An Empirical Investigation of Embodiment in the *Heal* Concept

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Abstract

Embodied cognition approaches argue that the body is intertwined with the development and functioning of concepts. The overarching aim of this project was to empirically investigate the heal concept from an embodied cognition perspective. For the purposes of the present project, heal was broadly defined as the recovery from psychological and physical pain. Viewed from the embodied perspective, the concept may therefore have implications for the poorly understood placebo phenomenon in medicine.

One specific embodied cognition perspective, Barsalou’s (1999) Perceptual Symbol Systems theory, was selected to frame the project’s empirical studies. In Perceptual Symbol Systems theory, concepts are modal representations and the activation of a concept involves a neural reconstruction of its experience in modal centres of the brain, which is termed “simulation”.

Three empirical studies were conducted. Study 1 utilised a word association/property generation task to test Perceptual Symbol Systems theory assumptions about the human cognitive system, the representation of abstract concepts, and heal in particular. As hypothesised, Study 1 findings were consistent with the assumption that the simulation process occurs later in cognitive processing than the more superficial language-based processing. Also as predicted, abstract concepts were found to differ from concrete concepts in evoking a higher proportion of introspective properties.

Studies 2 and 3 were designed to investigate the impact of priming the putatively embodied heal concept. In neither study was activation of the heal concept (simulation of heal, in Perceptual Symbol Systems terminology) directly measured; rather, it was assumed that this hypothetical mechanism could be deemed to have been in operation should a stimulus argued to prime the heal concept be shown to have the expected effects on cognitive performance (Study 2) and phenomenological experience (Study 3).

Study 2 was an “offline” cognitive task (determining whether a word was associated with the target word ‘heal’), in which the effects of activating the heal concept were expected to manifest as more rapid decision making. Study 3 investigated “online” cognition, in which the effects of activating the heal concept were expected to appear in a more pronounced experience of healing (operationalised as decreased perceived pain sensation subsequent to a cold pressor task). Both studies 2 and 3 were
underpinned by literature suggesting that the *up bodily state* embodiment is part of the *heal* concept. It was predicted that, to the extent that *heal* is embodied, the concept would be simulated when primes related to the up bodily state were presented. In both studies, the bodily state prime was presented in two forms, namely, visual (photograph of a person looking upwards vs. downwards) and visual + motor (participant additionally instructed to enact looking upwards vs. downwards). The latter condition was expected to be the stronger of the two primes.

Results of studies 2 and 3 were only partially consistent with predictions. As expected, Study 2 found shorter latencies in categorising words as related or unrelated to *heal* after the up bodily state was primed. However, adding a congruent motor prime to the visual prime did not augment this effect. Contrary to Study 3 predictions, healing was not more pronounced when the up bodily state was primed, thus there was also no effect to be augmented by adding a congruent motor prime to the visual prime. However, when the joint visual + motor primes were examined independently of the visual prime, healing was found to be more pronounced when the up bodily state was primed. Furthermore, there were nonsignificant trends toward the moderation of the significant effect of up bodily state primes facilitating processing related to *heal* found in Study 2 by individual differences in cultural background and the intensity of pain experiences.

Findings across all three studies are discussed in terms of implications for the hypothesised embodiment of the *heal* concept, Perceptual Symbol Systems theory, and embodied cognition approaches more broadly. It is tentatively concluded that the *heal* concept is partially embodied in the up bodily state and more broadly that the human cognitive system may be representationally pluralistic, but that more definitive findings for *heal*, and for the broad embodied cognition agenda await conceptual and methodological clarification in a number of areas.
Declaration

This is to certify that:

i. this thesis contains no material which has been accepted for the award to the candidate of any other degree or diploma;

ii. to the best of the candidate’s knowledge, this thesis contains no material previously published or written by another person except where due reference is made in the text of the examinable outcome;

iii. where the work is based on joint research or publications, discloses the relative contributions of the respective workers or authors; and

iv. the ethical principles of the Australian Psychological Society and the codes, guidelines and principles of Swinburne University of Technology in relation to research have been adhered to during the course of this research project.

Nuwan Leitan

2013
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1. LITERATURE REVIEW

1. Background and Overview

1.1 Embodied Cognition and the Heal Concept

The overarching aim of this project was to empirically investigate the *heal* concept from an embodied cognition perspective. Thus, the two central components of the project were “embodied cognition” and “the *heal* concept”. The project examined these two components since each allows for novel inferences to be drawn about the other. The *heal* concept, viewed from an embodied cognition perspective, had the potential to illuminate the poorly understood placebo phenomenon in medicine and, conversely, the rigorous examination of *heal* across a variety of conditions provided an examination of one embodied cognition perspective.

1.1.1 Embodied cognition. Embodied cognition is one of numerous approaches which provide frameworks by which concepts can be defined and studied (e.g., Perceptual Symbol Systems theory and Conceptual Metaphor Theory); other approaches include computational and connectionist approaches (Fodor, 1975; McClelland & Rumelhart, 1986). Some theories stemming from the latter approaches adhere to frameworks which suggest that the mind and the body serve distinct functions in the development and functioning of concepts (Johnson, 2007). Thus, these approaches are linked to the philosophical stream of thought known as dualism. Broadly, dualism is the view that the mind, which is for thinking, is separate from the body, which is for perceiving and doing (Stent, 1998). Conversely, embodied approaches adhere to frameworks which suggest that the mind and body are intertwined in human cognition (Johnson, 2006). Thus, embodied approaches are linked to nondualistic philosophical perspectives such as naturalism and phenomenology (Johnson, 2007).

Embodied cognition is an approach which covers a wide range of theories, assumptions, and hypotheses, introducing the risk of ambiguous operationalisation in the design of empirical tests of embodied cognition predictions (Shapiro, 2011). To prevent this, the present project selected one specific perspective of embodied cognition, Barsalou’s (1999) Perceptual Symbol Systems theory, to frame the empirical studies. According to Perceptual Symbol Systems theory, concepts are modal representations and the activation of a concept involves a neural reconstruction of its experience in modal centres of the brain, which is termed “simulation”. Links between
the abovementioned philosophical ideas and the approaches, accounts, and theories of conceptual knowledge stemming from them are diagrammatically represented in Figure 1 (dualist) and Figure 2 (nondualist), below.

**Figure 1.** Links between dualistic philosophical ideas, approaches to conceptual knowledge and the accounts and theories stemming from them. Philosophical ideas (solid ovals), approaches to conceptual knowledge (solid squares), and theories which stem from them (dashed rectangles).\(^1\)

**Figure 2.** Links between nondualistic philosophical ideas, approaches to conceptual knowledge and the accounts and theories stemming from them. Philosophical ideas (solid ovals), approaches to conceptual knowledge (solid squares), accounts of the approaches (dashed ovals), and theories which stem from them (dashed rectangles).\(^2\)

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\(^1\) Not all perspectives are covered here, only those discussed in the upcoming literature review.

\(^2\) Not all perspectives are covered here, only those discussed in the upcoming literature review.
Perceptual Symbol Systems theory has a number of advantages as a framework for the project’s investigation of the heal concept. Firstly, the theory has a substantial history and has been comprehensively articulated and critiqued in the literature. Secondly, Perceptual Symbol Systems theory has directly addressed the problem of the embodiment of abstract concepts, therefore prior Perceptual Symbol Systems theorising and data informed the present project’s focus on heal. Finally, and most importantly, since Perceptual Symbol Systems theory potentially bridges the Cartesian divide by positing modal grounding, it had the potential to shed light on how mental states can be physically realised, consequently illuminating the poorly understood placebo phenomenon in medicine.

1.1.2 The heal concept. To the best of the author’s knowledge, the present project was the first to examine the heal concept. For the purposes of the present project, heal was broadly defined as the recovery from physiological and psychological pain. Heal was considered an abstract concept which, as implied by metaphor and Perceptual Symbol Systems theory, is proposed to be constituted of the “up bodily state”, the “visual perception of light”, and “introspections of positive emotion”. The present project focussed on the up bodily state component of heal’s putative embodiment.

The heal concept was ideal for the comprehensive examination of an embodied cognition perspective, such as Perceptual Symbol Systems theory, for a number of reasons. Firstly, embodied theories have been criticised for being unable to account for abstract concepts (Mahon & Caramazza, 2008). Secondly, the concept was suitable for examination from a number of different methodological perspectives, namely; linguistic (i.e., word association and property generation), offline (i.e., in the absence of task relevant inputs and outputs), and online (i.e., in the context of task relevant inputs and outputs) conditions (Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Wilson, 2002).

1.2 Project Outline

The project consisted of three empirical studies. Study 1 utilised a word association/property generation task to test Perceptual Symbol Systems theory assumptions about abstract concepts in general and heal in particular. Study 1 examined the Perceptual Symbol Systems theory-related assumption that the putative simulation process occurs later in cognitive processing than the proposed language-based process.
Furthermore, the Perceptual Symbol Systems theory assumption that abstract concepts differ from concrete concepts by evoking a higher proportion of introspective responses was examined.

Studies 2 and 3 were designed to investigate the impact of priming the putatively embodied heal concept. In neither study was activation of the heal concept directly measured; rather, it was assumed that this hypothetical mechanism could be deemed to have been in operation should a stimulus argued to prime the heal concept be shown to have the expected effects on cognitive performance (Study 2) and phenomenological experience (Study 3).

Study 2 was an offline cognitive task (determining whether a word was associated with the target word ‘heal’), in which the effects of activating the heal concept were expected to appear in more rapid decision making. Study 3 was an online experiment, in which the effects of activating the heal concept were expected to appear in a more pronounced experience of healing (operationalised as decreased perceived pain sensation subsequent to a cold pressor task). Both studies 2 and 3 were derived from arguments suggesting that up is linked to the heal concept, and it was predicted that, to the extent that heal is embodied, the concept would be simulated when primes related to the up bodily state were presented. In both studies, the bodily state prime was presented in two forms, namely, visual (photograph of a person looking up vs. down) and visual + motor (participant additionally instructed to enact looking upwards vs. downwards). The latter condition was expected to be the stronger of the two primes.

Finally, a novel investigation of the moderating effects of individual differences on study 2 and 3 main effects was conducted to draw further inferences regarding the proposed underlying Perceptual Symbol Systems theory processes. Differences in culture, pain experience, and pain intensity were predicted to influence embodiment simulation of the heal concept in the up bodily state. Thus, the individual differences investigation aimed to examine whether differences in culture, pain experience, and pain intensity would influence the speed of decision making in Study 2, and the perceived degree of healing in Study 3.

1.3 Thesis Outline

The thesis introduction is structured in a funnel style, from broad philosophical theories to the focussed study of the heal concept from a Perceptual Symbol Systems

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3 Simulation of heal, in Perceptual Symbol Systems theory terminology.
theory perspective. Chapter 2 contains an exploration of the philosophical perspective of dualism and linked approaches to cognition. Dualism was chosen as a starting point because it has been the most influential philosophical basis for theories of cognitive psychology since the cognitive revolution in the mid-twentieth century (Johnson, 2007; P. J. Marshall, 2009). After a short introduction to Rene Descartes, the father of “substance dualism”, the discussion turns to its cognitive successors, namely “computational cognition”, which is the currently dominant theory of cognition, and “connectionism”.

Chapter 3 is dedicated to the nondualistic philosophical movements of “naturalism” and “phenomenology”. The chapter first outlines naturalism, with a focus on John Dewey’s “principle of continuity”, which posits that there is no break in experience between the processes of perceiving, thinking, and moving and that they are simply levels of organic functioning from which higher functions emerge organically. This is followed by a description of phenomenology, with a focus on Maurice Merleau-Ponty’s “lived-body” theory which views the body not as a slave of the mind but as “lived-through”, thus elevating the importance of the body in cognition.

Chapter 4 is a substantial chapter centring on the embodied cognition approach. Three major accounts under the umbrella of embodied cognition are discussed including: extended mind, dynamical systems, and grounded cognition. The chapter begins with a summary of the three views, followed by an exposition of dynamical systems theory and its limitation in relation to offline cognition. Finally, the grounded cognition account, and theories stemming from it are discussed.

Chapter 5 details Barsalou’s (1999) Perceptual Symbol Systems theory, which formed the central framework for the present project. The chapter begins with a detailing of its basic theory followed by its crucial “situated conceptualisation” extension. The following sections turn to other important aspects of the theory for the current project including: the manipulation and behavioural realisation of simulation, online and offline cognition, and the embodiment of abstract concepts.

Chapter 6 takes a diversion from the flow of the thesis by detailing a further extension to Perceptual Symbol Systems theory called the Language and Situated Simulation theory (Barsalou, Santos, Simmons, & Wilson, 2008). This theory updates Perceptual Symbol Systems theory by adding to it a linguistic system.

Chapter 7 focuses on operationalising the heal concept from a Perceptual Symbol Systems perspective and detailing how it can help illuminate the placebo effect.
The chapter begins with the operationalisation of *heal* from a Perceptual Symbol Systems perspective, leading to the selection of the up bodily state embodiment of *heal* as the focus of studies 2 and 3 of the present project. This is followed by the exposition of potential individual differences factors hypothesised to influence the embodiment of *heal* in the up bodily state and a detailing of the question of how the embodied *heal* concept could illuminate understanding of the placebo effect.

Finally, Chapter 8 provides a summary of the project followed by the aims and hypotheses for studies 1, 2, 3, and the individual differences investigation.

### 2. Dualism, Computational Theory of Mind, and Connectionism

This chapter explores the philosophical idea of dualism, followed by two approaches to conceptual knowledge whose core tenets are derived from it. The chapter begins with a short introduction to Rene Descartes, the father of “Cartesian dualism”, and a description of his idea. This is followed by a review of two cognitive successors of dualism, namely “computational cognition”, which is the currently dominant theory of cognition, and “connectionism”. The chapter concludes with a comparison of the two approaches and an analysis of limitations of cognitive approaches underpinned by the dualistic framework.

#### 2.1 Dualism

Dualism is a philosophical position on the “mind-body problem”, which was first brought to attention when Plato suggested that mind and body are fundamentally different entities (Stent, 1998). Plato’s argument was that statements made about peoples’ bodies are obviously different in kind from statements made about their thoughts and feelings (Stent, 1998). Since this suggestion, there have been a number of conceptions of the dualist paradigm (e.g., property dualism), the most influential of these being Cartesian dualism (hereafter referred to as “dualism”), named after Rene Descartes (Stent, 1998).

Descartes was one of the leading anatomists and physiologists of his time and believed that animal and human bodies were complex machines made of bone, muscles, and nerves (Van Gelder, 1993). He devoted considerable effort to demonstrating how these complex biological machines could give rise to many different kinds of behaviours and ultimately came to the conclusion that all animal behaviour could be

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4 Also known as “substance dualism”.
explained in these terms. However, he was unable to explain how the biological machine accounted for human-specific activities and therefore had to attribute these skills to a substance separate from the biological machine, the ideal candidate being the mind (Van Gelder, 1993). This is where Descartes’ well known distinction between *res extensa* (the body) and *res cogitans* (the mind) originated (Rozemond, 1998). He conceived of the body as a physical substance extended in space and time but lacking mental characteristics such as consciousness, and the mind as a mental substance lacking physical characteristics such as extension in space and time (Johnson, 2006; Kirkeben, 2001; Muller & Newman, 2008).

Descartes’ position has been the dominant view of human nature in western philosophy and psychology for centuries. Dualistic thought provided the answer to a number of significant philosophical problems (Muller & Newman, 2008). Firstly, if the mind was a different substance to the body, then life after death would be metaphysically plausible since the mind/soul may be able to survive death of the physical body. Secondly, everyday experience and language appear to confirm that the body is separate from the mind. For example, the statement “I will use my fingers to type out this thesis”, gives the impression that the body is controlled by a separate and disembodied mental self. Finally, a disembodied mind explains how moral responsibility can be possible in a physical world. If minds are not of physical substance, they are not subject to causal determination, thus allowing for free choice and action (see Johnson, 2006 for further discussion).

