress and coping were examined for changes across the three quantitative phases of the study (i.e., Baseline, Post-train and Follow-up) using profile analysis. Changes in gender (levels), study phase (flatness) and interactive effects (parallelism) were examined for each variable.

Stress. The mean change in each facet of stress across the study is presented in Figure 1. The results indicated that there was a significant effect for study phase, \( F(7, 50) = 7.73, p < .001 \), indicating significant changes in reported levels of stress across the longitudinal phases. There was no significant effect for gender \( F(4, 53) = 1.44, p = .23 \) or for the interaction between gender and study phase \( F(7, 50) = 1.32, p = .26 \).

Tests of within subjects effects indicated that the assumption of sphericity was violated for general distress \( (\hat{\nu} = .83, p = .006) \) and somatic distress \( (\hat{\nu} = .88, p = .03) \), accordingly Greenhouse Geisser corrections were applied to these two constructs. Results showed a significant effect of study phase for total stress \( F(2,112) = 28.84, p < .001 \). This effect was also apparent for performance difficulties \( F(2,112) = 18.41, p < .001 \), somatic distress \( F(1.79, 100.12) = 9.67, p < .001 \) and general distress \( F(1.71, 95.63) = 23.99, p < .001 \).

Repeated measures contrasts indicated that all changes for each facet of stress at each time point were significant \( (p < .004) \), with the exception of somatic distress between post-training and follow-up phases \( (p > .004) \).

Figure 1: Changes in reported levels of stress across the three quantitative phases of the study.

Coping. Changes in coping were examined across the three quantitative time points using profile analysis. The results indicated that there was a significant effect for study phase, \( F(28,198) = 6.78, p < .001 \) and for gender \( F(14, 43) = 3.13, p = .001 \). However, there was no significant interaction between gender and study phase \( F(28,29) = 1.0, p = .51 \).

The significant effect of study phase was followed up with tests of within subjects effects and post-hoc repeated measures contrasts, to determine where significant changes in coping usage were occurring between study phases (see Figure 2). Greenhouse Geisser corrections were applied to religious coping \( (W= 19.19, p < .001) \) and Focus and venting of emotions \( (W= 17.51, p < .001) \) as the assumption of sphericity was breached for these two variables.

Figure 2: Reported use of each coping strategy across each phase of the study.

Tests of within subjects effects indicated that there were significant changes across the three study phases in use of all coping strategies with the exception of Suppression of Competing Activities and Alcohol/drug Disengagement. A bonferroni adjustment \( (\alpha = .004) \) was applied, and Positive Reinterpretation. Acceptance, Religious Coping and Denial did not reach the alpha threshold, and can only be regarded as showing significant trends.

As the effect for gender was significant, a series of univariate independent groups ANOVAs were performed to examine the gender differences in mean coping strategy use (see Figure 3) A bonferroni adjustment set, \( \alpha = 0.004 \). Males reported significantly higher use of Active Coping \( F(1,56) = 12.11, p = .001 \), while females reported higher use of Focus and Venting of emotions \( F(1,56) = 11.62, p = .001 \).

There were trends towards males reporting significantly higher use of Planning \( F(1,56) = 5.68, p = .02 \) and Suppression of Competing Activities \( F(1,56) = 5.09, p = .03 \) and lower use of Emotional Social Support \( F(1,56) = 4.48, p = .05 \). The figure also indicates that the mechanisms used most, regardless of gender, were Acceptance and Positive Reinterpretation.
Discussion

The data indicated that hypothesis 1 was supported, as there was a significant decrease in stress across the three phases of the study. Hypothesis 2 was also supported, in that officers consistently reported higher levels of stress from performance difficulties than from general or somatic distress. Hypothesis 3 was not supported as there was no effect for gender on stress. Hypothesis 4 was supported, as officers reported high use of strategies such as Acceptance which would be considered adaptive in this context. Hypothesis 5 was supported as there was no significant interaction between study phase and gender.

The decrease in stress as officers become more experienced with policing is a likely reflection of them feeling more comfortable in their job role, and is consistent with the adjustment argument forwarded by Nelson (1987). The continued report of evaluative stress (performance difficulties) reflects the visibility of policing, and the accountability to which officers are held by the public and other officers (Fielding, 2001, Noblet et al., 2005). It is expected that this trend would be expected to be maintained throughout the officers’ careers.

Officers reported a high use of coping strategies that would be considered to be adaptive (Carver et al., 1999) and while the reported use of coping decreased over the course of the study, corresponding to the decrease officers reported in their levels of stress. This occurrence is indicative of the demands of the job being considered less threatening, and more likely to be appraised as challenging, as the officers adapt to their new work environment (Gist & Woodall, 2000).

Acceptance was the only strategy that increased in use over the course of the study, and this may reflect the change from training to operational policing, and increased experience and operational exposure on the part of these officers. Acceptance, while an emotion focussed strategy, represents an adaptive way of coping with events that the officer may perceive they have little or no control over (Carver et al., 1999).

The overall pattern of strategy use was very similar for each gender. Both reported using strategies such as Positive Reinterpretation, Acceptance, Planning and Social Support (both emotional and instrumental) to a greater extent than other strategies. The main gender differences were apparent between the specific strategies reportedly used most and in the way each gender used social support as a coping mechanism.

Females reported greater use of Focus on and Venting of emotions and Emotional Social Support while males showed a trend towards greater use of Instrumental Social Support. Thus, there were no real differences in the use of contextually adaptive strategies for each gender, but rather in which specific strategy they chose to engage in. For example, both genders reported using social support, however males looked for instrumental support, whilst females looked for someone with which to discuss their problems. This is consistent with general population patterns, which indicate that men and women show differential patterns of social support use in response to occupational stress (Bellman, Forster, Still & Cooper, 2003).
The use of alcohol as a coping mechanism did not register in the quantitative data at any study phase. This finding is inconsistent with the findings of Obst, Davey and Sheehan (2001) who argued that socialisation into policing involved joining a drinking culture, where alcohol was used as a means of coping with the demands of the job, and in which those who chose not to partake experienced a degree of ostracism. However, the results of the qualitative phase of the larger investigation (Burke, 2008), suggest that this may be due to officers’ failure to conceptualise alcohol use as a coping mechanism, thereby not reporting it as a response that they consciously used to cope with on the job events.

In summary this paper provides an overview of the changes in stress and coping as officers move through the first 20 months of exposure to the police profession. The results indicate that while the training period at the academy was regarded as stressful, this stress decreased somewhat upon commencement of operational duties. Furthermore, the data indicates that officers are reportedly utilising contextually adaptive coping mechanisms effectively, which suggests positive implications for their future well-being as police.

References
The Relationships between Learning Approaches, Personality, and Academic Success: School Leavers versus Nonschool Leavers

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Abstract
The aim of this study was to examine the relationships between approaches to learning, personality, and academic success in a sample of 177 first-year psychology students. Most of the students (n = 144; 81.4%) were first-year tertiary students (school leavers); 33 students (18.6%) had more than one-year tertiary experience (nonschool leavers). The students were enrolled either on-campus or via distance education at the University of Southern Queensland and completed an online survey for course credit. Academic achievement was measured as grade point average (GPA). This paper will report the relationships among the key variables. Univariate analyses of variance showed that nonschool leavers obtained higher GPAs and scored higher on the Deep and Strategic learning approaches than did school leavers. Conversely, school leavers scored higher on the Surface approach to learning. A regression analysis showed that the Strategic approach predicted GPA. None of the five personality traits were related to academic achievement. However, Intellect and Conscientiousness were each found to predict the Deep approach to learning; Conscientiousness was found to predict the Strategic approach to learning; and Emotional Stability and Intellect were each found to predict the Surface approach to learning. The implications of these findings are discussed.

Introduction
The first year at university is crucial for students as it can often lay the platform for future academic success. Individual differences factors thought to influence student transition to higher education include students’ perceptions and attitudes towards the course, approaches to learning, self-confidence, and personality (McKenzie, Gow, & Schweitzer, 2004). University administrators and academics need to better understand how such factors might impact on student learning to determine how best to cater for today’s diverse student cohorts and maximise students’ chances of academic success. In an era where students must “become masters of their own learning” (Zimmerman, 1990, p. 4), it is imperative that they become acquainted with their own learning preferences and understand how to study effectively.

Approaches to Learning
Researchers have long been interested in how students go about learning, what strategies they use, and why they choose particular approaches (Vermunt, 2007). Approaches to learning reflect the individual differences in strategies used to achieve a particular learning task (Diseth, 2003). The student approach to learning (SAL) tradition distinguishes between Deep, Surface, and Strategic learning approaches (see Entwistle & Peterson, 2004 for a review). A Deep approach involves finding meaning in what is being studied to maximise understanding. A Surface approach involves investing little time in the academic task and memorising information with rote-learning. A Strategic approach involves being guided by the assessment criteria and enhancing self-esteem through competition.