These reasons sustained dualism until the so-called cognitive revolution in psychology throughout the mid-twentieth century when cognitive science utilised Descartes’ division in forging an approach to cognition underpinned by the computer metaphor (A. Newell, 1980). These theories are referred to as “computational theories of mind”, and are the focus of the next section.

### 2.2 Computational Theory of Mind

Computational theory of mind, first articulated by Hilary Putnam (1960), is the theoretical position that the mind functions as a symbol manipulator. It posits that the mind represents the external world, and a cogitator’s relations to it, via symbols which are manipulated according to syntactic rules and semantic properties to form a specific output (Fodor, 1975; Hershfield, 2005; Horst, 1999). Symbols in computational theory of mind have no content; they are designations derived from their manipulation. Thus, it
is the structure and organisation of the system, rather than the content of the symbols, which is considered important (Meteyard, Cuadrado, Bahrami, & Vigliocco, 2012). Consequently, computational theory of mind focuses on how concepts and words are processed and related to one another rather than their content and how they refer to things in the world (Meteyard, et al., 2012).

Cognition in computational theory of mind is a process of rule-governed symbol manipulation which has been described as being analogous to that seen in a computer (Shapiro, 2007). Viewed through this metaphor, sense organs serve as input devices, as would the mouse or a keyboard, which relay information from the environment. The brain acts much as a central processing unit which translates information into the relevant processing format, and performs manipulations on the translated information. This information is then sent to the appropriate effector, analogous to what is displayed on the computer’s screen (Shapiro, 2007).

The dualism inherent in computational theory of mind is apparent in the above description. A central aspect of computational theory of mind is that cues presented to the senses need to be translated into symbols to be processed in the mind, which implies that the mind is a distinct substance with different characteristics (i.e., mental) to the body, and world (Shapiro, 2007). A helpful illustration of this point is found in the brain-in-a-vat thought experiment in which a scientist has a live brain kept in an insulated vat and delivers the same sensory code to it as if it was in a jungle or school. In this case the brain’s cognitions would not differ at all from one that is actually in a jungle or school. Since cognitions begin and end with inputs to, and outputs from the nervous system, it can operate without bodily interaction with the external world, consistent with the dualist idea that the mental substance of the mind can operate independently of the physical substance of the body (Shapiro, 2011).

Computational theory of mind approaches have accounted for cognition in both offline and online conditions. Cognition which occurs in the context of task relevant inputs and outputs is called “online” cognition (Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Wilson, 2002). Correspondingly, cognition which occurs in the absence of task relevant input or output is called “offline” cognition (Niedenthal, et al., 2005; Wilson, 2002). A jigsaw puzzle is an exemplification of an online task because it involves solving a problem with the pieces of the puzzle physically present. By contrast, an example of an offline task is one in which a video clip is shown and then after a delay, aspects of the video clip are to be recalled. This is considered an offline
task since the task relevant input (i.e., the video clip) is not physically present during the recall.

2.2.1 Online demonstrations of computational theory of mind. This section will present two different computational theory of mind-linked cognitive programs which address online processes: Newell and Simon’s General Problem Solver\(^5\) and the Computational Vision Program. The first of these programs, the General Problem Solver, was developed before the advent of computational theory of mind, thus is not based on it but was a precursor of it (Gugerty, 2006).

The General Problem Solver was a computer program designed not only to solve logical problems, but to solve them in the same fashion as a human would. In order to do this, S. Newell and Simon (1961) set up an experiment in which simple logical problems were presented and processes used to solve the problems were to be expressed verbally during the task. The assumption behind the General Problem Solver was that human cognition would operate like a computer, as exemplified by the following extract from S. Newell and Simon (1961):

we can postulate that the processes going on inside the subject’s skin – involving sensory organs, neural tissue and muscular movements controlled by the neural signals – are also symbol-manipulating processes; that is, patterns in various encodings can be detected, recorded, transmitted, stored, copied and so on, by the mechanisms of this system. (p. 2012)

The steps taken to solve the problem were compared to that of the computer program and it was concluded that “the General Problem Solver provided a good approximation of information processing for certain kinds of logical tasks…..and that the thinking process was no longer a mystery” (S. Newell & Simon, 1961, p. 2016). The success of the program was task dependent, but some major theoretical points were drawn, which marked a paradigm shift in cognitive psychology, including that the aim of cognitive science was to uncover the inner working of the mind (in addition to related behaviours) and that human cognition was a computation process involving symbols (Shapiro, 2011).

In addition to higher order cognition such as problem solving, the computational theory of mind approach also generated theories about lower order cognitions such as vision. Computationalists\(^6\) saw the visual system as a problem solver, addressing the

\(^{5}\) Also known as the “Logical Theorist”.
\(^{6}\) Computational theory of mind theorists or proponents.
question of how retinal stimulation becomes a perception of the world by utilising computational information processing (Shapiro, 2011). One important conclusion from computational vision was that patterns of stimulation on the retina do not carry enough information on their own for visual perception, thus requiring computations (Shapiro, 2011). It was theorised that when one object is presented in the visual field, the object is represented at corresponding points on each retina. However, when more than one object is presented, the objects are represented at different points on each retina (Shapiro, 2011). This difference on each retina is named the “degree of disparity” and is a cue which can be used to calculate relative depth. The problem becomes apparent not in the calculation (which only requires basic trigonometry) but in that the visual system must match the points of the correct image to the correct point on each retina (Shapiro, 2011).

This is called the problem of “false targets”. In response to this problem, Marr and Poggio (1976, in Shapiro, 2011) developed an algorithm which made two assumptions about the physical world. One assumption was that each point on a retina corresponds to only one point in the physical world, thus each point on the left retina corresponds to only one point on the right retina. The second assumption was that surfaces in the physical world tend to be smooth rather than disjointed, so points on a surface near to each other are proposed to lie along the same plane. These two assumptions meant that there was only one disparity value for each point on a retinal image and that disparity will generally occur smoothly (Shapiro, 2011). The computation is complex but these two assumptions prevented the problem of false targets occurring. Marr and Poggio’s account displays the hallmarks of computational theory of mind; vision has a well-defined start point at the retinal image, computations underpinned by rules which inherit assumptions about the physical world then manipulate these symbolic representations, and finally a symbolic description of the physical world is produced (Shapiro, 2011). Theories which display these computational hallmarks continue to pervade the literature and provide fruitful accounts of vision (Wei & Guan, 2008; Yuille, 2010).

2.2.2 Offline demonstrations of computational theory of mind. A series of memory scanning experiments suggested that offline cognition may also be underpinned by computational theory of mind (Sternberg, 1969). One of the tasks involved the memorisation of a list of items, after which an item from the list was presented to be judged according to whether it was on the list or not. The aim was to examine whether
the process utilised was an exhaustive search, in which the test item is compared to all items in the mental list; or a self-terminating search, in which the test item is compared to each item in the list until a positive match is made, after which the search is terminated (Shapiro, 2011). It was determined that both search strategies required a determinate amount of processing time, independent of the number of items on the list. Regardless of the number of items on the list, identification of the test item, production of a response (yes or no), and finally an actioning of the response was required (pulling a lever up or down). Another assumption was that both search strategies were serial processing strategies, which meant that if a test item was not on the list, either strategy would take the same time since both strategies would require a search of the entire list. Therefore, only trials in which the test item was in the list would provide information about which strategy was utilised; since an exhaustive search would require comparison of the test item to every item on the list, while the self-terminating search would cease when the test item is matched with an item on the presented list. The experiments suggested that the exhaustive search strategy was utilised (Shapiro, 2011).

The memory scanning experiments had a number of significant implications for the conceptualisation of cognition. Firstly, these experiments were designed to provide information about the “program” underlying the task, thus suggesting that cognition is structured similar to a computer (Shapiro, 2011). Secondly, the description of the process, with a determinate start point (exposure to the list) and a determinate end point (positive or negative response), is analogous to a computational system. The experiment suggested that cognition involves the manipulation of symbols, in that the memorised items were stored as symbols in a “data buffer” and item recognition involved comparing the test item symbol to the symbols in the buffer, comparable to the functioning of a computer (Shapiro, 2011).

The two online cognition examples presented in the preceding section and the offline cognition example presented above speak to notably different aspects of cognition, but all are consistent with computational theory of mind. The next section is devoted to the most influential psychological theory of cognition, Fodor’s (1975) Language of Thought theory, which elevated computational theory of mind as the dominant foundation for psychological theories of cognition (Glenberg, 2006; P. J. Marshall, 2009).

2.2.3 Language of Thought. Language of Thought theory has been referred to as a “folk”, “propositional”, or “belief-desire” theory because of its suggestion that
cognition can be explained by attributing intentional states to people, which relate to aspects of the world (Fodor, 1975; Johnson, 2007). Thus, according to Language of Thought theory, cognition is about the chain of connections between mental states which are causally connected to the world (Fodor, 1975; Johnson, 2007). It was proposed that this chain of connections between mental states can be understood in the same way as language is understood; that is, cognition constitutes “words”, “syntax”, and “semantics”. The “words” in Language of Thought theory are simple concepts, or “tokens”, which obtain their meaning from their law-like relations to events in the world that cause them to be tokened in the Language of Thought (Fodor, 1975; Johnson, 2007). The “syntax” are the rules which govern how the “words” are manipulated according to their tokening and this structure is what produces the “semantics”, or meaning, in cognition (Horst, 1999; Johnson, 2007). In summary, “words”, or concepts, in the Language of Thought are arbitrary representational symbols which are given meaning only by their tokening according to events in the world (relating to mental states), which are mentally expressed as “syntax”, or combinatorial rules, which provide the “semantics”, or meaning, in cognition (Horst, 1999; Johnson, 2007a; Prinz, 2005).

The dualism inherent in Language of Thought theory is best illustrated in the function it attributes to concepts. Opponents of Language of Thought theory have suggested that it implies that concepts are for thinking, not for doing, thus conceptually separating body and mind (Prinz, 2005; Prinz & Clark, 2004). These theorists have argued that due to their nature as mental states, concepts in Language of Thought have no relation to perceptions and actions in the physical world, they only stand in as arbitrary symbols for things in the world and their sole purpose is to represent (Prinz, 2005). These representations are “amodal”, that is, they are stripped of any perceptual or motor features, thus they do not inherit any direct information on how to interact with the concept represented (Prinz, 2005).

Fodor and Pylyshyn (1988) made three central arguments for Language of Thought theory. The first argument was related to productivity; the idea that the human cognitive system must be able to produce an infinite number of unique thoughts. They argued that since humans are finite beings, they cannot have an infinite number of atomic mental representations. Thus a computational system is required to transform a finite number of representations into an infinite number of thoughts (Fodor & Pylyshyn,
1988). Their second and third arguments were that thought is systematic\(^7\) and inferentially coherent,\(^8\) and the best description of systematicity and inferential coherence in thought is a representational system operating in an analogous manner to the operation of language (i.e., meaning determined by "combinatorial syntax" and "compositional semantics"; Fodor & Pylyshyn, 1988).

2.2.4 Limitations of theories underpinned by computational theory of mind.

Theories underpinned by a computational theory of mind framework, such as Language of Thought, have a number of limitations. The first limitation is related to the putative existence of amodal symbols in the brain. Amodal symbols and linguistically derived amodal vectors have been suggested to be involved in conceptual processing (Landauer & Dumais, 1997; Snodgrass, 1984). However, as discussed below (Section 4.3, p. 34), recent psychological research has suggested that, in some cases, conceptual knowledge may be underpinned by perceptual characteristics (Glenberg, 1997; Solomon & Barsalou, 2004). Furthermore, neuroscientific and neuropsychological research has implied that some conceptual processing may be grounded in the same sensorimotor regions of the brain as is used for perception (Damasio, 1989; Gainotti, Silveri, Daniele, & Giustolisi, 1995; Kemmerer, Castillo, Talavage, Patterson, & Wiley, 2008).

The second limitation of cognitive theories underpinned by a computational theory of mind framework is known as the transduction problem. The problem arises from the question of how perceptual input is encoded into the arbitrary symbols that are used to represent concepts (Pecher & Zwaan, 2005). Pylyshyn (1984) inadvertently identified this problem as a feature of his cognitive theory. Due to the computational theory of mind requirement that perceptual features must be transformed into symbols on which computations can be conducted, Pylyshyn posited an input “transducer” to do the job. For Pylyshyn, the difference between computer and human cognition is that humans input the relevant information into a computer, whereas the transducer must filter all input and select the relevant input from the environment, thus making a judgement of cognitive relevance (A. J. Wells, 1998). The problem is that because transducers are not a part of the cognitive architecture, they are unable to make this judgement (A. J. Wells, 1998).

\(^7\)The idea that if one can entertain a certain proposition (e.g., Mary loves John) they can also entertain a proposition which has the same components (representations) and whose content is determined by the arrangement of the components within the structure (e.g., Bob loves Mary).

\(^8\)The idea that if one can make an inference of a specific logical type (e.g., ‘A’ from ‘A&B’) they can also make other inferences of that type (e.g., ‘C’ from ‘A&B&C’).
The final criticism forwarded against theories underpinned by a computational theory of mind framework is that they are too powerful, in the sense that they can explain almost any finding post hoc, but without much insight into the phenomena (Anderson, 1978; Barsalou, 1999; Prinz, 2002). For example, a number of accounts of imagery underpinned by the computational theory of mind approach failed to make a priori predictions regarding perceptual phenomena such as distance and orientation effects in scanning and rotation, but accounted for them post hoc (Kosslyn, 1980 and Finke, 1989 as cited in Barsalou, 1999).

2.3 Connectionism

In contrast to the computational theory of mind approach to cognition, which was inspired by the apparent functional similarity between a computer and the brain, the connectionist approach was inspired by the apparent structural similarity between the brain and a connectionist network (Shapiro, 2011). Connectionists argue that the neuronal structure of the brain has no discrete “parts” like the von Neumann computers which the computational theory was derived from, but rather is structured as a “distributed network” (Shapiro, 2011). A distributed network, is one in which processing is not localised to one neural area but spread among connected brain regions (Reynolds, Sinatra, & Jetton, 1996). Connectionism proposes that cognition is achieved by a distributed network of “nodes” and the interaction between them as a function of their connections. In contrast to the computational theory of mind approach in which cognition is centred upon symbol manipulation, connectionists theorise that cognition arises from the activation level of “nodes” in an interconnected network (Reynolds, et al., 1996).

A number of different connectionist network types have been proposed, but they all have a similar foundational architecture (Read, Vanman, & Miller, 1997). They all contain “nodes”, which are simple processing units that sum incoming activation according to a specified equation and send the resulting activation to nodes to which it is connected (Read, et al., 1997). These nodes are typically organised into three so-called layers, an input layer, a hidden layer, and an output layer (Shapiro, 2011). The operation of a simple connectionist network begins with raw information sent to nodes in the input layer which in turn send activation information to nodes in the hidden layer, which then consequently send activation information to nodes in the output layer,
illustrating the “spreading activation” feature of connectionist networks (McClelland & Rumelhart, 1986; Read, et al., 1997).

A key aspect of a connectionist network is the “weightings” between connections of nodes, which influence how the activation is spread (Read, et al., 1997). These weightings are dependent on learning rules related to experience (Read, et al., 1997). Two basic learning rules hypothesised to operate in a connectionist network are the Hebbian rule, in which the connection weight between two nodes are strengthened when they activate simultaneously; and a rule in which when two nodes are connected and one fires and the other does not, the connection weight is weakened (Reynolds, et al., 1996). These rules are apparent in “feed-forward” networks, in which processing is unidirectional and there is usually no hidden layer (Reynolds, et al., 1996). The presence of a hidden layer allows for the operation of another learning rule called “back-propagation”, in which error information is fed back through the network, allowing for more complex learning (Read, et al., 1997; Reynolds, et al., 1996).