Research has investigated the relationships between these three learning approaches and academic success. The SAL paradigm argues that high achievement can be predicted by a Deep approach, either alone or in combination with a Strategic approach (Diseth & Martinsen, 2003; Diseth, Pallesen, Hovland, & Larsen, 2006). In contrast, low achievement can be predicted by a Surface approach to learning (Diseth & Martinsen).

Personality
Debate continues about the exact number of factors comprising personality, however, most research favours a five-factor model (Goldberg, 1999): Emotional Stability, Extraversion, Intellect, Conscientiousness, and Agreeableness. Each factor is bipolar. People low on the Emotional Stability trait (i.e., high on Neuroticism trait) tend to experience such negative feelings as humiliation and low self-esteem. Individuals high on the Extraversion trait tend to be social and self-confident. The Intellect trait, also known as Openness to Experience, is characterised by an open-mind and a willingness to experience new situations. Individuals high on the Agreeableness trait are altruistic, adaptable, and supportive. Conscientiousness is characterised as being responsible, hardworking, and dependable.
Previous research has shown most of the five personality traits to predict academic success, although the findings are varied (Diseth et al., 2006). Conscientiousness is the trait most consistently positively correlated with academic performance (Nguyen, Allen, & Fraccastoro, 2005). Intellect has also been positively associated with academic success in undergraduate studies (Burton & Nelson, 2006). Introverted students are expected to outperform extraverts (Entwistle & McCune, 2004), however, findings are inconsistent. In contrast, Neuroticism and Agreeableness are generally not associated with academic success (Diseth et al., 2006).

**Academic Success**

The current study used grade point average (GPA) as the measure of academic success. GPA is a standardised measure of overall academic performance across all courses completed by the student (Zeegers, 2001). Aggregating marks over several courses leads to a more reliable criterion of academic success which in turn, results in higher correlations with measures of approaches to learning and personality (Paunonen & Ashton, 2001).

**School Leavers versus Nonschool Leavers**

The influence of the demographic variable age on student success is also of interest (cf. Duff, Boyle, Dunleavy, & Ferguson, 2004). Researchers have classified students into (a) traditional and non-traditional (Bowl, 2001); (b) mature-age, those aged 21 and over on March 1 of the year of tertiary entry and younger (Leder & Forgasz, 2004); and (c) recent school leavers and nonschool leavers (Zeegers, 2001). This study used the variable school (school leavers versus nonschool leavers) to examine how age influences academic achievement. School leavers accessed higher education within a year of completing high school; nonschool leavers delayed their tertiary enrolment more than one year after completing high school (cf. Zeegers).

Previous research has shown that nonschool leavers favour the Deep approach (Duff et al., 2004; Gijbels, Van de Watering, Dochy, & Van den Bossche, 2005). In contrast, school leavers prefer the Surface approach (Richardson & Newby, 2006). Few studies, however, have investigated how the variables school, personality, and approaches to learning combine to predict academic success. This study aims to redress this imbalance using a sample of on-campus and distance students.

Nonschool leavers tend to be more successful academically than school leavers (McKenzie & Gow, 2004). For example, Wilding and Andrews (2006) found that mature age (β = .12) and the Strategic learning approach (β = .22) each predicted the average mark in 612 first-year students from a university in London. Similarly, Duff et al. (2004) examined the relationships between personality, learning approaches, and academic success in a sample of 146 social science undergraduate students. Duff et al. performed a linear regression analysis, with age, prior academic success, and Conscientiousness as independent variables, accounting for 24.1% of the variance in academic achievement. Their findings indicated that age (β = 3.55) and personality (i.e., Conscientiousness, β = 2.43), together with prior academic success, predicted GPA.

**Research Aims**

The main aim of this study was to investigate the relationships between school, approaches to learning, personality, and GPA in a cohort of first-year undergraduate students. It was hypothesised that nonschool leavers would score significantly higher than school leavers on the Deep approach; school leavers would score significantly higher than nonschool leavers on the Surface approach. The Strategic approach was expected to positively predict GPA and the Surface approach was expected to negatively predict GPA. Conscientiousness and Intellect were each expected to positively predict GPA. Based on previous research, Conscientiousness and Intellect were each expected to positively predict the Deep approach; Conscientiousness was also expected to positively predict the Strategic approach; Emotional Stability and Intellect were each expected to negatively predict the Surface approach. It was further hypothesised that nonschool leavers would achieve significantly higher GPAs than school leavers in the current sample.

**Method**

**Participants**

A total of 183 first-year psychology students participated in the survey for course credit (response rate = 64.2%), however, only 177 had complete data for analysis. The sample comprised 36 (20.3%) males and 141 (79.7%) females. Participants’ ages ranged from 15 to 84 years, with a mean age of 29.05 years (SD = 12.23). A total of 80 (45.2%) students were studying on-campus; 97 students (54.8%) were off-campus. The average age of the 68 school leavers (35 females, 13 males) was 18.48 years (SD = 1.23); the 109 nonschool leavers (86 females, 23 males) had an average age of 35.57 years (SD = 11.32). The majority of the school leavers were on-campus students (79.4%) while the majority of the nonschool leavers were distance students (76.1%).

**Measures**

The self-report survey was developed for use in a longitudinal study of individual differences in student achievement. However, only those measures relevant to the current research aims will be discussed here.
The 52-item Approaches and Study Skills Inventory for Students was used to measure the three learning approaches (Entwistle & McCune, 2004). Participants indicated their relative agreement using a 5-point Likert-type scale, ranging from 1 (disagree) to 5 (agree). The 16-item Deep approach scale measures whether students (a) seek meaning, (b) relate ideas, (c) use evidence, and (d) show interest in concepts. The 16-item Surface approach scale measures whether students (a) lack purpose, (b) memorise material, (c) are syllabus bound, and (d) show a fear of failure. The 20-item Strategic approach scale measures whether students (a) organise their study, (b) can time manage, (c) are alert to assessment demands, and (d) monitor their performance. Total scale scores for both the Deep and Surface approaches could theoretically range between 16 and 80; total scores ranged between 20 and 100 for the Strategic approach scale. Entwistle and McCune reported acceptable reliabilities for the Deep (α = .84), Strategic (α = .80), and Surface (α = .87) scales.

The short form of the International Personality Item Pool (IPIP, Goldberg, 1999) was used to measure the Big-Five factors of personality: Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Intellect. Participants completed the 50-item IPIP using a 5-point Likert-type scale (1 = very inaccurate; 5 = very accurate). Total scores for each major trait could theoretically range between 10 and 50. Goldberg (1999) showed that the five IPIP scales each demonstrated acceptable internal reliabilities, with coefficient alpha estimates ranging between .79 (Conscientiousness) and .87 (Extraversion). Academic success was measured by GPA.

Procedure

The current data was collected on-line. The total testing time for the Internet-administered survey was about 1.5 hours. Testing was carried out over a 4-month period. Personalised feedback was provided to each participant, summarising each student’s learning approaches and major personality traits and outlining strategies for optimising individual learning environments.

Results and Discussion

Key Findings

Table 1 shows means and standard deviations for key variables. The average GPA was above a pass level (C) for school leavers and above a credit level (B) for nonschool leavers. A univariate analysis of variance (ANOVA) showed this difference to be statistically significant, $F(1, 175) = 15.93$, $p < .001$, $d = .67$. The nonschool leavers scored higher than school leavers on the Deep, $F(1, 175) = 11.96$, $p = .001$, $d = .45$, and the Strategic, $F(1, 175) = 9.16$, $p = .003$, $d = .41$, approaches. Conversely, school leavers scored higher than nonschool leavers on the Surface approach, $F(1, 175) = 6.20$, $p = .014$, $d = .36$. Both school leavers and nonschool leavers scored highest, on average, on the personality trait Agreeableness. In contrast, school leavers scored lowest, on average, on the trait Emotional Stability; nonschool leavers scored lowest, on average, on the trait Extraversion.

Table 1: Summary Statistics: Learning Approaches, Personality, and Academic Success.

<table>
<thead>
<tr>
<th>Scale</th>
<th>School $(n = 68)$</th>
<th>Non-school $(n = 109)$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha$</td>
<td>$M$</td>
</tr>
<tr>
<td>Learning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approaches</td>
<td>Deep</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td>Strategic</td>
<td>.88</td>
</tr>
<tr>
<td></td>
<td>Surface</td>
<td>.81</td>
</tr>
<tr>
<td>Personality</td>
<td>Extraversion</td>
<td>.90</td>
</tr>
<tr>
<td></td>
<td>Agreeableness</td>
<td>.75</td>
</tr>
<tr>
<td></td>
<td>Conscientiousness</td>
<td>.81</td>
</tr>
<tr>
<td>Emotional</td>
<td>Stability</td>
<td>.89</td>
</tr>
<tr>
<td></td>
<td>Intellect</td>
<td>.79</td>
</tr>
<tr>
<td>Academic</td>
<td>GPA</td>
<td>-</td>
</tr>
</tbody>
</table>

Note. $\alpha$ = Cronbach’s alpha coefficient.