In contrast to the symbol manipulation theorised in the computational theory of mind approach, connectionism posits “distributed representation” (E. R. Smith, 1996). According to connectionism, representation (and thus conceptual knowledge) originates via patterns of activation across many nodes (McClelland & Rumelhart, 1986). Thus, no individual node has meaning independent of the pattern of activation it is part of, but at the same time there is no central executive “combining” individual nodes into meaningful representations (Read, et al., 1997; Reynolds, et al., 1996; E. R. Smith, 1996).

Distributed representation has significant implications for cognitive tasks such as categorisation. In computational theories, concepts are discrete symbolic representations independent of how similar they are to each other (e.g., cow is discrete compared to horse and spaceship even though cow and horse are both animals and spaceship is not), thus they require an executive process for categorisation (E. R. Smith, 1996). Connectionism posits that similar patterns of activation represent similar concepts, thus they can be categorised in terms of their activation pattern similarity rather than requiring an executive processor (E. R. Smith, 1996).

2.4 Computational Theory of Mind vs. Connectionism

Due to connectionism’s rise as the first alternative to the computational theory of mind approach, the two have frequently been compared and contrasted. As mentioned
above, a major theoretical tenet of connectionism is that it proposes to offer a better
analogue of the brain than the architecture suggested by the computational theory of
mind approach (Shapiro, 2011). This is consistent with evidence for the robustness and
parallel processing nature of the brain. Firstly, unlike a von Neumann computer, in
which a simple programming error such as missing a semi-colon renders the whole
program invalid, the brain is robust in that minimal damage continues to allow function
at a decreased capacity or sometimes even full capacity (Doidge, 2007; Shapiro, 2011).
Secondly, again unlike a von Neumann computer, in which processing is serial, the
speed at which cognition occurs implies that processing must be parallel (see Feldman
& Ballard, 1982 for details).

Computationalists replied to these arguments with the claim that connectionism
is irrelevant to cognitive psychology because it is a lower level theory of how symbolic
operations are performed in the brain (Fodor & Pylyshyn, 1988; Smolensky, 1988).
Their argument was that human thought is systematic and systematicity requires
representations with compositional structure, which connectionist models do not have,
thus connectionist models are not suitable models of human cognition (Fodor &
Pylyshyn, 1988). However, they do agree that connectionist networks may implement
compositional representation for systematicity (Fodor & McLaughlin, 1990).

Despite the differences in theories underpinned by the computational theory of
mind approach and theories underpinned by connectionism, some connectionist models
share a core similarity with computational models (Barsalou, 1999). Akin to the
assumptions of the computational theory of mind approach, it can be argued that some
connectionist models imply amodal, arbitrary representations since perceptual content
of input nodes are irrelevant to conceptual processing in the sense that their processing
is solely derived from co-occurrence of activation, which does not consider perceptual
content (De Vega, Glenberg, & Graesser, 2008). This is expressed in Rogers and
McClelland’s (2004, p. 117) explanation of their connectionist model, which states that
“it is not the identity of the properties themselves, but their patterns of covariation that
is essential to the model’s behaviour”. In other connectionist networks, the hidden layer
is seen as the “conceptual processing” layer and the input layer is seen as the perceptual
layer (McClelland & Rumelhart, 1986). It can be argued that the hidden layer bears an
arbitrary relation to the perceptual layer because prior to learning their weightings are
set at random values,\(^9\) thus arbitrarily different conceptual states correspond to the same perceptual states (Barsalou, 1999).

2.5 The Symbol Grounding Problem

The symbol grounding problem is a longstanding challenge to “amodal accounts” derived from the computational theory of mind approach and some connectionist theories of cognition (to be called "amodal accounts" henceforth; Steels, 2008). The symbol grounding problem is the problem pertaining to how amodal, arbitrary representations are mapped back onto the real world (Glenberg, 1997; Glenberg & Robertson, 2000; Pecher & Zwaan, 2005). Amodal accounts assume that the meaning of a symbol (or representation) is captured in its relations to other symbols (or representations e.g., semantic network models). However, it has been argued that without any reference to the outside world, such symbols are meaningless (Pecher & Zwaan, 2005). Harnad’s (1990) version of Searle’s (1980) famous “Chinese room” argument captures the essence of the symbol grounding problem.

Harnad (1990) posited a thought experiment in which an English speaking man who knows no Chinese has just landed in China with only a Chinese dictionary and no translators around. He hops off the plane and sees a sign with Chinese writing (arbitrary, abstract symbols for him). So, he uses the dictionary to look up the first word in the sign, but he does not know the meaning of any of the words in the definition. So, he looks up the first word in the definition, but he doesn’t know the meaning of the words in that definition, and so on. No matter how many words he looks up (i.e., no matter how many structural relations he determines among the arbitrary abstract symbols), he will never figure out the meaning of any of the words.

Some embodied cognition theorists have suggested that the only way the man in the thought experiment could ever know what the Chinese sign said was if he had a Chinese-English translation dictionary, so that Chinese could be “grounded” in English (Glenberg, Havas, Becker, & Rinck, 2005; Glenberg & Robertson, 2000). In the same fashion, they argue that the only way that symbols could have meaning in cognition is if they are modal\(^{10}\) and thus grounded in the language natural to the mind, which they propose to be perception and action (Glenberg, et al., 2005; Glenberg & Robertson, 2000). It can be argued that if the same associative network represented perception and

\(^9\) Because if set to 0, learning cannot occur.
\(^{10}\) Retaining perceptual and motor features.
conception, it grounds meaning in perception and action, deeming it modal and nonarbitrary and thus exempting it from the above symbol grounding problem (Pulvermuller, 1999). However, a number of philosophers and cognitive theorists have suggested that the symbol grounding problem is not as dire for amodal accounts as some embodied theorists suggest (Fodor, 1983; Shapiro, 2011). It has been suggested that the symbol grounding problem can be interpreted not only as being about how symbols come to mean something about the world but also about how people come to understand symbols (Shapiro, 2011). The ambiguity appears when considering what is meant by meaning and understanding. It is important to note that symbols in the Chinese room are inherently meaningful since the Chinese use them to refer to things in isolation. Amodal accounts such as Language of Thought are not about how symbols come to mean, since symbols are simply designations,11 rather they are about how people come to understand symbols (Meteyard, et al., 2012; Shapiro, 2011). Thus, embodied theorists have little ground to use the Chinese room argument to refute amodal accounts of how symbols come to mean, however arguments inferred from the Chinese room referring to how people come to understand symbols are still valid (Shapiro, 2011).

2.6 Chapter Summary

This chapter focused on two approaches to cognition underpinned by the dualistic assumption that the body and mind are fundamentally different entities. This view of the relationship between body and mind (and world) has dominated research into human cognition since the advent of the so-called cognitive revolution in the mid-twentieth century (P. J. Marshall, 2009). Dualism’s most influential cognitive successor was Language of Thought theory, which inspired numerous other cognitive theories underpinned by the computational theory of mind framework. Despite their popularity, these theories face significant philosophical challenges, such as the existence of amodal symbols and the transduction problem. Connectionism, which was anchored in the structural neuroscience of the brain, arose as an alternative to the computational theory of mind approach. However, along with theories derived from the computational theory of mind framework, some theories underpinned by the connectionist approach entail a dualistic problem, namely, how can representation be grounded when mind and body are conceptualised as two separate entities? In contrast, embodied cognition theorists

11 Can also be applied to nodes in amodal connectionist accounts.
have suggested that representation is grounded in perception and action, which they argue to be the “natural language” of the mind, due to its naturally emergent and phenomenological nature (Johnson, 2007).

3. Naturalism and Phenomenology

The embodied cognition approach is arguably founded on two philosophical traditions - naturalism and phenomenology (Johnson, 2006, 2007). Naturalism is committed to an account in which all things in the world, including body and mind are natural or naturally emergent (Aikin, 2006; Horst, 2002). In turn, naturalism posits that all explanation should be causal and reducible to natural explanations (Aikin, 2006; Johnson, 2006). Phenomenology, on the other hand, focuses on meaning for the subject via their experience. Thus, explanation in phenomenology comes from the experience of the subject (Gallagher & Zahavi, 2007). Consequently, these two paradigms have differing methodological commitments.

Naturalism is committed to the study of the person as an object and is somewhat reductionist due to its commitment to the natural evolution of all things (Aikin, 2006). Phenomenology, by contrast, studies the subject “in-the-world” and focuses on their experience rather than its causes (Gallagher & Zahavi, 2007; Horst, 2002). These differences between the perspectives have led to the suggestion that they are incompatible, however apparent tensions between the two perspectives are not relevant to the present exposition of the philosophical foundations of embodied cognition, but the interested reader is directed to a discussion of these issues in Appendix A. The following two sections will detail one account of naturalism, Dewey’s “principle of continuity” and one account of phenomenology, Merleau Ponty’s “lived-body” which are reflected in the embodied cognition approach.

3.1 Dewey’s Naturalistic Principle of Continuity

3.1.1 Naturalism. Despite the definition of naturalism presented above, the term is used much more broadly and its meaning changes with context (Horst, 2002). This was expressed by the philosopher of science, Ernest Nagel in his 1955 address to the American Philosophical Association, when he stated that “the number of distinguishable doctrines for which the word “naturalism” has been a counter in the history of thought is notorious” (E. Nagel, 1956, p. 3). The term’s multiplicity of referents is consistent with its complex origin in three paradigms: Galileo’s reductive paradigm, in which
understanding is derived from the breaking down of a whole into its parts; Newton’s nomological paradigm, in which mathematical laws are used to describe observable phenomena; and Darwin’s evolutionary paradigm, in which explanations are underpinned by natural adaptation, selection, and reproductive history (Horst, 2002). The focus of the present discussion will be Dewey’s principle of continuity which is an account of Darwinian evolutionary naturalism.

### 3.1.2 Principle of continuity.

The principle of continuity posits that there is no break in experience between the processes of perceiving, feeling, moving, and thinking; instead they are levels of organic functioning from which higher function emerges organically (Johnson, 2006). The principle of continuity describes three levels of organisation relevant to the mind: the “physical” level of inanimate material processes; the “psycho-physical” level of living things which have needs, interests, and satisfactions; and the “mental” level of organisms which possess a mind (Johnson, 2006). The principle explains the progression from the physical level to the level of the mind without introducing new ontological entities, structures, or forces (Johnson, 2006). Dewey argued that new organisation is the reason that organisms with minds can do things which psycho-physical entities cannot do, and why psycho-physical entities can do things which physical entities cannot do (Johnson, 2006). Thus, according to Dewey, the “mind” is a complex new organisation of the “body” but they are in essence the same entity, as the “body” is of the “world”. According to the principle of continuity, what is termed “mind” and “body” are simply ways to identify aspects of the organism-environment interaction which have arisen from an organic process (Johnson, 2007).

The principle of continuity has important consequences for the philosophy of cognitive science since it assumes that the body is in the mind as much as the mind is in the body (Johnson, 2006). According to this view, the mind and body are simply two aspects of an ongoing interaction in experience. However, the mind is emergent from the body, so what is experienced, and thus mental activities, are dependent on the body (Johnson, 2006). For example, Damasio (1994) has suggested that evolution has built

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12 Thus, it is not as ironic as it seems that Fodor (1987) argued for naturalism. Despite his theory being based on separate entities for mind and body, thus mind not emergent from body, his theory is natural in the Galilean, reductive sense that explanation is fundamentally micro-explanation, but not in the Darwinian, evolutionary sense.

13 Under a continuity view, the only sense in which mental activities are “inner” is that they are personal (they may be yours and not mine), but they are not inner in the sense of being inside the mind as a separate entity to the world (Johnson, 2007).
the highest cognitive functions such as reasoning and decision making upon representations of the body in the somatosensory and motor cortices of the brain.

3.1.3 Evidence for the principle of continuity. Many systems biologists, including Maturana and Varela (1998), have argued that the central nervous system evolved in multicellular organisms to coordinate sensorimotor activity. Their investigations suggest that for single celled organisms such as amoeba and multicellular organisms such as the hydra, changes in the environment cause sensory changes in the organism which, in turn, produce movement. Thus, these organisms display sensorimotor coordination via simple organism-environment coupling as opposed to any type of representation (Johnson, 2007). In line with the principle of continuity, embodied approaches imply that human cognition is evolutionarily continuous with this sensorimotor coordination and that humans think in order to act (Johnson, 2007).

A number of biological experiments have demonstrated the principle of continuity using organisms from higher up the evolutionary chain. For example, if a tadpole’s eye is rotated 180 degrees during its development into a frog (then rotated back), later in life when it tries to catch a fly, its tongue extends to the point on its visual field exactly 180 degrees from where the fly is (Sperry, 1943). No amount of practice can correct this error as the tongue operates solely according to the retinal image. These “neural maps” are made up of adjacent neural cells which fire sequentially when a stimulus moves across the field. They have been found in many mammals including humans, and apply not only to the visual field but to all the senses (Johnson, 2007).

A similar experiment explored the effect of cross modal neural mapping in barn owls (Knudsen, 2002). Prismatic glasses were sutured onto juvenile and adult barn owls for eight weeks, which distorted their visual field 23 degrees. Interestingly, the adult barn owls could not learn to compensate for the distortion while the juvenile owls could. Furthermore, when the glasses were reintroduced to the juvenile owls as adults they were able to compensate. The experiment not only suggested neural plasticity in cross modal mapping but also showed that two maps could co-exist.

These examples suggest that online cognition is built upon and constrained by neural maps, which in terms of cognitive representation, imply that the body plays an important role in the formation of the mind (Johnson, 2007). A number of studies conducted in the field of grounded cognition have suggested that this continuity is

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14 Who were chosen since they use their auditory sense to detect prey before locating it visually.
maintained when considering the relationship between cognition and sensorimotor coordination in humans (some prominent examples include Bargh, Chen, & Burrows, 1996; Tucker & Ellis, 1998; G. L. Wells & Petty, 1980) and that it extends to offline cognition (some prominent examples include Meier, Hauser, Robinson, Friesen, & Schjeldahl, 2007; Meier & Robinson, 2004; Schubert, 2005).

3.2 Merleau-Ponty’s Phenomenology

3.2.1 Phenomenology. Edmund Husserl developed the philosophical approach of phenomenology as a reaction to his concern that the assumptions which naturalistic, Western science made about the nature of the mind, body, and world had caused it to miss fundamental questions about human nature (Marcum, 2004). He argued that primary consideration should be given to the subject’s experience in the world, before studying the mind, body, and world objectively (Gallagher & Zahavi, 2007; Marcum, 2004). Merleau-Ponty proposed that this would both uncover the subjective element of knowledge, which was being overlooked by naturalistic sciences, and provide a stronger framework for its enquiries (Gallagher & Zahavi, 2007). Thus, phenomenology does not provide a mechanistic account of mind in the vein of dualism, naturalism, or psychological and neuroscientific accounts because it focuses on giving a proper description of humans’ experience in life, rather than attempting to forge an objective account of mind (Gallagher & Zahavi, 2007; G. J. Marshall, 2008).

3.2.2 Brief history of phenomenology. As described by Gallagher and Zahavi (2007), the end of the nineteenth century saw an upsurge of interest in consciousness, intentionality, and the methodological questions arising from these perennial philosophical issues. Phenomenological views were emerging at this stage from Husserl and his teacher Brentano, along with analytical philosophical views from Russell and Frege, which were derived from a formal logic view of mind, and the naturalistic view of William James. During the early twentieth century introspection was the dominant method of analysis in psychology, led by Wundt and associated with phenomenology, before it was replaced by behaviourism between the early and mid-twentieth century. Behaviourism was led by Watson and saw a move from the inner mind analysis of introspection to the analysis of observable action. However, the advent of computers and computational models saw the dawn of the “cognitive revolution” in the mid-

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15 The idea that consciousness is always “about something” or “directed” (Hershfield, 2005; Poellner, 2003).
twentieth century which remains the dominant approach in psychology. Due to the logical and formal basis of computational models, analytic philosophy regained its ascendancy as the dominant philosophical approach, thus pushing phenomenology to the sidelines.