Pearson’s product moment correlations were computed for all variables shown in Table 1. An alpha level of .05 was used for all statistical analyses. As shown in Table 2, school correlated negatively with GPA, and with the Deep and Strategic learning approaches, respectively. School also correlated negatively with the traits Agreeableness, Conscientiousness, and Emotional Stability, respectively. In contrast, school showed a positive relationship with the Surface approach, and with the trait Extraversion. As hypothesised, the Strategic approach correlated significantly with GPA. However, contrary to expectations, the Surface approach did not significantly negatively correlate with GPA. Further, contrary to expectations, none of the five personality traits correlated significantly with GPA. As expected, the Deep approach correlated positively with the traits Conscientiousness and Intellect; the Deep approach was also significantly correlated with Agreeableness. As expected, the Strategic approach was significantly correlated with Conscientiousness. The Surface approach correlated negatively with both Emotional Stability and Intellect, as hypothesised.

A series of regressions were performed to further investigate the relationships between approaches to learning, personality, school, and academic success. In the following analyses, all t-test results that relate to individual predictors within a multiple regression model
reflect the significance of the unique contribution of the predictor within that model. A test of the complete model was beyond the scope of this paper.

First, GPA was regressed onto the three approaches to learning, \(R^2 = .17, F(3, 160) = 11.03, p = .002, \beta = .21\). The result indicated that the Strategic approach positively predicted GPA, \(t = 3.74, p = .001\). Second, the three approaches to learning were each regressed onto the five personality traits. As expected, both Conscientiousness, \(t = 2.54, p < .001\), and Intellect, \(t = 5.61, p < .001\), positively predicted the Deep approach, \(R^2 = .27, F(5, 166) = 11.94, p < .001, \beta = .37\). Further, as expected, Conscientiousness, \(t = 8.88, p < .001\), positively predicted the Strategic approach, \(R^2 = .37, F(5, 166) = 19.80, p < .001, \beta = .59\). Emotional Stability, \(t = -6.21, p < .001\), and Intellect, \(t = -5.36, p < .001\), each negatively predicted the Surface approach, \(R^2 = .36, F(5, 164) = 18.61, p < .001, \beta = .56\). However, Conscientiousness, \(t = -2.28, p = .025\), also negatively predicted the Surface approach.

The question of whether the strategic approach and school combined to predict academic success was then examined. The result, \(R^2 = .18, F(2, 167) = 18.91, p < .001, \beta = .22\), indicated that School negatively, \(\beta = -2.8; t = -3.92, p = .001\), predicted GPA; the Strategic approach positively predicted GPA, \(\beta = .28; t = 3.91, p = .002\).

School and Academic Success
A key finding of this study is that nonschool leavers obtained significantly higher GPAs than did school leavers. Further, nonschool leavers scored higher than school leavers on the trait Conscientiousness. This finding indicates that nonschool leavers are conscientious and responsible, efficient, self-disciplined and organised, and have high aspirations for academic success. Additionally, nonschool leavers scored higher than school leavers on the Strategic approach. This finding implies that nonschool leavers intend to do well in the course by organising and planning their study in response to assessment requirements and criteria; they manage time and effort effectively. As expected, Conscientiousness predicted the Strategic approach to learning. Further, the Strategic approach predicted GPA, in line with previous research. Thus, students who adopt the Strategic approach intend to succeed and are motivated to obtain the best possible mark by effectively organising their study time and learning environments.

Another key finding of this study is that nonschool leavers scored higher than school leavers on the Deep approach. This suggests that nonschool leavers are better able to relate ideas and use evidence, are more meaning-oriented in their studies, and are more interested in understanding the subject matter than are school leavers (Entwistle & Peterson, 2004). Conversely, school leavers scored higher on the Surface approach to learning suggesting that they are more syllabus bound and use more unrelated memorising in their learning (Entwistle & Peterson). Consistent with previous research, both Intellect and Conscientiousness predicted the Deep approach. Conscientious people are determined and strong-willed; individuals scoring high in Intellect are intelligent, imaginative and perceptive. It is therefore not surprising that people with these characteristics aim to understand what they learn and relate new concepts to ideas already assimilated, indicative of a Deep approach.

In contrast, Emotional Stability and Intellect traits each negatively predicted the Surface approach to learning, supporting previous research. Individuals scoring low on Emotional Stability tend to manifest anxiety and are easily stressed; those scoring low on Intellect are typically conventional and conservative and prefer straightforward things. It is therefore not surprising that people with these characteristics favour reproducing content to cope with course requirements.

Table 2: Correlation Matrix: GPA, School, Approaches to Learning, and Personality.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPA</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School</td>
<td>-0.29**</td>
<td>-0.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep</td>
<td>0.12</td>
<td>-0.20**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategic</td>
<td>0.30**</td>
<td>-0.20</td>
<td>0.53**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface</td>
<td>-0.09</td>
<td>0.17**</td>
<td>-0.37**</td>
<td>-0.37**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extraversion</td>
<td>0.03</td>
<td>0.22**</td>
<td>0.12</td>
<td>0.12</td>
<td>-0.10</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agreeable</td>
<td>0.05</td>
<td>-0.18*</td>
<td>0.29**</td>
<td>0.17*</td>
<td>-0.17*</td>
<td>0.25**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conscientious</td>
<td>0.13</td>
<td>-0.32**</td>
<td>0.23**</td>
<td>0.58**</td>
<td>-0.21**</td>
<td>-0.02</td>
<td>0.20**</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotion Stab</td>
<td>0.02</td>
<td>-0.17*</td>
<td>0.11</td>
<td>0.17*</td>
<td>-0.43**</td>
<td>-0.21**</td>
<td>-0.01</td>
<td>0.12</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Intellect</td>
<td>0.04</td>
<td>-0.06</td>
<td>0.46**</td>
<td>0.20**</td>
<td>-0.37**</td>
<td>-0.28**</td>
<td>0.35**</td>
<td>0.06</td>
<td>0.10</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Note. Agreeable = Agreeableness; Conscientious = Conscientiousness; Emotion Stab = Emotional Stability. *p < .05. **p < .01.
Conclusion
The current findings contribute to our understanding of key differences between school leavers and non-school leavers and the way they approach their studies. The data indicate that non-school leavers achieve higher academic success than school leavers and are more likely to use the Deep and the Strategic approaches than are their counterparts. Further, the Strategic approach predicts academic success; the trait Conscientiousness predicts use of the Strategic approach. In contrast, school leavers are more likely than non-school leavers to use the Surface approach. Emotional Stability and Intellect each negatively predict the Surface approach.

The current findings indicate that educators of first-year students need to ensure school leavers are equipped with self-management and study skills to help them organise their study time more effectively and to understand their learning materials at a deeper level. School leavers have different needs to non-school leavers and structures and processes should be put in place to help all students, regardless of previous experience or study mode, make a successful transition to university. Academics teaching into the first-year program should look to develop transition programs that help those students new to tertiary life achieve success. Future research should ensure students are tracked over time to determine the role of key individual differences variables on academic success throughout their degrees. Specifically, further research with larger samples of diverse groups of students is needed to test the complete model.

References
McKenzie, K., & Gow, K. (2004). Exploring the first year academic achievement of school leavers and mature-age students through structural equation modelling. Learning and Individual Differences, 14, 107-123.
Wellbeing in Long-term Primary Carers: Biopsychosocial Outcomes

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Abstract

Carers are vital to sustaining the independence and optimal functioning of some of the most vulnerable members of the community, yet carers themselves are at risk of poor health and wellbeing outcomes. Indeed, carers often subjugate their own needs in order to fulfill their caring role. This study examined wellbeing outcomes in long-term primary carers. The consequences of providing extended informal care were investigated using a mixed methodology, including questionnaires, saliva sampling and individual interviews. Carers and age and gender matched non-carers were compared across stress, distress, and subjective wellbeing as well as sleep variables and stress hormones. The findings are used to explore the biopsychosocial bases of carer wellbeing. This research has the potential to inform policy on the growing population of Australian carers and to add to the developing wellbeing literature.

Introduction

An informal caregiver, or carer, is someone who “provides care and support for their parent, partner, child or friend who has a disability, is frail aged, or who has a chronic mental or physical illness” (Carers Association South Australia Inc, 1999). This involves the provision of “extraordinary care” that far exceeds what might be provided within an ordinary spousal, parental, or other relationship and which is considered to consume disproportionate time and energy (Schulz & Quittner, 1998, p.107).

In Australia more than 2.6 million people are recognised as carers (Australian Bureau of Statistics, 2003). Around one fifth of these are described as primary carers who provide the bulk of care for a given individual (Australian Bureau of Statistics, 2003). Informal caregiving in Australia is said to be vital and to have an estimated replacement cost of around $31b per annum (Access Economics, 2005), yet the personal cost to carers from providing such unpaid work is largely unrecognised (Noon, 1999). For carers who enable those they care for to sustain independence and achieve optimal functioning (Vitaliano, Scanlan, & Zhang, 2003), it is likely that the cost to their own welfare will be exorbitant.

It is generally acknowledged that caregiving is a severe and persistent stressor (Schulz & Quittner, 1998). Caregiving is seen as a problem of over-demand combined with few available response options (Wheaton, 1997). This is consistent with Lazarus and Folkman’s (1984) notion of stress as the result of an appraisal of one’s environment as exceeding resources and endangering well-being. According to Lazarus (1999), the main outcomes of successful adaptation to stress are: 1) subjective wellbeing; 2) work and social functioning; and 3) physical health. These domains clearly correspond to an holistic biopsychosocial model of health and wellbeing (Inui, 2003).

For many carers, the difficulty of juggling care work with other roles and their own needs leads to substantial personal distress (Briggs & Fisher, 2000) and carers typically forfeit work, education, leisure and relationship opportunities (Carers Association South Australia Inc, 1999). There is strong evidence that carers commonly experience depression and anxiety (Pakenham, Stebbins, Cannon, & Samios, 2005; Schulz & Quittner, 1998). Thus, while carers commonly report a conviction that care recipients have the right to the best possible quality of life (Vitaliano et al., 2003) recent reports indicate that carers themselves report extremely low levels of subjective wellbeing (Cummins et al., 2007). Subjective wellbeing, SWB, is said to comprise a cognitive component involving the assessment of life satisfaction in addition to an affective component of felt happiness and is an extremely stable trait that is kept in the upper positive range (Cummins, Gullone, & Lau, 2002). It is usually resistant to external circumstances, however low carer SWB levels are thought to reflect a failure of the capacity of internal cognitive mechanisms to maintain life satisfaction in...
the face of extreme objective life circumstances (Cummins, 2003). Furthermore, once substantial caregiving is required, the disability of the recipient seems to be irrelevant to the effects of the role on subjective wellbeing (Cummins, 2001).

There is also evidence, though less robust, that carers report poor physical health and greater sleep problems and fatigue than non-carers (Briggs & Fisher, 2000; Shewchuk, Richards, & Elliott, 1998; Vitaliano & Young, 2004). Metabolic dysregulation has also been detected amongst caregivers (Vitaliano et al., 2005). In addition, biochemical characteristics that reflect stress, such as morning cortisol levels, have been found to be elevated in dementia carers (de Vugt et al., 2005) even after controlling for depression (Da Roza Davis & Cowen, 2001). Caregiver distress has also been associated with higher cortisol levels (de Vugt et al., 2005). Nevertheless other studies have found no differences in cortisol levels (Vedhara et al., 1999).

It has been suggested that many carer studies may be confounded by the interactive effects of ageing on health outcomes (Lutgendorf & Costanzo, 2003). Indeed, there has been sparse research investigating biological correlates in younger carers (Kuster & Merkle, 2004). A recent study of non-spousal carers of the elderly found only minor differences between carers and non-carers on psychological and biological measures, including cortisol (Provinciali et al., 2004). Additionally, few caregiver studies address outcomes on all biopsychosocial dimensions (Smith, Folan, & Haaland, 2002). Yet this is considered to be the most suitable framework for investigating wellbeing under chronic conditions (Fava & Sonino, 2008).

The aim of the current study was to describe wellbeing outcomes in long-term primary carers as one component of a larger study of carer wellbeing. The specific aim was to examine the differences between carer and non-carer outcomes within biological (salivary cortisol levels, sleep measures, and self-reported health), psychological (distress, coping and life satisfaction) and social spheres (social adjustment).

Method

The full study employed a mixed methodology, using morning and evening saliva sampling, self-report questionnaires, a sleep diary and qualitative data derived from personal interviews. Biochemical analyses were still in progress at the time of writing. Further discussion of some findings will be presented in future reports. Thus, a subset of the results and associated methods are reported here.

Participants

Thirty-five primary carers who had been in a caregiving role for a minimum of 12 months were recruited for the study via Carers Queensland support group meetings and regional mailout as well as two articles in local newspapers. Selected carers were parents or spouses, not children, of those requiring care in an attempt to exclude the element of choice of role. Non-carers were individuals without a major caring role and were recruited through the same newspaper articles, as well as flyers and through email mailing lists. They were then placed on a wait list and matched by gender and age to carer participants. If an exact age match was not available the person of nearest age on the wait list was asked to participate.

Four carers were unable to complete the study. The circumstances leading to their withdrawal included: the person being cared for going missing; the carer’s own ill health; the injury of another family member (not the person with a disability); and the death of the person being cared for. The final sample consisted of 31 carers (mean of 12.64 years in caring role) and 35 non-carers.

Materials

The psychological measures used in this study were the Perceived Stress Scale, PSS-10 (Cohen, Kamarck, & Merzelstein, 1983); the Depression Anxiety Stress Scale, DASS-21 (Lovibond & Lovibond, 1995); and the Personal Wellbeing Index, PWI (International Wellbeing Group, 2005). These were employed to measure perceived stress; depression, anxiety, and stress symptoms; and subjective wellbeing respectively. An adaptation of the Work and Social Adjustment Scale, WSAS (Mundt, Marks, Shear, & Greist, 2002) was also used to gauge social functioning. The reference to a specific illness in the original scale was replaced, with permission, by “my life circumstances” (Marks, I., personal communication, 8 February 2007).

Procedure

All participants received a participation pack which consisted of a folder containing the scales, demographic questions and a sleep diary. Participants were also asked to list their current medications and to estimate the number of doctors visits they had made in the last year, however no exclusions were made on this basis. The participation pack included saliva sample tubes and instructions for collection of unstimulated saliva. The 7-day sleep diary sought information on sleep patterns, health, and ratings of morning restedness and sleep quality (from very poor to excellent) using a 10cm visual analogue (VAS) scale.

Participants collected all data during one week. They collected approx 4ml saliva on waking and going to bed on two consecutive days. Participants provided bedtime saliva samples at 22.00 hours. Actual collection times differed between participants. However, there was no significant bedtime collection, t(1,33) = 1.305, p =
0.205, difference between the groups. The data for the morning samples were not available at the time of writing. Participants placed saliva samples in their own freezer until collection. Samples were stored below minus 20°C until assaying. All specimens and documents were individually coded to allow data collection. All participants indicated that they had followed the protocol provided. Some participants were unable to provide sufficient bedtime saliva, with subsequent missing cases in the saliva analyses.

The semi-structured interviews were conducted outside the data collection week.

**Cortisol Determinations**

Coded saliva samples were analysed by an independent biochemist at ARL Pathology, Melbourne Australia. Cortisol levels were determined by competitive electrochemiluminescence immunoassay (ECLI, Elecsys 2010, Roche Diagnostics) as described elsewhere (Vogeser, Durner, Seliger, & Auernhammer, 2006).

**Results**

The demographic and biopsychosocial data for the carer and non-carer groups are given in Table 1.

One-way between-groups multivariate analyses of variance were performed to investigate the differences between carers and non-carers on clusters of dependent variables. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity with no serious violations observed. Due to the high correlation between sleep quality and morning restedness, r = .88, N = 66, p<.001, sleep quality was excluded from subsequent multivariate analyses.

There was a statistically significant difference between carers and non-carers on the dependent sleep variable combining sleep time and morning restedness, F (2,63), p < .001. The partial eta squared value for the overall MANOVA model was .403. However, only morning restedness made a unique statistically significant contribution, F (1,64) = 42.49, p<.001, with carers experiencing lower restedness on awakening.

Cortisol and health-related variables were explored using independent t-tests (with a Bonferroni adjusted alpha level of .02) due to missing data and unequal variance. Bedtime cortisol levels did not differ significantly between the two groups, t(1,47) = 1.22, p = .233. Similarly, doctors visits were not significantly different between carers and non-carers, t(1,61) = 1.97, p = .056. However, carers reported significantly lower self-rated health than non-carers, t(1,59) = -3.27, p = .002.