However, the last 20 years have seen a rise in the focus on phenomenology cognitive science, due to three major reasons: the interest in the question of phenomenal consciousness; the advent of brain imaging techniques; and finally the rise of embodied cognition (Gallagher & Zahavi, 2007). The third is the most important for the present project since the rise of embodied cognition approaches saw proponents such as Varela, Thompson, and Rosch (1991), Damasio (1994) and A. Clark and Chalmers (1998) point to French phenomenologist Maurice Merleau-Ponty’s (1962) work “Phenomenology of Perception” to argue their case against a dualistic, disembodied mind (Gallagher & Zahavi, 2007).

3.2.3 Merleau-Ponty’s lived-body. Merleau-Ponty was one of the most influential phenomenologists, and has recently begun to posthumously regain his influence due to the centrality of his thesis in the argument for embodied cognition (Gallagher & Zahavi, 2007; G. J. Marshall, 2008). He argued for the primacy of the body-in-the-world in cognition and more specifically that the meaning of things in the world (i.e., concepts) cannot be understood without reference to the bodies which engage with it (G. J. Marshall, 2008). Thus, he saw the body as having primary importance in that it is “lived-through”, making it the ultimate condition for discovering meaning in the world (G. J. Marshall, 2008).

Although Merleau-Ponty provided the most comprehensive theory of the lived-body, it was Max Scheler who first introduced the distinction between the lived-body and the “thing-body” (G. J. Marshall, 2008). The lived-body can be considered the body experienced from a first-person perspective which acts on the world, whereas the thing-body can be considered the body as an object of the world experienced from a third-person perspective.

The primary reason for this distinction was in response to the two dominant philosophies of knowledge, which came from rationalists, who viewed the manipulation of sense data as “real knowledge” and empiricists, who viewed sense data alone as “real knowledge” (G. J. Marshall, 2008). Both perspectives viewed the body as a physical data input device instead of being a condition for the existence of physical things (G. J. Marshall, 2008; Muller & Newman, 2008). Both Scheler and Merleau-Ponty argued for
the primacy of the first-person perspective in opposition to the dualistic notions of both rationalism and empiricism (Muller & Newman, 2008).

When considering the notion of dualism in relation to phenomenology, it is important to note that phenomenology is “experientially (or phenomenally) dualistic” in that there is a world out there and there is the person who is perceiving the world (Muller & Newman, 2008). This phenomenal dualism is illustrated in the difference between the first-person and third-person perspectives of the body, in what Merleau-Ponty describes as the “ambiguity of the body” (Muller & Newman, 2008). However, phenomenology is not dualistic in a Cartesian sense, in that the first-person and third-person perspectives of the body are of the same substance and are the same entity (Muller & Newman, 2008).

A number of accounts of embodied cognition are underpinned by aspects of Merleau-Ponty’s account of phenomenology. Grounded cognition is underpinned by Merleau-Ponty’s position that the body is not just a causal condition for experience, but a vehicle which mediates interaction with the world through its sensorimotor processes (G. J. Marshall, 2008; Muller & Newman, 2008). Most dynamical systems accounts are underpinned by Merleau-Ponty’s “operative intentionality”, which posits that the lived-body projects its goals onto the world and acts directly on the world rather than on symbolic representations of the world (Merleau-Ponty, 1962 in G. J. Marshall, 2008; Muller & Newman, 2008). Extended mind accounts are underpinned by Merleau-Ponty’s perspective on habituation, which proposes that the body, and thus cognitions, extend beyond the skin when an element of the environment becomes a habitual part of life (G. J. Marshall, 2008).

3.3 Chapter Summary

This chapter focused on the philosophical perspectives of naturalism and phenomenology as alternative philosophical frameworks to dualism, from which amodal accounts of cognition are derived. The chapter focused firstly on the principle of continuity, which is an account of naturalism contending that the mind, body, and world are all emergent phenomena of the same entity, only differing in their level of organisation (Johnson, 2006, 2007). In relation to cognition, the principle of continuity contends that mental activities are emergent from bodily experiences in the world. The second philosophical perspective described was Merleau-Ponty’s lived-body phenomenology, which centres on the primacy of the lived-body in cognition and more
specifically the assertion that the meaning of things in the world (i.e., concepts) cannot be understood without reference to the bodies which engage with them. These two philosophical perspectives provide a foundation for the discussion of embodied cognition.

4. Embodied Cognition

Embodied cognition is an approach consisting of a multiplicity of accounts held together by the key assumption that the body functions as a constituent of the mind rather than a perceiver and actor serving the mind, thus being directly involved in cognition (Shapiro, 2007). Therefore, embodied cognition offers an alternative to the amodal account of cognition. Proponents of embodied cognition have argued that it eradicates the mind/body dichotomy associated with dualistic, amodal accounts since embodied cognition proposes that “mental entities” such as reason, judgement, and problem solving directly involve the “physical entity” of the body (Johnson, 2006). Embodied cognition follows both the naturalistic principle of continuity, in its position that cognition emerged and evolved from the organism-environment relationship and Merleau-Ponty’s account of phenomenology, in that it posits subjective bodily experiences as primary to the constitution of cognition (Johnson, 2007).

Embodied cognition is often used as a synonym for what is referred to in the current thesis as grounded cognition. Consistent with theorists such as Shapiro (2011), the present thesis conceptualises embodied cognition as an approach which covers the “grounded cognition” account as well as the “dynamical systems” and “extended mind” accounts. All three of these accounts will be briefly introduced and compared, before two of them of particular relevance here (dynamic systems and grounded cognition) are discussed in detail.

4.1 Accounts of Embodied Cognition

4.1.1 Extended mind. The extended mind account not only posits that the body is part of the mind, but also that cognition extends beyond the skin and into the world (A. Clark & Chalmers, 1998). The “body-is-mind” aspect of the theory is not only an important component of the extended mind account but also the grounded cognition and dynamical systems accounts. It is important to note that the computational theory of mind approach considers the body an important component of the cognitive system (Shapiro, 2011). Where extended mind theorists differ from computational theorists is
that they consider the body as a central *constituent* rather than an important *component* of the cognitive system (Shapiro, 2011). For example, considering head movements in visual perception, computationalists view the eyes/head as causal contributors to perception, which occurs in the mind. Alternatively, extended mind theorists consider the eyes/head themselves as constituents of perception (Shapiro, 2011).

Amongst accounts of embodied cognition, the extended mind account is unique in arguing that the *world* can also be a constituent of cognition (A. Clark & Chalmers, 1998). The extended mind account suggests that whenever the world serves a function, which if done in the “mind” would be considered cognition, that part of the world should also be considered a constituent of cognition (A. Clark & Chalmers, 1998). This is exemplified by A. Clark and Chalmers (1998) in their thought experiment involving Inga, a normal functioning individual with full memory capacity, and Otto, who has Alzheimer’s disease, resulting in a memory deficit. Both hear about an exhibition in the museum of modern art, a place which both have previously visited. Upon hearing about the exhibition, Inga must pause for a second and consult her memory to recall that the museum is on 53rd St. It is important to note that Inga had a belief that the museum was on 53rd St before consulting her memory, these beliefs are called “non-occurrent” beliefs in that they are present, but only consciously present when attended to (via memory in this case). Otto on the other hand cannot do this due to his memory deficit, instead he must consult his notebook, in which all his information is stored. Thus, Otto’s notebook acts in place of his biological memory and store of non-occurrent beliefs. A. Clark and Chalmers argue that the notebook is a constituent of cognition for Otto, just as Inga’s neural memory is a constituent of cognition for her.

One argument against extended mind theory focuses on the definition of cognition, claiming that although “transcranial cognition” (cognition outside the bounds of the mind) is *possible*, there is no evidence that it is a constituent of cognition (Adams & Aizawa, 2001). Another argument is that extended mind theorists commit the coupling-constitution fallacy, which is the fallacy of calling things which always occur together “constituents” (Adams & Aizawa, 2001). Finally, there are philosophical

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16 In order to avoid the linguistic arguments regarding constituents and causal contributors, it is important to define both. As Shapiro (2011) puts it, if C is a constituent of P, C exists when and where P exists. Thus if C takes place prior to a process P or if C takes place apart from P’s occurrence then C is not a constituent of P. Computational theorists believe cognition takes place after and can take place apart from bodily movements, while extended mind, as well as all EC theories within all three areas, believe that cognition is (at least partly) constituted of bodily movements.
arguments relating to the breakdown of “self” when extending cognition beyond the body (see Gertler, 2007).

4.1.2 Dynamical systems. Any system which changes over time can potentially be described as a dynamical system (Shapiro, 2011). There are three steps in the development of a dynamical systems account. The first is to describe the behaviour of a system and identify the parts in it which change. The second is to identify all the ways in which these parts could change. The final step is to devise a mathematical rule which describes the change in the system over time (Shapiro, 2011).

Two key features of dynamical systems are emergence (or self-organisation) and coupling. Emergence is the idea that there are no predefined rules governing the behaviour of parts in forming the whole. Coupling is the idea that when described mathematically, parts within a system must include a term which describes the other parts within the system. Cognition is a system which changes over time, thus it has the potential to be described according to a dynamical systems account (Shapiro, 2011; L. B. Smith, 2005; Van Gelder, et al., 1998).

A number of dynamical theorists have argued that a dynamic systems account offers the best way of describing, understanding, and studying cognition. Their first argument is that since cognition occurs in time, it is dynamic and therefore a viable candidate for a dynamical systems account. The second argument concerns the description of the coupled brain, body, and world. Dynamical systems theorists believe that the mathematical descriptions utilised by dynamical systems accounts offer the most effective way to eliminate the Cartesian split inherent in amodal accounts of cognition. The final argument for a dynamical systems account of cognition is that it offers an explanation of cognition which is nonrepresentational, thus avoiding an additional level of cognitive processing (Chemero, 2009; Shapiro, 2011; Van Gelder, et al., 1998).

4.1.3 Grounded cognition. Grounded cognition proposes that cognition is derived from bodily interactions with the world which are represented in the brain (Barsalou, 2008a). Theories within grounded cognition differ on how these bodily interactions are represented in the brain, with some theories positing “image schemas” of bodily interactions in the world which are proposed to underpin abstract conceptual knowledge (Lakoff & Johnson, 1999). However, most grounded cognition theories propose “simulations” (see Section 4.3.3, p. 37) of representations contained in the putative modal system of the brain, which is commonly referred to as the sensorimotor
system (Barsalou, 1999; Gallese & Lakoff, 2005; Glenberg, 1997). It has been argued that representations in modal systems of the brain allow theories underpinned by grounded cognition to overcome the aforementioned symbol grounding and transduction problems associated with representation in amodal accounts of cognition (Barsalou, 1999). The modal system of the brain allows for representations to be directly grounded in the body and world without requiring transduction (Barsalou, 1999).

**4.1.4 Comparing and contrasting embodied cognition accounts.** As noted by Shapiro (2011), while the dynamical systems and grounded cognition accounts are about cognitive processes,\(^{17}\) the extended mind account is about what constitutes cognition. Thus, although these three accounts fall under the heading of embodied cognition, the extended mind account considers a different question to the dynamical systems and grounded cognition accounts (Shapiro, 2011). However, the extended mind account’s contention that the world is a *constituent* of cognition is a crucial assumption for both the dynamical systems and grounded cognition accounts. It is crucial that the world be considered a constituent of cognition in the dynamical systems account because it considers the world as inherently meaningful (Van Gelder, et al., 1998). For grounded cognition, the world must be considered a constituent of cognition because representation of the body in the brain is reliant on the world (Barsalou, 2008a).

It is useful to describe ways in which dynamical systems and grounded cognition accounts differ (see Shapiro, 2011). Firstly, the dynamical systems account views the cognitive process as emerging from the body’s activity in the world and as an active, self-organising system requiring no representation and no central executive (Van Gelder, et al., 1998). Alternatively, most theories underpinned by grounded cognition posit representations which are directly grounded in the body and situated in the world as central to the cognitive process (Barsalou, 2008a).

Secondly, grounded cognition posits representations for cognition while the dynamical systems account does not (Shapiro, 2011). In terms of representation, the dynamical systems account has been considered a direct descendent of ecological psychology, while grounded cognition displays a mixture of principles of ecological psychology and the computational theory of mind approach (Chemero, 2009). Despite these differences, both accounts are consistent with the principle of continuity and

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\(^{17}\) A self-organising system and modal representations in the brain, respectively.
Merleau-Ponty’s phenomenological perspective in that they regard cognition as emergent from the body and subjective experience as primary in cognition, respectively (Johnson, 2006)

4.2 Dynamical Systems

4.2.1 Ecological psychology. The dynamical systems account of cognition is underpinned by the assumptions of ecological psychology, particularly cognition’s active, dynamic, online, and nonrepresentational nature (Gibson, 1979). Gibson’s ecological psychology was seen as a response to the rising popularity of the computational theory of mind approach (Chemero, 2009). The theory was underpinned by three major principles (Chemero, 2009). The first principle, that perception is direct, argued that perception occurs through the direct sensorial contact between an organism and the environment, rather than as a result of the manipulation of symbols in the mind. The second principle, that perception is for action, argued that the environment is perceived primarily in order to act with and on it, as opposed to passively thinking about it. These two principles were a direct challenge to the computational theory of mind approach, which posited abstract symbol manipulation in perception. The final principle followed from the first two, arguing that if perception did not involve symbol manipulation but could still guide action, the environment must contain enough information to allow for this. This meaningful environmental information was termed “affordances” (Chemero, 2009; Garbarini & Adenzato, 2004; Gibson, 1979).

The second and third of these principles form the foundation for the overarching assumptions of the embodied cognition approach (Chemero, 2009; Pezzulo, 2011). Firstly, the embodied cognition approach assumes that perception is for action before thinking rather than being a necessary intermediary step for action, as implied by the computational theory of mind approach (Garbarini & Adenzato, 2004; Prinz, 2005). Secondly, when divorced from direct perception, the principle of affordances has been popular within psychological (e.g., Glenberg & Robertson, 1999) and neuroscientific (e.g., Gallese & Lakoff, 2005) theories of grounded cognition. However, it is the first principle of direct perception which has instilled ecological psychology as the primary theoretical foundation for the dynamical systems account of cognition.

The notion of direct perception implies that meaning is intrinsic to the environment (Garbarini & Adenzato, 2004). This is apparent in Gibson’s (1979) statement that:
the affordance of something does not change as the need of the observer changes. An affordance is not bestowed upon an object by a need of an observer and his act of perceiving it. The object offers what it does because it is what it is. (pp. 138-139)

Direct perception is best illustrated in Gibson’s (1979) theory of vision, which posits that environmental perceptual inputs are adequate for perception and that the retinal image is the incorrect starting point for a theory of vision. Instead he contended that light entering the retina which is reflected off various surfaces contain invariant features which unambiguously specify their sources. Invariant features were considered features such as the relations between angles on a tabletop which do not change during the process of moving around the object. Thus, Gibson argued that movement allowed for direct perception, in the sense that an organism’s ability to move around its environment allows for converging light from the environment to the retina, which he called the “ambient optic array”, to extract enough information for perception (Chemero, 2009; Gibson, 1966, 1979; Shapiro, 2011).

However, ecological psychology did not specify exactly how the brain “picks up” this information from the environment, only stating that it does not organise or process visual information but rather “resonates” with it. Fiddling with a radio’s knob to get the correct frequency has been used as an analogy for “resonance”. However, the human perceptual system was considered to be self-tuning rather than needing an agent to tune the knob (Shapiro, 2011).