<table>
<thead>
<tr>
<th>Table 1: Carer and Non-carer Group Comparisons on Demographic and Biopsychosocial Outcomes.</th>
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<tr>
<td>Variable</td>
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<tr>
<td><strong>Demographics</strong></td>
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<tr>
<td>Gender, female (%)</td>
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<tr>
<td>Age, in years (M±SD)</td>
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<tr>
<td><strong>Sleep-related measures</strong></td>
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<td>Sleep, hours/night (M±SD)</td>
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<td>Sleep quality (M±SD)</td>
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<td>Morning restedness (M±SD)</td>
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<tr>
<td><strong>Cortisol levels</strong></td>
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<td>Bedtime Cortisol, nmol/L (M±SD)</td>
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<td><strong>Health-related measures</strong></td>
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<td>Doctors visits, past year (M±SD)</td>
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<td>Self-rated Health (M±SD)</td>
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<td><strong>Psychological measures</strong></td>
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<td>Perceived Stress Scale, PSS-10 (M±SD)</td>
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<td>DASS-21 Depression (M±SD)</td>
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<td>DASS-21 Anxiety (M±SD)</td>
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<td>DASS-21 Stress (M±SD)</td>
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<td>Personal Wellbeing Index, PWI (M±SD)</td>
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<tr>
<td><strong>Social measures</strong></td>
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<td>Social Functioning,</td>
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<td>WSAS (M±SD)</td>
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<th>Table 2: Correlations for PSS and DASS Scores.</th>
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<td><strong>PSS</strong></td>
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<td>-----------------------------------------------</td>
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<tr>
<td>Depression</td>
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<tr>
<td>Anxiety</td>
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** correlation is significant at the .01 level (2-tailed)**

Carers’ mean DASS scores for depression, anxiety and stress place them within the moderate range for all three indicators of psychological distress, whereas non-carer means were indicative of non-clinical Australian norms (Lovibond & Lovibond, 1995). Due to strong positive correlation between the DASS subscale scores and the PSS scores (see Table 2), a new variable, distress, was created from the mean of these psychological measures. Distress and SWB were then
compared across the groups using MANOVA. There was a significant difference between the two groups on the combined psychological variable, \( F(2,63) = 16.742, \ p<.001 \), with a partial eta squared for the model of .354. Carer distress was significantly higher than that of non-carers \( F(1,64) = 29.14, \ p<.001 \). Carer subjective wellbeing scores were very similar to recent Australian norms (Cummins et al., 2007) and significantly lower than those of the non-carers, \( F(1,64) = 20.56, \ p<.001 \).

Social functioning among carers was also significantly lower, \( t(1,64) = -6.375, \ p<.001 \).

In order to examine the key differences between the groups on biopsychosocial wellbeing a MANOVA was conducted using the key differentiating variables from previous analyses. These were morning restedness, self-rated health, distress, SWB and social functioning. This model contained fewer cases than previous models due to missing health ratings for some participants. Nevertheless, carers and non-carers differed significantly on the combined outcome variable, \( F(5,50) = 13.003, \ p<.001 \), with each of the contributing variables differing significantly between groups. Partial eta squared for the full model was .565.

The extent of these group differences can perhaps be best illustrated by a few comments from the participants themselves. When asked to describe their life in general the majority of non-carers responded with comments such as “life’s just fine”, “I’m happy” “I’m glad I’m alive” and “I have a good life and I know it”. Carers, on the other hand, tended to respond with “life as I knew it is gone”, “I’m coping, not enjoying”, “it’s hell on earth” and even “at least one day I’ll be dead”.

Discussion

Overall, this study reveals a picture of poor outcomes for long-term primary carers across biological, psychological and social spheres. The current finding that carers had significantly worse outcomes on two indicators of physical wellbeing: restedness after sleep and self-rated health, is in line with previous research (Briggs & Fisher, 2000; Shewchuk et al., 1998; Vitaliano & Young, 2004). Interestingly, differences in sleep quality did not appear to be associated with sleep duration. However, sleep time was well below eight hours in both groups and may rather speak to levels of sleep debt in the general population. Furthermore, cortisol levels, as an objective physiological measure, were not found to be significantly elevated in the carer group in contrast to many previous studies (Da Roza Davis & Cowen, 2001; de Vugt et al., 2005) but in line with Provinciali et al. (2004). Though it may be that the morning cortisol results will show group differences.

The current results provide clear support for previous findings that carers experience reduced psychological health. In addition to evidence of greater levels of depression and anxiety such as found by Schulz and Quittner (1998) and Pakenhan et al. (2005) the current findings provide evidence of more symptoms of stress and greater perceived stress among carers. Taken together these would indicate that carers are struggling to maintain psychological wellbeing. Indeed, distress makes a unique contribution to the final model. In addition, in line with the few studies to date (Cummins, 2001, 2003; Cummins et al., 2007) the results indicate that satisfaction with life provides a unique contribution to the differences between carers and non-carers.

With regard to social functioning, the results clearly point to very different experiences for the two groups. This is an area of carer wellbeing which has had little formal investigation but which appears very sensitive to the caregiving context. Further analysis of the findings on social functioning will be reported elsewhere.

The results of the current study need to be interpreted with caution due to the small sample size and the heterogeneity of the carers involved. It may be that comparisons using larger carer groups with more similar caregiving demands would provide more clearly differentiated effects, particularly on physiological measures such as cortisol levels. Nevertheless, the current findings provide evidence of several sharp differences between carers and non-carers on key variables spanning biopsychosocial spheres. The extent of the impact across life domains points to an urgent need for recognition and support for caregivers.

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References


Objective Tests of Movement Imagery Predict Movement Skill Performance

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Abstract
The study reported here sought to evaluate the psychometric properties of a new objective measure of movement imagery—the Radial Pointing Task (RPT). We were particularly interested in whether the RPT would prove a stronger predictor of movement skill than a widely used imagery questionnaire, the Movement Imagery Questionnaire—Revised (MIQ-R; Hall & Martin, 1997). Thirty-five healthy adults were administered the RPT, a Mental Hand Rotation Task (MHRT), MIQ-R, and two measures of movement skill. The RPT was found to have adequate test-retest reliability and predicted different levels of fine-motor skill. We argue that the RPT has the potential to advance the assessment of motor imagery ability, transcending some of the limitations of self-report instruments.

Motor imagery is a dynamic mental state that involves the simulation of body movement. When performed from an internal (or first-person) perspective, it is thought to represent a predictive model of an action, sharing the same spatiotemporal parameters as real movement (Jeannerod, 2001). Even though motor imagery appears similar to visual manipulation of objects, evidence from behavioural (e.g., Decety & Jeannerod, 1996), neuroimaging (Decety et al., 1994), and lesion studies (e.g., Sirigu & Duhamel, 2001) suggests two imagery systems: visual imagery, the manipulation of object-related information, and motor imagery, the mental simulation of self-movement.

Historically, mental imagery has been assessed using subjective measures, based mainly on the vividness of the images a person experiences (Isaac & Marks, 1994). For motor imagery, subjective scales are also based mainly on vividness ratings. The two most commonly used measures are the Vividness of Movement Imagery Questionnaire (VMIQ; Isaac, Marks, & Russell, 1986) and the Movement Imagery Questionnaire—Revised (MIQ-R; Hall & Martin, 1997); the latter boasts more robust psychometric properties and assesses both the visual and kinaesthetic (or feel) components of imagery (Abma, Fry, Yuhua & Relyea, 2002).

Several lines of evidence suggest that for any measure of movement imagery to claim construct validity it should predict movement skill. First, a tight spatiotemporal coupling exists between real and imagined movements, mirrored also in shared neural systems, notably at the level of the fronto-parietal axis (Jeannerod, 2001). Second, skilled performers often report more vivid and controllable imagery. And third, populations who have difficulty learning movement skills also show deficits in movement imagery (Wilson, Maruff, Butson, Williams, Lum & Thomas, 2004).

Research using subjective instruments has suggested a relationship between imagery ability and motor performance (e.g., Goss, Hall, Buckolz & Fishburne, 1986; Isaac & Marks, 1994), supporting construct validity. However, because these instruments also correlate with subjective measures of object-related imagery, such as the Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973), there is some doubt as to whether the VMIQ and the MIQ-R tap the kinaesthetic aspect of motor imagery (Lequerica, Rapport, Axelrod, Telmet & Whitman, 2002).

Whereas subjective measures of imagery rely on introspection, objective instruments use tasks that are judged by verifiable criteria (Lequerica et al., 2002). Two tasks of potential use in assessment are the mental (hand) rotation task (MHRT) and the visually guided pointing task (VGPT). Of the former, response speed is shown to be a linear function of the angle at which hand stimuli are presented, supporting the argument that the imagined rotation conforms to the same biomechanical constraints as real limb movement (Parsons, 2001). Another probe for motor imagery is (imagined) movement tasks (like the VGPT) that conform to Fitts’ Law (Fitts, 1954), the lawful relationship between response time and task difficulty. Sirigu, Cohen, Duhamel, Pillon, Dubois, et al. (1995), for example, verified that the durations of real and imagined movements of healthy participants were highly correlated on the VGPT. Importantly, individual differences on this function were also noted. Wilson, Thomas and Maruff (2005) replicated these findings using a modified task (the Radial Pointing Task—RPT) designed to eliminate use of a counting heuristic. This task was shown to be intuitive, even for 6-year-olds and discriminated between those with high and low levels of motor skill (Caeyenberghs, Swinnen, Wilson &
Smits-Engelsman, in press; Wilson et al., 2005). However, its use in normal adults is yet to be determined. Moreover, the relationship of these objective measures with subjective scales is uncertain, as is their predictive validity in terms of actual movement skill (Lequerica et al., 2002).