This idea of direct perception was the basis for the dynamical systems contention that cognition is a “self-organising” system governed by movement of the body in an environment. Since the environment was theorised to provide inherently meaningful information when combined with a moving body, dynamical systems theorists considered representations as unnecessary for cognition (Chemero, 2009; Van Gelder, et al., 1998)

4.2.2 Demonstrations of dynamical systems. Dynamical systems accounts contend that the cognitive system is complex and composed of numerous individual elements which are exposed to an environment, allowing them to exhibit coherent behaviour without a central executive (L. B. Smith, 2005). The behavioural coherence emerges from the interaction of the individual components and the constraints and opportunities afforded by the environment (L. B. Smith, 2005). This is known as “self-organisation”, in which no individual component of the system has causal priority and
the system is characterised by the stability of their states (L. B. Smith, 2005). Van Gelder (1995) used an example of a centrifugal governor of a steam engine, developed by James Watt, to demonstrate how such a dynamic system in cognition would work.

The job of a governor is to control the power from a steam engine using a flywheel which translates up-down piston motions into a rotary motion. Prior to Watt’s governor, steam engines could not maintain constant output because the flywheel would fluctuate variably (Shapiro, 2011). Inventively, Watt added a throttle valve to the system so that when the flywheel slowed, the throttle valve would open, thus providing more power, and when too much power caused the flywheel to overspin, the governor would close the valve thus reducing the speed of the flywheel (Shapiro, 2011). As displayed in Figure 3, Watt’s governor worked by using steam from the engine to turn the flywheel, which in turn rotates the shaft, causing the flyballs to rise. When the flywheel overspins the rising flyballs decrease the throttle valve opening, thus decreasing steam from the engine and causing the flywheel spin to slow. If on the other hand, the engine is not generating enough power and the flywheel is spinning too slowly the flyballs drop, causing the throttle valve to open, thus generating more power (Chemero, 2009; Shapiro, 2011; Van Gelder, 1995).

It is important to note that this description started with the steam from the engine, but it could have started at the flyballs, flywheel, throttle valve, or any component of the system. Thus, it is a cyclically organised system with all parts coupled and dependent on each other, and as with any dynamic system, the operation of one component must include a term describing the other components (Shapiro, 2011; Van Gelder, 1995). So, even though this system can be described using a computational model (see Van Gelder, 1995, p. 348), Van Gelder (1995) argues that it is not the best way to describe the system since a computational description must have determinate start and end points. Correspondingly, Van Gelder argues that human cognition does not have determinate start and end points, and thus is best described as a dynamic system in which the brain, body, and world constitute the system. An example of human cognition as a dynamic system is suggested by Thelen, Schoner, Scheier, and Smith’s (2001) explanation of the A-not-B error.
Figure 3. Watt’s centrifugal governor (diagram adapted from Shapiro, 2011, p. 121)

In the late 1950’s developmental psychologist Jean Piaget developed an experiment to illuminate the question “when do infants acquire the concept of object permanence?” In the experiment, a toy is hidden under a lid at location A and the infant reaches for the toy. This A-location trial is repeated several times. Then there is the crucial switch trial; the toy is hidden at a new location, B. If there is a short delay between hiding and reaching, 8 to 10 month-old infants reach back to location A, where they found the object previously, not to where they saw the object disappear. This is referred to as the A-not-B error. However, after 12 months, infants no longer make this error, leading Piaget to assume that this is when infants learn that objects exist apart from their own actions (L. B. Smith & Thelen, 2003; Thelen, et al., 2001). This interpretation was advocated by computational cognitive theorists due to its representational nature (Shapiro, 2011). However, later experiments using the same paradigms with slight changes in task conditions suggested that Piaget’s explanation was not sufficient (Shapiro, 2011; Thelen, et al., 2001).

A dynamical systems interpretation of the A-not-B error experiment was that the infant’s behaviour is guided by a collection of processes, instead of an object representation, and it is the course of interaction between these processes which causes the error (Thelen, et al., 2001). It was argued that the most salient interaction of processes is between the infants past reaching behaviour and their current reaching
behaviour. Thus, the aim for the infant is to break their habit of reaching to location A (Shapiro, 2011). When the A-not-B error experiment was interpreted according to information obtained from a dynamic field,\textsuperscript{18} it was found that environmental changes to the task,\textsuperscript{19} as well as temporal changes between conditions, lead to elimination of the error (Shapiro, 2011; L. B. Smith & Thelen, 2003; Thelen, et al., 2001). On the basis of these findings, it was argued that the A-not-B error could be better understood in terms of the coupled processes between the infant and the toy, rather than an object representation. Furthermore, this interpretation suggests that knowing, or cognition, is constitutive of moving and perceiving as they evolve over time (Thelen, et al., 2001).

4.2.3 The offline cognition problem. The examples presented thus far of dynamical systems accounts (i.e., Gibson’s ecological theory of vision and infant reaching) have only considered interpretations of online cognitive phenomena. The question remains regarding whether dynamical systems can account for “representation-hungry problems” (A. Clark & Toribio, 1994).

Representation-hungry problems are those which involve “reasoning about absent, nonexistent, or counterfactual states of affairs” and those requiring the “agent to be selectively sensitive to parameters whose ambient manifestations are complex and unruly” (A. Clark & Toribio, 1994, p. 419). The first of these problems is self-explanatory; the second refers to the need for organisms to recognise internal characteristics of things in the environment which cannot be physically perceived, such as whether or not something is dangerous (A. Clark & Toribio, 1994; Shapiro, 2011). Both these problems require what A. Clark and Toribio (1994) describe as “strong internal representations”, which are available offline, and thus are crucial to processes such as planning, imagination, memory, reasoning, and abstract conceptual knowledge. Despite various proposals about how dynamical systems could account for these types of problems (Keijzer, 2002; Van Rooij, Bongers, & Haselager, 2002), it has been argued that they do not come close to covering the gamut of representation-hungry problems which theories underpinned by representation can convincingly address (Shapiro, 2011).

\textsuperscript{18} Simulates the decisions of infants to reach to location A or B by integrating, over time, the various influences on that decision.

\textsuperscript{19} Such as drawing the infant’s attention to location B or using novel bodily, motor movements to obtain the toy from location B.
4.3 Grounded Cognition

4.3.1 Assumptions of grounded cognition. Grounded cognition encompasses a variety of theories drawn together by two major assumptions, namely that cognition involves bodily interactions with the world and that these interactions are represented in the brain (Barsalou, 2008a). Grounded cognition’s first assumption is illustrated neatly by Shapiro (2011) in considering the concept of a morel mushroom for Sally, a mycologist, Charles, a Provencal chef, and Lucy, a young child.

Sally conceptualises a morel as an epigenous ascocarp, Charles conceptualises a morel as a delicacy to be sautéed with butter, and Lucy conceptualises a morel as the yucky thing she has to eat before being allowed dessert. Thus, each according to their bodily experiences with morels forms different conceptualisations of it. However, these concepts are not determinate: for example, if Lucy grows up to become a mycologist, her concept of a morel would be more similar to Sally’s. Furthermore, it is important to note that there is nothing stopping Sally, Charles, and Lucy from having the same concept for a morel, it is simply their differing bodily interactions with the morel which has determined their conceptualisations. Finally, it can be assumed that they have the same visual conceptualisation of a morel; they all know one when they see it. However, if Lucy were to have been born blind, she would never be able to obtain the same concept of a morel as Sally and Charles. This example demonstrates how grounded cognition posits a relationship between the type of body an organism has and conceptual knowledge (Johnson, 2006; Shapiro, 2011).

The second major assumption of grounded cognition is that the body’s relationship with the world is represented in the brain (Barsalou, 2008a). Since these neural representations of the body’s interaction with the world have been suggested to be available for recall when “reasoning about absent, nonexistent, or counterfactual states of affairs” and when the agent is required to be “selectively sensitive to parameters whose ambient manifestations are complex and unruly”, grounded cognition

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In light of the central focus on conceptual knowledge in the current project, it is important to consider the difference between a concept and a conception. As mentioned in the example of the concept of a morel mushroom, Sally, Charles, and Lucy are all able to pick out a morel mushroom when they see one. This seems to suggest that they all have the same concept of a morel mushroom and only different conceptualisations of it. However, if concepts are considered conceptualisations, it would be unlikely that anyone would have the same concepts for anything, due to inter-individual variations in experiences with things in the world (Shapiro, 2011). In most cases there are necessary and sufficient conditions that define concepts, but people tend to think of things as being more or less like a representative concept (E. E. Smith & Medin, 1981). The current thesis will not enter into the debate about what does and does not constitute a concept, except to say that conceptualisations significantly affect the way concepts are viewed, whether or not they are the primary basis of a concept (E. E. Smith & Medin, 1981).
can cope with representation-hungry problems (Barsalou, 2008a; A. Clark & Toribio, 1994). It has been suggested that not only is it crucially important to have these “strong” representations for offline cognition, but it is also beneficial to have “weak” representations for online cognition (Shapiro, 2011).

Shapiro’s (2011) example of holding an apple, then putting it away and describing the feel of it requires strong representations, but describing the feel of the apple whilst holding it seems to be accomplishable without the aid of representation. However, consider a hypothetical situation in which a neuroscientist uses a transcranial magnetic stimulation device to temporarily disable the tactile area of the cogitator’s brain during the task. In this case they would still be in contact with the apple but they would not be able to describe how it feels because their brain would not be able to process any information about the feel of the apple. This hypothetical case suggests that not only is contact with the apple required online, but also the information provided by the contact, which is provided by the tactile region of the brain.

4.3.2 Conceptual Metaphor Theory. Conceptual Metaphor Theory (Lakoff & Johnson, 1980, 1999) directly addresses the “abstract concept problem”, which is the argument that theories eschewing representations or which contain only modal representations cannot account for abstract concepts, since abstract concepts do not have salient perceptual components (Mahon & Caramazza, 2008; Meteyard, et al., 2012). However, Conceptual Metaphor Theory argues that bodily metaphors can be used to understand abstract concepts (Lakoff & Johnson, 1980, 1999).

Conceptual Metaphor Theory posits that humans possess a small set of directly experienced concepts which are defined by the physical experience of them, including a set of basic spatial relations (e.g., up/down, front/back), a set of physical ontological concepts (e.g., entity, container), and a set of basic experiences or actions (e.g., eating, moving; Lakoff & Johnson, 1980, 1999). These primary concepts are proposed to be represented in image schemas which ground abstract concepts with a similar structure (Lakoff & Johnson, 1980, 1999). For example, the abstract concept power is grounded in the primary concept up, as reflected in the common linguistic use of up when referring to power (e.g., he is too high ‘up’ to deal with).21

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21 It is important to note here that linguistic metaphors are an epiphenomenon of conceptual metaphors, in that they only exist as an expression of the conceptual metaphor and not a cause of it (Lakoff & Johnson, 1999).
Unlike most theories underpinned by grounded cognition, Conceptual Metaphor Theory does not posit modal representations. However, it is still considered a grounded cognition theory here since it posits a role for bodily experience in the processing of conceptual knowledge. Furthermore, extensions to Conceptual Metaphor Theory have seen modal representations replace image schemas to represent primary concepts, whilst maintaining basic tenets of the theory (Gibbs Jr & Berg, 1999; Gibbs Jr, Costa Lima, & Francozo, 2004).

There has been much psychological, behavioural evidence gathered for Conceptual Metaphor Theory (prominent examples include Boroditsky, 2000; Boroditsky & Ramscar, 2002; Meier, et al., 2007; Meier & Robinson, 2006). A typical study examined the grounding of the abstract concepts, positive and negative (valence) in the spatial metaphors of up and down, respectively (Meier & Robinson, 2004). The second study in their series of three displayed a word (e.g., ‘hero’, ‘crime’ etc.) which was to be categorised according to whether it was positive or negative. Immediately following categorisation, a cue (the letter p or q) was shown either at the top or bottom of the screen according to which the p key on the keyboard was to be pressed if the letter p was presented or the q key was to be pressed if the letter q was presented. Findings suggested that a cue was identified faster if it was congruent with the valence of the word shown prior (i.e., cue presented at top of screen was identified faster if the word presented before was of positive valence).

Despite the substantial amount of evidence consistent with Conceptual Metaphor Theory, a number of limitations have been identified. Firstly, although Conceptual Metaphor Theory argues that abstract concepts are grounded by their structural similarity to primary concepts, knowledge of the structure of the abstract concept is required before it can be grounded in the primary concept (Murphy, 1996). Thus, abstract conceptual knowledge cannot be entirely explained by Conceptual Metaphor Theory, although it may be useful in elaborating on and construing abstract concepts (Murphy, 1996). Secondly, according to Conceptual Metaphor Theory, a single primary concept (e.g., up) only describes part of an abstract concept (e.g., power), thus it would require multiple structural mappings to obtain a complete understanding of the concept (Barsalou, 1999). Despite these problems, Conceptual Metaphor Theory demonstrates that bodily experience could theoretically be used to explain abstract conceptual knowledge.
4.3.3 A neural theory of grounded cognition. Gallese and Lakoff’s (2005) neural theory of grounded cognition takes the important step of demonstrating how grounded cognition is neurally plausible. It is important to note that Gallese and Lakoff’s theory extends to abstract concepts and higher level cognitions such as inference patterns, but this section will be focussed only on a summary of the neuroscientific basis of their theory.

Similar to many theories underpinned by grounded cognition, Gallese and Lakoff’s (2005) theory centres on the argument that “the sensorimotor system not only provides structure to conceptual content, but also characterises the semantic content of concepts in terms of the way that we function with our bodies in the world” (Gallese & Lakoff, 2005, p. 456). An important component of the theory is that “imagining and doing use a shared neural substrate” and “the same neural substrate used in imagining is used in understanding” (Gallese & Lakoff, 2005, p. 456). Thus, their theory takes the body’s interaction in the world into the brain in a so-called “neural exploitation”, which is the adaptation of the brain’s sensorimotor system for cognition via a process termed “simulation” (Gallese & Lakoff, 2005, p. 456).

Simulation is the putative process of the reconstruction of experience via activation of representations in various modality specific areas in the brain (Barsalou, 1999; Gallese & Lakoff, 2005; Gibbs Jr, 2006; Glenberg & Kaschak, 2002; Meteyard, et al., 2012). According to numerous grounded cognition theorists, simulation exploits not only the visual modality but all modalities (Barsalou, 1999; Gallese & Lakoff, 2005). Simulation forms a central component of numerous theories underpinned by the grounded cognition account (Barsalou, 1999; Gallese & Lakoff, 2005; Glenberg & Kaschak, 2002; Zwaan & Ross, 2004). Furthermore, simulation is not necessarily conscious, in fact it is more than often nonconscious (Barsalou, 1999; Gallese & Lakoff, 2005). Finally, grounded cognition theorists propose that simulation is multimodal, meaning that cognition consists of the associated activation of different modal areas of the brain at the sensorimotor level (Barsalou, 1999; Gallese & Lakoff, 2005).

4.4 Chapter Summary

This chapter commenced by introducing embodied cognition as an approach underpinned by the principle of continuity and Merleau-Ponty’s lived-body

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22 An example of this from vision is that when a cogitator imagines seeing something, the same portion of the brain is activated as when something is actually seen (Gallese & Lakoff, 2005).
phenomenology which consists of various accounts centralising the assumption that the body is inextricably intertwined in the development and functioning of cognition. The extended mind account considers the question regarding *constitution* of cognition rather than the *cognitive process*. This constituency assumption was an important assumption for both the dynamical systems and grounded cognition accounts.

Foundations, demonstrations, and limitations of the nonrepresentational, self-organising, and mathematically described dynamical systems account were then detailed. This was followed by an exposition of a number of theories underpinned by the grounded cognition account which centres on the assumption that cognition involves bodily interactions with the world and that these interactions are represented in the brain. Both accounts present alternative conceptualisations of cognitions to the computational theory of mind approach.

Due to the differences between theories derived from the embodied cognition approach it was important to choose one theory upon which to ground the central assumptions of the present project. Perceptual Symbol Systems theory (Barsalou, 1999) was chosen on the basis of its comprehensive articulation and critique in the literature, its coverage of abstract concepts, offline and online cognitive processes, and its potential to shed light on how mental states can be physically realised via modal grounding, which may help to illuminate the poorly understood placebo phenomenon in medicine via exposition of the embodied *heal* concept (see Section 7.3, p. 89).