The aim of this study was to investigate the psychometric properties of the RPT. First, we predicted adequate test-retest reliability. Second, with respect to predictive validity, it was expected the RPT would correlate significantly with measures of movement skill, and that this correlation would be higher than that for the subjective measure (the MIQ-R). Third, concurrent validity was expected to be sound, measured by the correlation between the RPT and the MHRT. Finally, we predicted only a mild correlation between objective and subjective measures of motor imagery.

**Method**

**Participants**

Thirty-five healthy adults participated in the study, recruited from the student population at RMIT University and acquaintances of the investigators. There were 21 females and 14 males aged between 19 and 57 years ($M=31.5$, $SD=10.9$). The research was approved by the Human Research Ethics Committee, RMIT, and all participants gave informed consent.

**Materials**

Participants completed the following battery of tests.

**Movement Imagery Questionnaire – Revised (MIQ-R).** The MIQ-R, (Hall & Martin, 1997), designed to assess kinaesthetic and visual aspects of movement imagery, contains eight items, four in each of two subscales: visual and kinaesthetic. Participants rated the ease/difficulty of visualizing or feeling each imagined movement on a 7-point scale (1= very difficult to see/feel, 7= very easy to see/feel); sub-scale scores ranged from 4 to 28. The MIQ-R has acceptable test-retest reliability, $r = .83$, and concurrent validity when compared to the VMIQ, $r = .58$ (Hall & Martin, 1997).

**Radial Pointing Task (RPT).** The RPT (Wilson et al., 2005) measured movement durations for real and imagined movements. Each trial used a plastic A4 sheet upon which is drawn a central circle (home base) and five target circles positioned on radials in a crescent formation, all 160mm from the home base. Diameters of targets varied over the five trials (2.5, 5, 10, 20, and 40 mm). A stopwatch recorded the total duration of the participants’ hand movements while holding a felt-tipped pen in their dominant hand; completed were five back-and-forth movements from home base to each target, in turn. For imagined trials, the participants’ hand remained fixed at the starting position (holding the pen) and eyes open while they imagined their hand moving; eye movements were permitted to ensure that simulated actions were still coded in eye- and shoulder-centred coordinates. Participants were asked to simulate the pointing movements from a first-person perspective. Timing began when the experimenter said, “go” and stopped when the participant said, “stop” after completing the imagined movements. The order of trials was randomised. Imagery performance was indexed by the correlation between real and imagined performance.

**Mental Hand Rotation Task (MHRT).** The MHRT (Wilson et al., 2004) also measured motor imagery. A laptop running E-Prime™ software package (Schneider, 1997) presented stimuli and recorded response times to the nearest 1 ms. Stimuli were single hands (left or right) rotated between 0 and 180 degrees from upright in 20-degree increments, presented after a random delay of between 2 and 3 s. Participants pressed one of two labeled keys on the keyboard when deciding whether each stimulus was a left (z key) or right (h key) hand. Ten practice trials and 80 test trials were completed. Imagery performance was indexed by the linear fit of the regression of response time on angle of rotation; higher correlations indicated greater imagery ability.

**Formboard.** Performance on a formboard task (Wilson, Thomas & Maruff, 2002) measured fine-motor skill. The A3-sized formboard presented a four by four matrix of different shaped receptacles. Working left to right and top to bottom, participants identified missing shapes, located them from an array positioned behind the board, and placed them in the formboard as quickly as possible. Performance was indexed by task completion time and the total number of response errors (selection and placement errors).

**Dynamic Ball Balance.** Performance on a dynamic ball balance task (adapted from Wilson et al., 2002) determined gross-motor skill. Using their dominant hand, participants balanced a tennis ball on a plastic cylinder (25 mm in diameter) while weaving in and out of five plastic cones placed 1 m apart. Performance on the task was indexed by movement time (measured using a digital stopwatch) and the number of response errors (ball drops), averaged over two trials.

**Procedure**

The order of tasks was counterbalanced. Assessment occurred in a large, open room at RMIT University. Testing took approximately 50 minutes per participant.

**Data Analysis**

Data from the RPT was collated by task (real or imagined). Fitts’ law was used to express each target...
width as an Index of Difficulty (ID): $ID = \log_2(2A/W)$, where $A$ is movement amplitude and $W$ is target width. For each participant, imagery performance was measured in two ways: the correlation between real and imagined movements (used in parametric tests) and the linear fit of the regression of response time on ID. Higher correlations were associated with better imagery ability. For the MHRT, the linear fit of the regression of response time on angle was calculated for each participant; the magnitude of fit indexed motor imagery ability. Fisher’s transformation of $r(z)$ was used for all parametric tests. All assumptions were tested and shown to be tenable. Outliers were removed.

**Results**

**Descriptive Analysis**

Performance on each task was first explored descriptively (see Table 1). For the RPT, Figure 1 shows a tight logarithmic relationship between response time and target width at the group level. Fit statistics describing the linear relationship between response time and ID is presented in Table 1; the fit was higher for real movements. For the MHRT, a linear relationship between response time and angle at the group level was revealed (Figure 2); mean fit is shown in Table 1.

**Predictive Relationship Between Motor Imagery and Movement Skill**

There was a significant negative correlation between the RPT and formboard time, $r = -.48$, $p = .004$; participants with better imagery ability recorded faster response times. No other significant correlations were found between the RPT, MIQ-R and motor skill tasks.

**Concurrent Validity of the RPT**

There was no significant relationship between the RPT and the MHRT, $p > .05$.

**Relationship Between Objective and Subjective Measures of Motor Imagery**

No significant relationship existed between the RPT and MHRT on the one hand, and the MIQ-R on the other (each $r < .1$, $p > .05$).

**Discussion**

The aim of this study was to investigate the psychometric properties of the RPT. Importantly, motor imagery was found to be tightly coupled to real movements at the cognitive process level; the real and imagined conditions of the RPT both complied with Fitts’ Law. This indicates that imagined movements were constrained by the same biomechanical and environmental factors as real movements (see also Wilson, Maruff, Ives & Currie, 2001). The programming of eye movements during performance does not account for this lawful relationship (Sirigu et
of recall is likely to reflect a common visuospatial coding such that vividness is part and parcel of the sketchpad component of working memory (viz Baddeley’s model). Supporting this argument is data showing that the MIQ-R not only correlates with other subjective measures of motor imagery, but also those measuring the vividness of object-based imagery, like the VVIQ (Lequerica et al., 2002). In sum, it remains unclear the extent to which the MIQ-R taps motor imagery specifically and not some general aspect of visuospatial imagery.

Concurrent Validity of the RPT
Contrary to predictions, the RPT did not correlate with the magnitude of fit for the MHRT, nor with the subjective scale (the MIQ-R). Interestingly, Lequerica and colleagues (2002) have argued that individuals may use strategies other than mental transformation when completing rotation tasks (see also Zacks, Braver, Sheridan, Donaldson, Snyder et al.,2001). In the study presented here, participants may have used critical features of the hand stimulus e.g., the angle formed between the thumb and index finger to circumvent a more resource demanding mental transformation. Indeed, some participants commented on how this strategy “made the task easier”. Participants may have used a mix of strategies to complete the task—for some trials mental rotation and for others a feature-based heuristic. The net result may be additional error in the measurement of movement imagery based on the regression function.

Limitations
The study was limited to some extent by test administration issues to do with the RPT. The accuracy of movements was not formally monitored on the real condition. The use of an automated writing tablet or touchscreen would permit this. Reinforcing the accuracy requirement in this way would likely enhance the fit of the regression of response time on ID, the integrity of the task, and its reliability.

Conclusion
The aim of this study was to assess the psychometric properties of the RPT. Although not achieving the .70 benchmark (Nunnally & Bernstein, 1994), the results were encouraging for reliability. To the extent that task conditions can be optimised (e.g., minimal distractors and reduced task schedule) and measurement error minimized, the RPT holds promise. In addition, the results showed that the RPT predicted the speed of fine-motor performance (on the formboard), while the subjective measure did not. This suggests that objective measures may say more about movement skill than subjective ones. Future research controlling for sources

Reliability Analysis
The reliability of the RPT could be considered borderline; while the test-retest correlation was significant, its magnitude (~ .60) was not strong. Several potential sources of error might have impacted the reliability of the RPT. First, our sample size was only moderate. A larger sample would better capture the wider range of individual differences thought to exist in mental imagery (Isaac & Marks, 1994). Variability is an issue when using Pearson’s correlation because range restrictions tend to reduce the magnitude of the estimate (Cohen & Swerdlik, 2002).

Furthermore, completing six tests in an hour was tiring for participants. The onset of fatigue may have affected performance on the RPT, depending on its order of administration; the retest condition would not have been affected in the same way. Hence, the differential effect of fatigue may have introduced an error source that impacted the reliability analysis.