### 5. Perceptual Symbol Systems Theory

Perceptual Symbol Systems theory posits that simulations of perceptual, motor, and introspective experience which are stored in sensorimotor centres of the brain underlie processing of conceptual knowledge (Barsalou, 1999; Niedenthal, et al., 2005). The theory combines symbolic and connectionist aspects of theories underpinned by the computational theory of mind approach with the dynamic and bodily-based aspects of the dynamical systems account. It has also been argued that it avoids the dualism inherent in theories underpinned by the computational theory of mind approach by *grounding* symbols directly in the body and world and avoids the offline cognition problem inherent in theories underpinned by the dynamical systems account by positing representations (Prinz, 2002; Prinz & Barsalou, 2000). Furthermore, the theory aligns

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23 Barsalou (1999) considers the putative “introspective system” as a constituent of the sensorimotor system.
with the principle of continuity, in the sense that it views cognition as emergent from
the body, as is illustrated by its grounding in sensorimotor representations of the body
and Merleau-Ponty’s lived-body phenomenology, in the sense that it proposes that all
conceptual knowledge is constitutive of subjective bodily experience.

This review draws heavily on Barsalou’s (1999) highly cited article arguing for
Perceptual Symbol Systems theory. However, numerous studies will be cited as
supporting aspects of Perceptual Symbol Systems theory throughout the upcoming
review. Table 1 outlines key features of all of these studies (listed in chronological
order).
Table 1

Studies providing evidence for aspects of Perceptual Symbol Systems theory

<table>
<thead>
<tr>
<th>Authors</th>
<th>Aim</th>
<th>Primary account of predication/interpretation</th>
<th>Sample size</th>
<th>Design (type, method, offline/online, IVs, DVs)</th>
<th>Limitations</th>
<th>Findings</th>
<th>Conclusions</th>
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</thead>
<tbody>
<tr>
<td>McCloskey and Glucksberg (1978)</td>
<td>-To examine whether categories were well-defined or ‘fuzzy’</td>
<td>-NONE</td>
<td>-64</td>
<td>-linguistic -mixed -offline -IVs: -category typicality -session -DV: -response</td>
<td>-7 of the 30 (~22%) subjects made a different category membership decision in Session 2 than in Session 1 (at intermediate typicality level)</td>
<td>-Natural categories are fuzzy sets, with no clear boundaries separating members from nonmembers</td>
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<tr>
<td>Wells and Petty (1980)</td>
<td>-To examine whether overt movement can either augment or inhibit certain cognitive activities</td>
<td>-NONE</td>
<td>-73</td>
<td>-experimental -between -online -IVs: -head movement -message content -DV: -attitude</td>
<td>-Between subjects design results in a number of possible confounding factors</td>
<td>-The horizontal movements led to significantly less agreement, whereas the vertical movements led to a marginally significant increase in agreement (for the counterattitudinal message, no significant differences for the proattitudinal message)</td>
<td>-People are less resistant to attitudinal influence when engaged in vertical head movement than when engaged in horizontal head movement</td>
</tr>
<tr>
<td>Bargh, Chen, and Burrows (1996)</td>
<td>-To explore whether trait concepts and stereotypes become active automatically in the presence of relevant behaviour or stereotyped-group features</td>
<td>-Principle of Ideomotor Action</td>
<td>-30</td>
<td>-experimental -within -online -IVs: -priming condition -DV: -walking speed</td>
<td>-Ease of task in the two conditions was not measured</td>
<td>-Participants in the elderly priming condition had a slower walking speed compared to participants in the neutral priming condition</td>
<td>-Exposing individuals to a series of words linked to a particular stereotype influences behaviour nonconsciously</td>
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<td>Authors</td>
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<tr>
<td>Rauscher, Krauss, and Chen (1996)</td>
<td>-To examine the role of lexical movements in speech production</td>
<td>-NONE</td>
<td>-experimental -within offline -IVs: gesture -speech -DV: speech rate</td>
<td>-Did not examine different types of gesture (e.g., nonspatial)</td>
<td>-Speakers spoke more slowly when they could not gesture for spatial content but no nonspatial content</td>
<td>-Gestural accompaniments to spontaneous speech can facilitate access to the mental lexicon</td>
<td></td>
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<tr>
<td>Reed and Vinson (1996)</td>
<td>-To examine whether prior knowledge of an object's typical movement in the real world affects the representation of motion</td>
<td>-NONE</td>
<td>-experimental -mixed offline (online implication) -IVs: group implied motion displacement -DV: response time error rate</td>
<td></td>
<td>-Performance differed as a function of the labelled identity of the stimulus and its associated motion</td>
<td>-Conceptions about real-world object motion influence the magnitude of representational momentum</td>
<td></td>
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<tr>
<td>Tucker and Ellis (1998)</td>
<td>-To examine the relationship between seen objects and potential actions</td>
<td>30</td>
<td>-experimental -mixed online -IVs: mapping response -DV: reaction time error %</td>
<td>-No orientation control condition</td>
<td>-Right-hand responses were faster when the irrelevant orientation of the object was also to the right. Similarly, left-hand responses were faster when the orientation of the object was also to the left</td>
<td>-Actions afforded by a visual object are intrinsic to its representation. According to this position, representing visual information involves representing information about possible actions and</td>
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<td>Authors</td>
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<tr>
<td>Vallée-Tourangeau, Anthony, and Austin (1998)</td>
<td>-To examine strategies used in retrieving category instances</td>
<td>-NONE</td>
<td>-linguistic, mixed, offline</td>
<td>-Participants used experiential strategy 52%, semantic strategy 28% and unmediated strategy 21% for common categories</td>
<td>-Category knowledge is grounded in terms of contexts where categories are encountered</td>
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<tr>
<td>Kellenbach, Brett, and Patterson (2001)</td>
<td>-To investigate whether retrieval of perceptual knowledge from long-term memory activates unique cortical regions associated with the modality and/or attribute type retrieved</td>
<td>-NONE</td>
<td>-linguistic/ neuroimaging, mixed, offline</td>
<td>-Issue relating mental states to brain states</td>
<td>-The modal area associated with the property of the block activated relative to the control condition</td>
<td>-The retrieval of perceptual semantic information activates not only a general semantic network, but also cortical areas specialised for the modality and attribute type of the knowledge retrieved</td>
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<tr>
<td>Glenberg and Kaschak (2002)</td>
<td>-To examine whether actions influenced the comprehension of sentences</td>
<td>-Indexical Hypothesis, -44/70</td>
<td>-experimental, mixed, online</td>
<td>-Did not control for length of frequency of words</td>
<td>-The interaction between response direction and implied sentence direction was significant</td>
<td>-Data supported an embodied theory of meaning that relates the meaning of sentences to human action</td>
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<td>Authors</td>
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<tr>
<td>Kan, Barsalou, Solomon, Minor, and Thompson-Schill (2003)</td>
<td>-To examine the extent to which activation of visual brain areas is dependent on task conditions</td>
<td>- NONE</td>
<td>-linguistic/neuroimaging -mixed -online - IVs: -associated/unassociated trials - DVs: -speed of processing -activated brain regions</td>
<td>-accuracy differing in relation to each other</td>
<td>-Reliable activity across subjects within the left fusiform gyrus when true trials were intermixed with associated false trials but not when true trials were intermixed with unassociated false trials</td>
<td>-Conceptual knowledge is organised visually and that it is grounded in the perceptual system</td>
<td></td>
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<tr>
<td>Pecher, Zeelenberg, and Barsalou (2003)</td>
<td>-To examine whether conceptual knowledge is derived from modal systems</td>
<td>-64/88</td>
<td>-experimental -mixed -online -IVs: -modality switch -stimulus onset asynchrony -DV$s$: -speed of processing</td>
<td>-Issue relating mental states to brain states</td>
<td>-When subjects verified pairs of properties, they verified the second property faster when it came from the same modality as the first property than when it came from a different modality</td>
<td>-Supported the hypothesis that perceptual simulation underlies conceptual processing</td>
<td></td>
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<tr>
<td>Zwaan and Yaxley (2003)</td>
<td>-To examine whether spatial iconicity affects semantic-</td>
<td>-36/40/48</td>
<td>-experimental -mixed -online</td>
<td>-No neutral match condition</td>
<td>-(Exp1) The reverse-iconic condition yielded significantly slower</td>
<td>-The similarity between the spatial arrangement of words</td>
<td></td>
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<tr>
<td>Authors</td>
<td>Aim</td>
<td>Primary account of predication/interpretation</td>
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<td>relatedness judgements</td>
<td>-To examine the association between affect and vertical position</td>
<td>-Conceptual Metaphor Theory</td>
<td>-34/82</td>
<td>-experimental</td>
<td>-No control position condition</td>
<td>-Participants were faster to evaluate positive words when presented at the top (vs. bottom) of the screen (opposite for negative words)</td>
<td>-When making evaluations, people automatically assume that objects that are high in visual space are good, whereas objects that are low in visual space are bad</td>
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<td>Meier and Robinson (2004)</td>
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</tr>
<tr>
<td>Pecher, Zeelenberg, and Barsalou (2004)</td>
<td>-To investigate whether representations are affected by recent experiences with a concept</td>
<td>-Perceptual Symbol Systems theory</td>
<td>-106</td>
<td>-experimental</td>
<td>-did not manipulate or control for the concept’s domain and category</td>
<td>-Verification times and error rates for the second presentation of the concept were higher if the properties were from different modalities than if they were from the same modality.</td>
<td>-Concepts may be represented by the same neural systems as those with which they are perceived</td>
</tr>
<tr>
<td>Schubert (2004)</td>
<td>-To examine the influence of making a fist in power conceptualisation between genders</td>
<td>-NONE</td>
<td>-42/78/37</td>
<td>-experimental</td>
<td>-Did not measure cultural influence</td>
<td>-(Exp1) Reactions to power-related words were slower when participants made a fist than when they made a neutral gesture in STROOP</td>
<td>-Different meanings men and women attribute to performing acts of bodily force</td>
</tr>
<tr>
<td>Authors</td>
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<td>Sample size</td>
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<tr>
<td>Solomon and Barsalou (2004)</td>
<td>-To examine under which conditions different strategies are used to verify concept properties</td>
<td>-‘Simulation account’</td>
<td>96</td>
<td>-word type&lt;br&gt;-hand position&lt;br&gt;-imageability&lt;br&gt;-trait valence&lt;br&gt;-trait hostility&lt;br&gt;-DV: -reaction time&lt;br&gt;-hope</td>
<td>task indicates advantage for power-related words&lt;br&gt;-(Exp2) Men expressed slightly more hope for control when they made a fist compared to the neutral gesture (opposite for women) &lt;br&gt;-(Exp3) Men judged character as more friendly when they made a fist than when they made a neutral gesture (opposite for women)</td>
<td>implicate differential effects of performing these behaviours on social information processing</td>
<td></td>
</tr>
<tr>
<td>Barsalou and Wiemer-Hastings (2005)</td>
<td>-To explore the content of concrete and abstract concepts</td>
<td>-Perceptual Symbol Systems</td>
<td>24</td>
<td>-word type&lt;br&gt;-hand position&lt;br&gt;-imageability&lt;br&gt;-trait valence&lt;br&gt;-trait hostility&lt;br&gt;-DV: -reaction time&lt;br&gt;-hope</td>
<td>-limited number (9) of concepts assessed&lt;br&gt;-50% of responses described settings&lt;br&gt;-15% entity properties for</td>
<td>Common situational content produced across concept types</td>
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<td>Authors</td>
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<td>Primary account of predication/interpretation</td>
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<tr>
<td>Schubert (2005)</td>
<td>-To examine whether the concept of power involves a perceptual simulation of vertical differences in space</td>
<td>-Perceptual Symbol Systems theory</td>
<td>78/91/59/44 (40,35)/113</td>
<td>-experimental -mixed -online/offline -IVs: proposition type -agent colour -task -position -group status -compatibility -valence -relevance -DV: -choice -latency</td>
<td>-No control conditions for powerless vs powerful for a number of studies</td>
<td>-(Exp1) Powerful = high vertical position and powerless = low vertical position -(Exp2/3) Power identified faster in up condition (maintained when motor response included) -(Exp4) Judgements of powerful groups as powerful were faster when the groups appeared at the top position compared with the bottom position -(Exp 5) Differences in valence cannot account for the effect of vertical position on accuracy of power judgement -(Exp 6) Powerful animals were indeed judged as more powerful when they</td>
<td>-Concrete and abstract concepts emphasise different situational content (concrete on objects, locations, behaviour, abstract on social aspects and introspections)</td>
</tr>
<tr>
<td>Authors</td>
<td>Aim</td>
<td>Primary account of predication/interpretation</td>
<td>Sample size</td>
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<tr>
<td>Crawford, Margolies, Drake, and Murphy (2006)</td>
<td>-To examine how the association between valence and verticality influences memory for the locations of emotion related stimuli</td>
<td>-Conceptual Metaphor Theory/Perceptual Symbol systems theory</td>
<td>-15</td>
<td>-experimental -within -offline -IVs: stimulus valence -position -DV: position memory</td>
<td>-No neutral set in stimulus valence</td>
<td>-Positive stimuli were shifted upward whereas negative stimuli were shifted downward</td>
<td>-Affective responses evoke spatial representations, leading to systematic biases in spatial memory</td>
</tr>
<tr>
<td>Marques (2006)</td>
<td>-To review the case for multiple systems in semantic memory</td>
<td>-NONE</td>
<td>-62/38</td>
<td>-experimental -within -offline -IVs: -stimulus valence -position -DV: position memory</td>
<td>-Cant rule out an amodal system on basis of findings</td>
<td>-Reaction times were slower when the modality switched from the context trial to the target trial than when the modality remained constant (although not significant by domain)</td>
<td>-Suggested that a single amodal system cannot account for conceptual processing</td>
</tr>
<tr>
<td>Meier and Robinson (2006)</td>
<td>-To investigate whether metaphorically consistent affective biases correlate with individual differences in emotional experience</td>
<td>-Conceptual Metaphor Theory</td>
<td>-24/28</td>
<td>-experimental -mixed -online -IVs: -neuroticism -depressive symptoms -word</td>
<td>-Double the amount of females limits generalisation -No manipulation check -No control</td>
<td>-(Exp1) The higher a person’s level of neuroticism, the faster one was to detect spatial probes occurring within lower (versus higher) areas of visual space -(Exp2) Similar relation</td>
<td>-Selective attention was biased downwards among individuals high in neuroticism or depressive symptoms</td>
</tr>
<tr>
<td>Authors</td>
<td>Aim</td>
<td>Sample size</td>
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<tr>
<td>Meier, Hauser, Robinson, Friesen, and Schjeldahl (2007)</td>
<td>-To examine whether cognitions related to divinity are embodied</td>
<td>-41/47/33/27/66,55</td>
<td>-location -DV: -response time</td>
<td>location condition</td>
<td>characterised depressive symptoms and vertical selective attention</td>
<td>-Representation of the divine versus profane ‘borrows’ from the vertical domain of perception</td>
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<tr>
<td>Authors</td>
<td>Aim</td>
<td>Primary account of predication/interpretation</td>
<td>Sample size</td>
<td>Design (type, method, offline/online, IVs, DVs)</td>
<td>Limitations</td>
<td>Findings</td>
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<tr>
<td>Estes, Verges, and Barsalou (2008)</td>
<td>-To examine whether object words direct attention to specific locations</td>
<td>&quot;Perceptual simulation&quot;</td>
<td>-59</td>
<td>-experimental -mixed online -IVs: -location -word -mask -context -DV's: -response time -error rate</td>
<td>-No location control condition</td>
<td>-(Exp1) Targets were identified more slowly and less accurately when they appeared in the typical location of the object denoted by the preceding word than when they appeared in the opposite location -(Exp2) Exp1 findings were replicated in the unmasked condition. In the masked condition, however, these effects were attenuated -(Exp3) Results were maintained with the inclusion of context words</td>
<td>-Words denoting objects that typically occur in high places hindered identification of targets appearing at the top of the display (opposite for words denoting objects which occur in low places). This perceptual interference is attributable to attentional orienting and perceptual simulation</td>
</tr>
<tr>
<td>Simmons, Hamann, Harenski, Hu, and Barsalou (2008)</td>
<td>-To examine whether linguistic brain areas activate prior to areas associated with situation generation (simulation)</td>
<td>-Perceptual Symbol Systems theory/ Language and Situated Simulation theory</td>
<td>-10</td>
<td>-linguistic/neuroimaging -within -offline -IVs: - task activation -DV's: -overlap between brain areas</td>
<td>-Assumes two separate systems -Designated time frames for early and late phase -Issue relating mental states to brain states</td>
<td>-Activations early in conceptual processing overlapped with activations for word association. Activations late in conceptual processing overlapped with activations for situation generation</td>
<td>-Conceptual processing uses multiple representations, linguistic and perceptual</td>
</tr>
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<td>Authors</td>
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</table>
| Chandler and Schwarz (2009)   | -To investigate the influence of culture-specific body movements, which involve arbitrary relationships between movements and associated concepts | -Perceptual Symbol Systems theory            | -58          | -experimental  
- between  
- online  
- IVs:  
- finger movement  
- trait type  
- gender  
- DVs:  
- rating of character | -Participants rated the character as more hostile when they read about him while extending their middle finger | -Body movements can prime related concepts, even when the movement–concept association is arbitrary and culture-specific. |
| Jostmann, Lakens, and Schubert (2009) | -To assess the influence of judgements of weight on judgements of the importance of concepts | -“Embodied cognition perspective”          | -49          | -experimental  
- between  
- online  
- IVs:  
- weight  
- DVs:  
- judgement of importance (various) | -No control weight condition | -Bodily experience of weight influenced currency importance, abstract decision making, person and argument importance judgements | -Much as weight makes people invest more physical effort in dealing with concrete objects, it also makes people invest more cognitive effort in dealing with abstract issues |
| Oosterwijk, Rotteveel, Fischer, and Hess (2009) | -To examine whether the activation of the specific emotion concepts of pride and disappointment are embodied in the sense that they are accompanied by changes in posture | -Perceptual Symbol Systems theory            | -65          | -experimental  
- within  
- online  
- IVs:  
- time  
- concept  
- DVs:  
- reports of pride/disappointment  
- vertical and | -Disappointment results only relative to pride, not control | -During the disappointment task participants decreased their posture height significantly more than during the pride task | -The activation of emotion knowledge about disappointment can lead to the spontaneous adoption of the posture associated with this emotion |
<table>
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<tr>
<th>Authors</th>
<th>Aim</th>
<th>Sample size</th>
<th>Design (type, method, offline/online, IVs, DVs)</th>
<th>Limitations</th>
<th>Findings</th>
<th>Conclusions</th>
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<tr>
<td>Schubert and Koole (2009)</td>
<td>-To explore embodiment of the self-concept (power in making a fist)</td>
<td>-76</td>
<td>-experimental -mixed -online -IVs:  -gesture -gender -trait valence -trait category -attribute valence -prime -DV$s$:  -rating of self -reaction time</td>
<td>-Influence of affect not measured</td>
<td>-Men described themselves as more assertive and socially esteemed when they made a fist, reverse for females -Self-primes facilitated power targets more strongly when men made a fist</td>
<td>-People’s conceptions of themselves are partly grounded in bodily experiences</td>
</tr>
<tr>
<td>Wilkowski, Meier, Robinson, Carter, and Feltman (2009)</td>
<td>-To examine idea that anger-related processing depends upon a rather automatic simulation of heat-related sensory experiences</td>
<td>-(111,43)/74/47/58/50</td>
<td>-experimental -mixed -offline/online -IV$s$:  -word type -cue type -background -prime type -facial expression -DV$s$:  -reaction time -error rate -rating of city temperature</td>
<td>-No control in facial expression condition</td>
<td>-(Exp1) Participants were faster (and less errors) to categorise anger-related words when they were presented in a heat-suggestive font or superimposed upon a heat-suggestive background -(Exp2) The hot background image biased categorisations in favour of anger (error and reaction times) -(Exp3) Participants estimated the temperature of</td>
<td>-Provided support for the metaphoric representation perspective, which contends that the representation of abstract social concepts often draws upon prominent metaphors at the implicit level of processing</td>
</tr>
<tr>
<td>Authors</td>
<td>Aim</td>
<td>Primary account of predication/interpretation</td>
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<td>Wu and Barsalou (2009)</td>
<td>-To examine whether perceptual simulation underlies conceptual combination</td>
<td>-“Perceptual simulation”</td>
<td>24/72/32</td>
<td>-experimental -mixed -offline -IVs: -production mode -concept type -noun phrase type -DV: -property type</td>
<td>cities to be hotter following anger related primes -(Exp4) Participants rated the current room temperature as hotter following anger-related primes -(Exp5) Participants were faster (and less errors) to categorise an angry facial expression when it appeared on the hot background</td>
<td>Occlusion modulated the proportion of internal and external properties produced -Neutral and imagery participants produced highly similar distributions of properties which differed from those for word participants -Participants produced substantial numbers of properties that described background situations for the target concepts</td>
</tr>
<tr>
<td>Hung and Labroo (2011)</td>
<td>-“Embodied cognition”</td>
<td>-54/47/91/66/98</td>
<td>-experimental -mixed -online -IVs:</td>
<td>-Interpretations based on the theorised process of simulation</td>
<td>-Occlusion modulated the proportion of internal and external properties produced -Neutral and imagery participants produced highly similar distributions of properties which differed from those for word participants -Participants produced substantial numbers of properties that described background situations for the target concepts</td>
<td>-(Exp1) 92% of respondents in the muscle-firming condition chose to make a donation to Haiti, whereas -Simply firming one’s muscles can firm one’s resolve and facilitate self</td>
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</tbody>
</table>
## Design (type, method, offline/online, IVs, DVs)