The Relationship Between Measures of Motor Imagery and Movement Skill
Results showed mixed support for the hypothesis that the RPT would “predict” movement skill. The one significant relationship was between the RPT and the formboard; those who showed a tighter relationship between real and imagined performance on the RPT took less time on the formboard. The shared physical requirements for these tasks might explain this effect. Both tasks involve fine-motor movements, i.e. they are functionally related. In contrast, the gross-motor patterns required for the ball-balance task bear little functional resemblance to the RPT. Previous research has found that during motor imagery, cortical activity in M1 is somatotopically related to those muscles relevant to the imagined motor movement (Jeannerod, 2001). It is plausible that for a predictive relationship to exist, the imagined task and motor skill may need to be linked biomechanically.

Our results were at odds with earlier work that showed the MIQ-R “predicted” motor ability status; however, this is probably a reflection of study design. In two earlier studies (i.e., Goss et al., 1986; Hall, Buckolz & Fishburne, 1989) participants were classified as either high or low imagers based on their MIQ-R scores. They were then tested on their ability to recall simple movements. Those classified as higher imagers had more accurate (motor) memory than low imagers. However, movement skill per se was not used as a correlate. The relationship between what is essentially a vividness rating of imagery and a measure

al., 1995). Similarly, results for the MHRT showed a tight linear relationship between response time and angle. Notwithstanding the above, results were somewhat mixed with regard to reliability and validity of the RPT. This is discussed in more detail below.
of measurement error will enable us to further assess the reliability and construct validity of the RPT.

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References


Social Comparison Processes, Prototypes and Exercise

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Abstract

Recent approaches to understanding how people respond to health risks have linked social comparison outcomes to prototype models of risk behavior (Buunk, Gibbons & Visser, 2002). Health-related decisions are consistently determined by the degree to which the prototype is considered to be similar to the self, and having favourable perceptions of the prototype (Rivis & Sheeran, 2003). This research examined direct and mediating influences of social comparisons, perceptions of inactive prototypes, and perceived control on exercise. Respondents (N=140) provided data for key study variables. Results indicated that those who made upward comparisons with others who are better at maintaining physical activity (a) were more psychologically distanced from inactive prototypes (Beta = .46) and (b) had greater perceptions of control over their ability to exercise (Beta = .43). Both psychological distancing from an inactive prototype and perceived control mediated the effect of preferred level of social comparison on exercise. The three variable model (social comparison, psychological distancing and perceived control) explained 41% of the variance in exercise. Upward comparisons were made by those who were more physically active. The findings can advise on how comparison targets may be implemented in health promotion programs aimed at motivating populations to be more active.

Introduction

Physical inactivity is a risk factor for many chronic medical conditions (Bryan, Hutchison, Seals & Allen, 2007). Australian guidelines for adult physical activity recommend at least 30 minutes of moderate level activity (brisk walking, swimming, cycling) on at least five days of the week (Department of Health and Ageing [DoHA] 2004). Over half of Australian adults (54%) report doing less than the recommended guidelines for physical activity.

The role of social processes in influencing intentions and actual health behaviour is seen in the construct of the subjective norm in the theory of planned behaviour (TPB) (Ajzen, 1991). Research interest has shifted more recently to the study of descriptive norms (perceptions of other people’s behaviour), and prototype perception (perception of types of persons who engage in a behaviour) as social influences (Buunk, Gibbons & Visser, 2002; Lockwood, Wong, McShane & Dolderman, 2005; Rivis & Sheeran, 2003; Rivis, Sheeran & Armitage, 2006). While descriptive norms influence behaviour by indicating what is the usual practice, prototype perceptions influence behaviour through social comparison (SC). Social comparison theory provides a useful framework for understanding factors which hinder, or prompt, participation in health-related behaviours (Buunk & Gibbons, 2007); knowledge of the role of SC processes on exercise can inform the design of health programs for reducing inactivity.

Social comparisons (SC) are learning processes that involve individuals comparing their characteristics to those of others and vice versa (Buunk & Gibbons, 2007). Current SC theory distinguishes between two main types of SC processes: upward SCs and downward SCs (Buunk & Mussweiler, 2001). Upward SCs are self-assessments in relation to others who are considered to be slightly better than the self; and downward SCs are self-assessments in relation to others who are considered to be worse-off than the self (Buunk & Gibbons, 2007). For health risks that can be avoided, improved, or managed (such as with exercise) upward and downward SCs can have both positive or negative outcomes (Mussweiler, Ruter & Epstude, 2004; Tennen, McKee & Affleck, 2000). SC interpretations appear to be more variable for non-terminal health problems at least partially because the likelihood that an individual will view either an upward or downward SC target as a future-self is dependant on a combination of many factors that can be changed (Lockwood et al., 2005).

Exposure to people who are doing better at managing their health (upward SCs) tends to evoke more negative feelings such as envy, low self-esteem and frustration when the comparer thinks that it is too difficult, or that it will take too long, for him or her to progress towards the upward target’s superior state (Lockwood et al., 2005). Importantly, these negative affect outcomes have been linked to decreases in health-promotion behaviours and increases in health-risk behaviours (Tennen et al., 2000; Thornton, Gibbons & Gerrard, 2002). However, when people believe that it is possible for them to reach an upward SC target’s level, information obtained from upward SCs has been found to evoke positive feelings such as inspiration and identification, which in turn, increase positive behaviours (Collins, 2000). Exposure to people who are doing worse at managing
health problems that are treatable (downward SCs) most often enhances self-esteem and positive mood (Lockwood et al., 2005). For health problems that are not terminal, it is unlikely that individuals will feel threatened from downward SCs because they do not interpret targets inferior to them as possible futures (Lockwood et al., 2005). Researchers have questioned whether exposure to others who are experiencing the costs of not taking care of their health may motivate people to increase healthy behaviours so that they do not become like the target. Lockwood et al. (2005) found that while participants were more likely to be motivated by outstanding exemplars of physical fitness rather than poor exemplars, when body shape consequences of poor or excellent fitness were emphasized, negative exemplars could also be motivating.

Recent approaches to understanding how people respond to health risks have linked SC outcomes to prototype models of risk behaviour (Buunk et al., 2002). Prototypes are interpersonal impressions of “the typical” person who performs a particular behaviour and can vary between individuals, over time and across situations (Ouellett, Hessling, Gibbons, Reise-Bergan & Gerrard, 2005). Two features of prototype perception that consistently influence health-related decisions are the degree to which one considers a prototype favourable (prototype favourability), and the degree to which one considers a prototype similar to the self (prototype similarity) (Rivis & Sheeran, 2003). Perceptions of both prototype favourability and prototype similarity are positively correlated with increases in behaviours that are identified with the prototype (Rivis & Sheeran, 2003). Perceived similarity to a prototype has been found to have a direct effect on exercise behaviour in young people, and interacted with descriptive norms (having friends who exercise). These effects seem to be independent of the theory of planned behaviour variables and past behaviour (Rivis & Sheeran, 2003).

Buunk and Ybema’s (1997) identification-contrast model of social comparison argues that psychological distancing involves a process of looking for differences (less perceived similarity) between the self and prototype. The more psychologically distanced a person is from a particular prototype, the less likely it is that he or she will engage in behaviours that are associated with the prototype. For instance, smokers who were successful at quitting, showed an increase in psychological distancing from “the typical smoker” over the course of a quit smoking program (Gibbons, Gerrard, Lando & McGovern, 1991). Other research by Gerard, Gibbons, Stock and Lane (2005) found that smokers who were unsuccessful in quitting made more downward comparisons presumably for self-enhancement purposes, while those who were successful at quitting preferred to compare their experiences with upward SC targets. Psychological distancing mediated the relationship between SC and performance such that low SC levels (downward SCs) prevented people from distancing themselves from a smoker prototype, and in turn, this influenced unsuccessful quit attempts (Gerrard et al., 2005). On the other hand, high SC levels (upward SCs) were found to facilitate distancing and quitting.

The current study aimed to link SC processes to prototype models of risk behaviour to determine whether relationships between these factors, influence the amount of exercise that people do. Perceived behavioural control as proposed by the TFB was also included as a predictor of exercise behaviour as there is evidence that perceived control adds significantly to the prediction of health behaviour (Armitage & Conner, 2001).

It was hypothesized that: (1) psychological distancing from an inactive prototype, preferred SC level, favourability of an active prototype, and perceived control over exercise will all increase as a function of the amount of exercise people do; (2), psychological distancing from an active prototype, favourability of an in-active prototype, and perceived personal risks associated with inactivity will all decrease as a function of the amount of exercise people do; and (3), the relationship between preferred SC levels and exercise will be mediated by psychological distancing from an in-active prototype and perceived control over exercise.

Method

Participants
A total of 140 adults (91 females, 49 males), with no serious physical disability or injury were recruited from the Cairns Shire through advertisements, as a convenience sample to participate in the study. Participants’ ages ranged from 18-73 years (M = 36.7 years, SD = 14.7 years).

Materials
A new questionnaire containing 36 items was developed specifically for the current study.