- grasp
- calf muscle
- finger stretch
- bicep muscle
- health goal

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## Limitations

- only 72.4% of participants in the control condition chose to do so
- (Exp2) Participants who clutched the pen were able to immerse their hands longer and had greater willpower than those who held a pen loosely between their index fingers and thumbs
- (Exp3) Participants who cared about long-term health, muscle firming increased vinegar consumption and had more willpower (not shown by those who didn’t care about long-term health)
- (Exp4) Significant effect of muscle firming in increasing the purchase of healthy snacks among people with a health goal but not among people with an indulgence goal
- (Exp5) When participants engaged in muscle firming when reading the Pat scenario, the action reduced the extent to which they chose to do so.
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<tr>
<th>Authors</th>
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<th>Conclusions</th>
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<tbody>
<tr>
<td>Gaillard and Urdapilleta (2011)</td>
<td>-To improve understanding of the consistency of the categorisation process in cognitive psychology</td>
<td>-NONE</td>
<td>100</td>
<td>-linguistic -mixed -offline -IVs: -group -session -DV: piles -rationale</td>
<td>-Only female participants -Only one category of objects used (food labels) -Assessed on group rather than individual level</td>
<td>- No difference in number of piles between or within subjects -Approximately half of the rationales differed within subjects. Approximately one-third of the rationales differed between-subjects</td>
<td>-Concept stability was not especially dependent on time, but dependent rather on the type of task performed.</td>
</tr>
<tr>
<td>Kousta, Vigliocco, Vinson, Andrews and Del Campo (2011)</td>
<td>-To examine the semantics of abstract knowledge</td>
<td>-“Embodied approach”</td>
<td>58/46/47</td>
<td>-linguistic -mixed -online -IVs: -items -participants -concreteness -imageability -DV: -reaction time -accuracy</td>
<td></td>
<td>-(Exp1) Abstract words were recognised as words faster than concrete words -(Exp 2/3) Emotional variables are significant predictors of reaction time and accuracy, whereas concreteness and imageability are not</td>
<td>-Once imageability and context availability ratings are taken into account, abstract words are processed faster than concrete due to a greater degree of affective associations for abstract words</td>
</tr>
<tr>
<td>Santos, Chaigneau, Simmons, and Barsalou (2011)</td>
<td>-To examine whether two systems underlie property generation</td>
<td>-Language and Situated Simulation theory</td>
<td>160/12</td>
<td>-linguistic -within -offline -IVs:</td>
<td>-qualitative and hierarchical nature of coding scheme</td>
<td>-(Exp1) Linguistic responses were produced earliest, followed by taxonomic responses, and</td>
<td>-Property generation is a relatively complex process, drawing on at least</td>
</tr>
<tr>
<td>Authors</td>
<td>Aim</td>
<td>Primary account of predication/interpretation</td>
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<tr>
<td>Chandler, Reinhard, and Schwarz (2012)</td>
<td>-To examine whether knowledge moderates embodied conceptual processing</td>
<td>-Conceptual Metaphor Theory</td>
<td>100/60/100</td>
<td>-concept -response code -DV: -median output position</td>
<td>then object-situation responses -(Exp2) Linguistic responses were produced fastest, taxonomic responses were produced just as fast and object-situation responses were produced more slowly</td>
<td>-(Exp1) Participants who had knowledge of the book found it more influential when holding the heavy rather than light copy -(Exp2) Participants who had read the novel considered it more influential when holding the heavy rather than light copy (not found for those who had not read the book) -(Exp3) Participants who were high in actual knowledge rated the heavier book as more important than the light book (did not influence those low in knowledge and perceived knowledge)</td>
<td>two systems somewhat asynchronously</td>
</tr>
<tr>
<td>Authors</td>
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<tr>
<td>Wilson-Mendenhall, Simmons, Martin, and Barsalou (in press)</td>
<td>-To examine whether distributed neural patterns of relevant, nonlinguistic semantic content represents the meanings of abstract concepts</td>
<td>-Perceptual Symbol Systems theory</td>
<td>-13</td>
<td>-neuroimaging -within -offline -IVs: -concept -scene -DV: - activated brain regions</td>
<td>-Subjectiveness of concept-scene judgement -Issue relating mental states to brain states</td>
<td>-Regions associated with specific abstract concepts (as per localiser tasks) were activated during concept-scene matching tasks</td>
<td>-The meanings of abstract concepts are represented by distributed neural systems underlying content specific to the concept</td>
</tr>
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</table>

*Note. Only findings/experiments relevant to present project are presented for each of the studies*

IV = Independent variable

DV = Dependent variable
5.1 Fundamental Assumptions of Perceptual Symbol Systems Theory

5.1.1 Convergence zone theory. Although the seminal Barsalou (1999) article did not propose a specific neural architecture underlying perceptual symbol systems, it mentions Damasio’s (1989) convergence zone theory in support of arguments for Perceptual Symbol Systems theory and in a later article, the authors note that it would be an appropriate theory to apply (Simmons & Barsalou, 2003, p. 457 note).

Convergence zone theory makes two central assumptions: (1) the existence of modality-specific representations in sensorimotor areas, and (2) the binding of modality-specific information in convergence zones (Simmons & Barsalou, 2003). The first assumption implies that when an object is perceived, it activates feature detectors in relevant sensorimotor areas of the brain called “feature maps”. For example, when an object is seen, feature detectors for line orientation, colour, direction of movement, etc. are activated in the visual cortex, which form a hierarchically organised distributed system representing the entity in visual perception (Simmons & Barsalou, 2003).

Feature maps are proposed to exist not only in vision but in all sensorimotor modalities, including the putative introspective system (see Section 5.5.2, p. 74). Feature maps in different modalities activate in parallel, so when an object is perceived, bodily movements made in response to it are coded in motor areas at the same time as visual, auditory, and emotional aspects as being coded in visual, auditory, and introspective areas, respectively (Simmons & Barsalou, 2003).

The second assumption refers to the capture and storage or “binding” of information within and across modalities by “conjunctive neurons” which exist in proposed association areas described by Damasio (1989) as “convergence zones” (Simmons & Barsalou, 2003). Convergence zones are hypothesised to be organised hierarchically so that those within a specific modality capture the pattern of information within that modality, while “higher level” convergence zones in the temporal and frontal lobes capture patterns of information across modalities (for more detail on the hierarchy of convergence zones see Damasio, 1989; and Simmons & Barsalou, 2003). Conjunctive neurons within convergence zones are proposed to code specifically combined arrangements of neurons active in a feature map, and establish associative relationships between them (Damasio, 1989; Simmons & Barsalou, 2003). Thus, states in feature maps across modalities are linked indirectly, because rather than linking neurons in one modality to those in another, higher level conjunctive neurons link lower
level conjunctions within one modality with those of another (Simmons & Barsalou, 2003).

Damasio (1989) states that convergence zones are an amodal record of the “combinatorial arrangements” which occur together in experience. However, transductions such as those associated with the computational theory of mind approach never occur such that amodal representations that lie in associative areas totally replace modal representations. As Damasio (1989) states, convergence zones:

are uninformed as to the content of the representations they assist in attempting to reconstruct. The role of convergence zones is to enact formulas for the reconstitution of fragment based momentary representations of entities or events in sensory and motor cortices. (p. 46)

Thus, although amodal records code combinatorial arrangements, these arrangements maintain their perceptual and motor features. Application of convergence zone theory to perceptual symbol systems allows it to fulfil the grounded cognition assumption that simulating and doing share the same neural substrate.24

It is important to note that the aim of Barsalou’s (1999) seminal article was to present a theoretically and empirically plausible theory of cognition and therefore he did not focus on the underlying neural mechanisms. Thus, although convergence zone theory may be a plausible neural architecture for Perceptual Symbol Systems theory, the proposed brain mechanisms mentioned in the seminal article were recognised by Barsalou (1999) as hypothetical.

5.1.2 Perceptual symbols. Perceptual Symbol Systems theory proposes that perceptual symbols are a record of the neural activations underlying perception (Barsalou, 1999). A number of fundamental assumptions underpinning perceptual symbols should be noted. Firstly, according to Barsalou (1999) perceptual symbols are not a holistic record of the entire brain state that underlies perception, rather they are schematic in nature. This schematic nature arises from selective attention25 which isolates aspects of a percept and stores them in long term memory. It is best described in terms of the neural representation outlined by convergence zone theory (see Section 5.1.1, p. 57).

24 Gallese and Lakoff (2005) use the word imagining, and later suggest that imagining is a form of simulation. When applied to Perceptual Symbol Systems theory imagining is simulation.

25 It is important to note that according to Barsalou (1999) selective attention is not necessarily conscious, rather it is the selective attention of the perceptual system.
That is, the conjunctive neurons in convergence zones operate on the selective attention of the perceptual system. For example, it is proposed that the perceptual system can focus attention on the shape of an object, filtering out its colour, texture, and position, as well as the surrounding objects. Once attention is focused on an aspect of an object, such as shape, it is stored in long term memory. When selective attention focuses on an object’s shape, the neurons representing this shape are selected, and a record of their activation is stored. As Barsalou (p. 584) notes “conscious experience may accompany the symbol formation process and may be necessary for this process to occur initially, falling away only as a symbol’s processing becomes automatised with practice”. Thus, it is contended that perceptual symbols are not conscious mental images but nonconscious neural representations. One of the key differences between amodal and perceptual symbols is that the latter remain grounded in sensorimotor areas of the brain whilst the former require transduction from a sensorimotor state to an amodal symbol.

Secondly, Barsalou (1999) contends that conjunctive neurons which code perceptual symbols are not holistic but componential. One theoretical problem with this contention is the question of how a perception is constructed whilst parts of it are left out. Barsalou suggests that conceptualising perceptual symbols as nonconscious neural representations solves this problem. For example, during the nonconscious processing of a perceptual symbol for a chair, the perceptual symbol for shape could represent the chair componentially, while perceptual symbols for other dimensions, such as colour, remain inactive. Thus, according to Perceptual Symbol Systems theory, things in the world are experienced as meaningful wholes but represented neurally in components, then again consciously recalled as meaningful wholes.