Exercise behaviour. Participants were presented with three Queensland Health (2003) recommendations for healthy physical activity and were asked to report how often per week they engaged in activities that reflected each recommendation by using a five point Likert scale: 1 = never; 2 = 1-2 times; 3 = 3-4 times; 4 = 5-6 times; and, 5 = 7 or more times. Responses to these questions were averaged and this index was used as a measure of the number of times participants engaged in exercise per week.
Preferred Direction of Social Comparison. Preference for direction of SC (SC level) was measured by two questions: (1) "If I were to join a new fitness program I would prefer to have people in my group who are _____", with anchors of very inactive and very active on a ten centimetre visual analogue scale; and, (2) "If I were to join a new fitness program I would prefer to have people in my group who are _____", with anchors of very inactive in comparison to me and very active in comparison to me on a ten centimetre visual analogue scale. Ratings on the preferred direction of SC items were averaged to form a single ten centimetre scale (α = .85).

Perceived Personal Control. Perceived personal control over exercise was assessed with eight items, each measured on a ten centimetre visual analogue scale, with anchors of strongly disagree and strongly agree. The items were adapted from Lippke and Plotnikoff (2006), and consisted of questions about people’s confidence in exercising when: feeling tired; in a bad mood or depressed; having to do it alone; it’s boring; there are no noticeable improvements; there are many other time demands; feeling stiff or sore; and, the weather is bad. Reliability in the current study was .84.

Perceived Risk. Perception of personal risk associated with physical inactivity was measured with the question: “I believe my health is at risk from not doing enough physical activity” on a ten centimetre visual analogue scale, with anchors of strongly disagree and strongly agree.

Favourability of, and Psychological Distancing from, Active and Inactive Prototypes Participants were asked to write down as many characteristics as they could think of to describe “the typical active person” and “the typical inactive person”. For both descriptions they were recommended to consider the following characteristics: appearance; general health; energy levels; attitude toward life; achievements; career; intimate relationships; family relationships; friendships, and social groups. Next, participants were asked to indicate on a 10 centimetre visual analogue scale (1) “how favourable is your impression of the typical type of person who is (a) active; and, (b) inactive?”; and, (2) “How similar you are to the typical (a) active; and, (b) inactive person?” Anchors of not at all similar and extremely similar were used respectively.

Procedure Potential participants from the Cairns Shire who were over the age of 18 with no serious physical disability or injury were asked to take part in the study. Willing participants were provided with a research package, which consisted of a 20 minute questionnaire, an information sheet, an instruction sheet, and a return envelope. Ethical clearance for the study was provided by James Cook University Human Ethics Subcommittee.

Results

As predicted in hypothesis 1, those who were more physically active had higher levels of preferred social comparison (i.e. made more upward social comparisons) as demonstrated by a significant (p<.001) Pearson correlation coefficient of .47, were more psychologically distanced from an inactive prototype (r=.47, p<.001), perceived active prototypes more favourably (r=.28, p<.05) and had greater perceived personal control over exercise behaviour (r=.58, p<.001).

As predicted from hypothesis 2, those who were more physically active were less psychologically distanced from an active prototype (r=-.45, p<.001), perceived an inactive prototype less favourably (r=-.17, p<.05) and perceived their health risk to be less than those who were less active (r=.34).

In order to test hypothesis 3, bivariate regression and hierarchical regression were used. Bivariate regression indicated that preferred level of SC was significantly related to both psychological distancing from an inactive prototype (β = .46, p<.01, R² = .21), and perceived control over exercise behaviour (β = .43, p<.01, R² = .19). Preferred level of SC predicted weekly exercise (β = .47, p<.01, R² = .22).

Table 1: Hierarchical Regression Analysis of the Mediating Effect of Psychological Distancing from an Inactive Prototype and Perceived Personal Control on the Relationship between Social Comparison Level and Exercise

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beta</td>
<td>Beta</td>
<td>Beta</td>
</tr>
<tr>
<td>Preferred level of social comparison</td>
<td>.47**</td>
<td>.32**</td>
<td>.22*</td>
</tr>
<tr>
<td>Psychological distancing from an inactive prototype</td>
<td>.32**</td>
<td>.17*</td>
<td></td>
</tr>
<tr>
<td>Perceived personal control</td>
<td>.40**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>.22</td>
<td>.30</td>
<td>.41</td>
</tr>
<tr>
<td>R² Change</td>
<td>.22</td>
<td>.08</td>
<td>.11</td>
</tr>
</tbody>
</table>

*p<.05, **p<.001
In support of hypothesis 3, hierarchical regression indicated that psychological distancing from an inactive prototype mediates the relationship between preferred levels of SC and exercise; as shown in Table 1 by the reduced Beta value in Step 3 (β = .22). Perceived control over exercise behaviour also mediates the effect of preferred level of SCs on exercise, although not to the same extent as psychological distancing from an inactive prototype. Preferred level of SC alone explained 22% of the variance; psychological distancing from an inactive prototype alone explained 8% of the variance; while perceived control alone explained 11% of the variance. The total model \( F(3, 136) = 31.53, p < .001 \), explained 41% of the variance in reported physical activity.

**Discussion**

There is evidence from the present study that SC processes may influence whether or not people engage in recommended exercise. The findings indicate that the more psychologically distanced people are from an inactive prototype and the more in control they feel about their ability to be active, the more likely it is that they will compare themselves to others who are better than them at maintaining exercise behaviour (upward SC targets). Higher levels of SCs were associated with greater exercise; thus, people who make upward SCs in regards to physical activity attributes, are more active themselves. Together, these results are in line with current SC theory assumptions (Buunk & Gibbons, 2007; Buunk et al., 2002) and research on smoking (Gerrard et al., 2005) that for behaviours that can be changed, upward SCs – as opposed to downward SCs – are more likely to facilitate positive behaviours when: (a) a person believes that it is possible for them to progress to an upward target’s state (as was measured by perceived control over exercise); and (b) when a person does not consider him- or herself similar to inactive prototypes (psychological distancing from an inactive prototype). The present findings are consistent with Rivis and Sheeran (2003) that similarity to a prototype has a direct effect on exercise.

The observation that high levels of favourability of an active prototype were related to higher levels of exercise is consistent with prototype models of behaviour, which hold that prototype favourability is positively correlated with behaviours associated with the prototype (Thornton et al., 2002; Gerrard et al., 2005). However, in contrast to prototype models and previous findings, which suggest that favourable impressions of health risk images facilitate risky behaviours (Gerrard et al., 2005; Blanton et al., 2001), those who were more inactive did not have overly favourable impressions of inactive prototypes. One explanation for this finding is that most of the stereotypical characteristics associated with physical inactivity (negative body images, low energy levels, lack of self-respect etc) are socially undesirable throughout Australia. Health-protective and health-risk behaviours are both driven by the aspiration to associate oneself with positive images as well as the aspiration to dissociate oneself from negative images (Ouellette et al., 2005). Research by Ouellette et al. supports this view with the finding that systematic contemplation of the negative aspects associated with inactive prototypes is linked to increases in physical activity over time. The present findings extend those of Lockwood et al. (2005) that negative exemplars of physical fitness can motivate behaviour change by demonstrating that this can be explained by social distancing from the negative prototype.

Findings from the present study are limited by the cross-sectional design. It is recommended that future research use longitudinal designs to monitor the influence of SC processes on the management of physical inactivity as a health risk, and on manageable health risks in general.

Social comparison processes, SC outcomes, and physical activity are often contingent on varying combinations of environmental, contextual, motivational and individual factors (Mussweiler & Strack, 2000), which were not measured in the current study. For example, behavioural intentions are strongly linked to SC processes and outcomes (Buunk & Gibbons, 2007; Ouellette et al., 2005); however, although less active participants had higher perceptions of “risk as a result of physical inactivity”, whether or not participants were trying to increase their levels of physical activity was not considered in the current analysis.

The present research has practical implications, particularly for interventions aimed at increasing physical activity. Given that higher levels of upward SCs and psychological distancing from inactive prototypes are both linked to higher levels of physical activity, interventions need to: (a) increase the likelihood that people will make upward SCs; and (b) encourage people to psychologically distance themselves from inactive prototypes. In order to do this, interventions must emphasize similarities between upward SC targets and the target audience, and dissimilarities between downward SC targets and the target audience. Importantly, in consideration of the demonstrated mediating effects of perceived control over exercise, people facing risks associated with physical inactivity must continuously be exposed to upward SC targets that are realistic enough to make them feel that they are capable of progressing towards the upward SC target’s “superior state”.

Future research should attempt to identify the variables which best predict: (a) the types of SCs that
specific populations of people are most likely to make in relation to physical activity; and (b) how specific populations of people respond to exposures to different activity-related SC targets. Such information may be used to implement SC targets into intervention programs in ways that would be most beneficial for different populations that are at risk of health problems resulting from physical inactivity. Physical inactivity is a growing problem in Australia and SC processes play a significant role.

References