Thirdly, Barsalou (1999) proposes that perceptual symbols are dynamically activated. Due to their nature as associative patterns of neurons rather than a discrete symbol, their activation on later occasions are not exactly the same as on previous occasions. Activation is dependent on new perceptual symbols which occur in the same association area, as well as dynamic contexts (see Section 5.2.1, p. 64). Since perceptual symbols are dynamic and componential, Barsalou posits that they do not represent individual referents. The same perceptual symbol can represent a variety of referents depending on how causal and contextual factors link it to referents in different contexts (see Section 5.2.1, p. 64).
Finally, Barsalou (1999) suggests that perceptual symbols can be indeterminate because neurons can code information qualitatively. For example, lines on a triangle can be coded as lines, independent of their position, orientation, and length. They can be coded qualitatively as three “lines” joined at three “vertices”. Since all of these detectors are qualitative, the lengths of the lines and the angles between them do not matter; they can represent all instances of a triangle simultaneously.

Perceptual symbols are of no use to a cognitive system if they exist independently of one another in long-term memory. Perceptual Symbol Systems theory posits that related symbols become organised into a “simulator” that allows the cognitive system to construct specific “simulations” (Barsalou, 1999).

5.1.3 Simulators. The hypothesised existence of simulators is what allows a perceptual symbol system to overcome the limitations of a simple recording system, such as a camera or a video recorder, and become a fully-fledged conceptual system (Barsalou, 1999, 2008b). Proponents of connectionism have found similar neural patterns of activation in feature areas on encountering different instances of the same concept (Cree & McRae, 2003; Farah & McClelland, 1991). According to Barsalou (1999, 2005), this activation of neural patterns is captured by conjunctive neurons in convergence zones which integrate modality-specific features of a concept. Over time, these neurons integrate across modalities, thus establishing a multimodal representation of the concept which Barsalou (1999) calls a “simulator”.

Simulators are hypothesised to function as a “type” or concept, which integrates multimodal information about a concept over time, consequently acquiring the ability to identify “tokens” or specific instances of the concept in later processing (Barsalou, 1999, 2008b). According to Barsalou, Niedenthal, Barbey, and Ruppert (2003), an indefinite number of simulators would exist in a developed human brain because, in principle, a simulator develops for any component of experience which attention selects repeatedly. These modal components are often referred to as “embodiments”26 of the concept (simulator) which they are a constituent of, and include external experiences such as objects (e.g., chairs), properties (e.g., red), people (e.g., politicians), events (e.g., dinners), and settings (e.g., restaurants) as well as internal experiences such as affect (e.g., disgust), motivational states (e.g., hunger), proprioception (e.g., muscle

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26 Different theories under grounded cognition use the term “embodiment” to refer to varying entities (e.g., Conceptual Metaphor Theory refers to primary metaphors as embodiments). The present project refers to the stated definition when alluding to embodiments throughout the thesis.
movements), and other cognitive states (Barsalou, 2005; Barsalou, et al., 2003; Niedenthal, et al., 2005).

Consider a hypothetical simulator for the concept face. Over time, visual (e.g., eyes, mouth, nose), auditory (e.g., sneeze, cough), motor (e.g., blink), sensory (e.g., feel of skin), and introspective (e.g., happy) embodiments are integrated from a variety of experiences with faces (see Figure 4). The result is a distributed system across different modality specific areas of the brain which establishes the face simulator (Barsalou, et al., 2003).

**Figure 4.** Capture of experiential instances of faces in a face simulator (diagram from Barsalou, et al., 2003, p. 68).

### 5.1.4 Simulations.

According to Perceptual Symbol Systems theory, once a simulator is established for a concept, it can partially re-construct its contents, which is known as a “simulation”. Simulations in a perceptual symbol system are always partial and sketchy and never complete because they only ever re-construct a small subset of the simulator’s content (Barsalou, 1999, 2008b). Barsalou (1999) argues that an infinite number of simulations can be produced by a single simulator, with differing content in each simulation. Thus, different simulations from a single simulator are tantamount to different conceptualisations of a single concept. Furthermore, according to Perceptual Symbol Systems theory, simulation is not a conscious process, and accordingly many important cognitive processes including memory, reasoning, problem solving, and conceptualisation require nonconscious simulation processes (Barsalou, 1999).

According to Barsalou (1999, 2005), simulation can be viewed as the reverse process of storing modality-specific information in a simulator. Whereas learning
involves modality-specific perceptual symbols becoming linked together by conjunctive neurons in convergence zones, simulation involves later using these neurons to trigger these modality-specific perceptual symbols which form the concept’s embodiments. Consider the previous example of a simulator for face concept. When recalling a face, instead of re-constructing all the information stored in the face simulator, only a specific subset of the information is re-constructed (see Figure 5; Barsalou, et al., 2003). The chosen subset of information is dependent on the current dynamic context of cognitive processing (see Section 5.2, p. 64).

![Diagram](image)

*Figure 5. Simulation of specific face from subset of information in face simulator (diagram from Barsalou, et al., 2003, p. 68)*

### 5.1.5 Limitations of Perceptual Symbol System theory.

A number of limitations of Barsalou’s (1999) theory have been noted. Firstly, the proposed simulation system requires top-down penetration of the sensorimotor system, but the sensorimotor system has been regarded as cognitively impenetrable (Pylyshyn, 1999). In reply to this issue Barsalou claims that neuroimaging evidence from visual, motor, and auditory imagery studies suggest that cognition can penetrate the sensorimotor system, although it is acknowledged that illusion and speech recognition studies suggest that sensorimotor, or bottom-up information is resilient in the face of top-down information. Thus, Barsalou concludes that when bottom-up information conflicts with top-down information, the former usually dominates. However, when bottom-up information is absent, top-down information penetrates, as in mental imagery. Most importantly for Perceptual Symbol Systems theory, when bottom-up and top-down...
information are compatible, top-down processing again penetrates, but in subtle manners which complement bottom-up processing.

The second limitation is related to concept stability within and between individuals. An example of this limitation is that an individual’s simulation of the bird concept is different on different occasions and different people’s simulation of bird is different on the same occasion. Barsalou (1999) argues that this is not a limitation, since any simulation of bird comes from the same bird simulator. In the case of within-individual concept stability, if the different simulations of a concept arise from the same simulator, then they can all be viewed as instantiating the same concept. In the case of between-individual concept stability, the key issue concerns whether different people acquire similar simulators. Barsalou argues that humans acquire similar simulators because of a common biological cognitive system (brain structure), common experiences with the physical world (e.g., everyone sees birds fly), and common experiences with socio-cultural institutions (e.g., churches are a place of worship). Thus, Barsalou contends that the bird concept is stable between individuals, even though simulators across individuals are not exactly the same.

5.1.6 Evidence for perceptual symbol systems in conceptual knowledge.

Perceptual Symbol Systems theory predicts that modality-specific, perceptual information is recruited for conceptual tasks. Numerous cognitive behavioural and neuroimaging studies have examined this prediction using a variety of tasks (prominent examples include Kan, Barsalou, Solomon, Minor, & Thompson-Schill, 2003; Marques, 2006; Pecher, Zeelenberg, & Barsalou, 2003, 2004; Simmons, Hamann, Harenski, Hu, & Barsalou, 2008). This subsection will detail one neuroimaging study which utilised a property verification task and one cognitive behavioural study which utilised a conceptual combination task, both of which evidence modality-specific information in conceptual knowledge.

Property verification studies typically involve deciding whether a property (e.g., mane) is true of a concept (e.g., horse). A neuroimaging study in which a judgement had to be made regarding whether a presented property could be predicated of each object in the block or not (e.g., was each object in the block colourful) suggested that conceptual knowledge is more likely to be grounded in simulation than the manipulation of amodal symbols (Kellenbach, Brett, & Patterson, 2001). Three properties were tested across blocks; colourful vs. monochromatic, loud vs. silent, and small vs. large (and a control condition) and results suggested that the modal area associated with the property
of the block activated relative to the control condition. Grounded cognition theorists have argued that amodal accounts would not predict this pattern of activation since amodal representations are stripped of perceptual and motor properties during the hypothesised process of transduction (Prinz, 2005).

A cognitive behavioural study in which properties were generated for isolated noun concepts (e.g., *lawn*) and for noun concepts which included a modifier (e.g., *rolled-up lawn*) examined the hypothesis that if people use simulation in conceptual combination, the manipulation of perceptual variables, such as occlusion, should affect the process (Wu & Barsalou, 2009). As predicted, responses to noun concepts which included modifiers revealed more internal properties (e.g., dirt and roots) than isolated noun concepts. The authors argued that amodal accounts could not make these predictions a priori because they posit that conceptual representations abstract over perceptual variables (i.e., symbols are transduced from perceptual representations and bear no further relations to them). This finding suggests that people may utilise simulations in conceptual combination. Both the abovementioned studies suggest that simulation may underlie conceptual knowledge.

5.2 Situated Conceptualisation

5.2.1 Fundamental assumptions of situated conceptualisation. This section will draw heavily from Barsalou’s (2002, 2003) and Barsalou et al.’s (2003) works which argue that concepts are “situated”, meaning that they are simulated within a background situation according to the current, online goals and needs of the cogitator. Prinz and Clark (2004), suggest that amodal accounts treat concepts as entities only for thinking. Consequently, when a concept is learned, a definition of it is transduced from the experience and stored in the mind. This definition is detached from the goals and interactions of the perceiver (Barsalou, 2003). Conversely, Barsalou (2003) and other grounded theorists (Glenberg & Robertson, 1999; Prinz, 2005; Prinz & Clark, 2004) posit that concepts are primarily for action, thus their job is to deliver information which will aid interaction with the concept in the cogitator’s current, dynamic situation. Barsalou (2003, 2005) contends that a situated conceptualisation is a simulation of a particular concept in a background situation, where the specific content of the simulation prepare the cogitator for interaction with the referent in their current, dynamic situation. Furthermore, situated conceptualisations are applicable to all concepts, since they all occur in context.
Consider the concept anger in two different situations, one which becomes active when dealing with the angry child, and another when dealing with an angry spouse (Barsalou, et al., 2003). Barsalou (2002, 2003) argues that amodal accounts would posit that the same anger concept is activated in both situations, while situated conceptualisation posits a different simulation of anger in each situation according to the information which will best aid situational interaction and goal achievement. A number of important aspects to situated conceptualisations which should be noted.

Firstly, it is suggested that simulations are situation specific, multimodal, and include aspects of both the self and the other in the situation (Barsalou, et al., 2003). For example, in the situation with the child, embodiments of shouting, foot stamping, restraining and scolding may be simulated from the anger simulator. Alternatively, in the situation with the spouse, embodiments of crying, silence, and arguing may be simulated from the anger simulator.

Secondly, it is proposed that situated conceptualisations occur in a background setting rather than a vacuum (Barsalou, 2003, 2005). For example, the aforementioned situated conceptualisation with the angry spouse may have been set in the family kitchen whereas the situated conceptualisation with the angry child may have been set in the child’s bedroom.

Thirdly, it is contended that common situations become entrenched in memory and these situated conceptualisations become activated automatically when the situation is present (Barsalou, 2005; Barsalou, et al., 2003). By the time adulthood is reached, a person would have experienced similar situations many times over. For example, an adult is likely to have been to the doctor many times throughout their life. Thus, when a person goes into the doctor’s office, activation of the entrenched situated conceptualisation informs them that there will be a desk, a bed, a stethoscope, and that they are to immediately sit down in the chair next to the desk and explain their ailments. Contrastingly, in a more novel situation of a radiographer’s office the person may wait at the door to be told where to sit and put their damaged limb, even though they may have had an ultrasound before. However, even if the person had not been to a radiographer before, the radiographer’s office would not be a complete surprise because the entrenched knowledge from the doctor situated conceptualisation can be used to guide their interactions in the radiography setting, since the situations are somewhat similar in that they are both set in a medical environment (Barsalou, 2005; Barsalou, et al., 2003).
Finally, Barsalou (2002, 2003) argues that when a situated conceptualisation occurs offline (e.g., when imagining being at the doctor’s office), it creates the experience of “being there” in the situation. Therefore, the concept or situation is not detached from the conceptualiser, even though they are not physically present in the situation.

In summary, a situated conceptualisation is a simulation of a particular concept in a background situation which consists of embodiments, including features of others, objects, actions, personal bodily states, introspections, and settings (Barsalou, 2005; Barsalou, et al., 2003). Thus, a situated conceptualisation is a “multimodal simulation of a multi-component situation, with each modality-specific component simulated in the respective brain area” (Barsalou, 2005, p. 627).

5.2.2 Inference process via pattern completion. Typically when a person enters a situation, they do not initially perceive the whole situation, but it is often in their best interests to anticipate what will happen next (Barsalou, 2005; Barsalou, et al., 2003). For example, if a person is swimming at the beach and they see a fin on the surface of the water, it is important that they anticipate that there could be sharks in that area in order to guide effective action and avoid danger. Thus, it is practically important that inferences are drawn which go beyond information provided in the current situation.

Situated conceptualisations are proposed to provide a rich source of inference because they contain a pattern of embodiments, or associated multimodal components representing the situation (Barsalou, 2005; Barsalou, et al., 2003). It is contended that it only takes a component of this pattern to match the situation to activate other components of the pattern which are not perceived in the current situation (Barsalou, 2005; Barsalou, et al., 2003). In the aforementioned shark example, it only takes the water and fin components to activate inferences regarding the components of shark and danger in that situation. Thus, as Barsalou (2005, p. 628) states, “when a partially viewed situation activates a situated conceptualisation, the conceptualisation completes the pattern that the situation suggests”. If the person in the abovementioned example happens to frequently swim in a beach which is shark infested, the situation is likely to have become entrenched in their memory and thus will activate automatically when a fin in the water is perceived.

Barsalou (2003) argues that context is crucial in determining which situated conceptualisation is activated by a specific embodiment during the putative “inference
process via pattern completion”. For example, if the embodiment “punch” is activated during a fight, it is likely to trigger the situated conceptualisation of anger. However, if the same embodiment is activated in a different situation, such as a goal in a football game, it is more likely to trigger the situated conceptualisation of elation rather than anger. Thus, dynamic context is very important to the inference process via pattern completion.

The hypothesised inference process via pattern completion has an inherently probabilistic character (Barsalou, 2005; Barsalou, et al., 2003). A situated conceptualisation can be compared to a connectionist account where it is essentially an attractor; a set of embodiments which have become associated through their frequent occurrence together (Barsalou, 2005). However, an infinite number of other embodiments which are statistically close to the attractor offer variations on the situated conceptualisation depending on the dynamic situation (Barsalou, 2005). Thus, it is suggested that different situations activate different patterns within the situated conceptualisation which result in different inferences. Consequently, inferences in situations also have a statistical character because their activation is dependent on how often their associated embodiments occur in the situated conceptualisation (Barsalou, 2005).

The proposed inference process via pattern completion provides an alternative interpretation for data suggesting that not only may concepts prime putative embodiments (prominent examples include Meier, et al., 2007; Meier & Robinson, 2004; Wilkowski, Meier, Robinson, Carter, & Feltman, 2009) but embodiments may also prime conceptual knowledge (prominent examples include Chandler, Reinhard, & Schwarz, 2012; Chandler & Schwarz, 2009; Jostmann, Lakens, & Schubert, 2009; Schubert, 2004; G. L. Wells & Petty, 1980). The former set of data can be accounted for by Conceptual Metaphor Theory (see Section 4.3.2, p. 35), however since Lakoff and Johnson (1999) contend that conceptual knowledge is based on sensory experience, but sensory experience is not linked back to conceptual knowledge, image schemas can trigger primary concepts but not vice versa; thus it is unable to account for the second set of findings. Interpretation using the inference process via pattern completion can account for both sets of findings, since although conceptual knowledge is argued to be derived from sensorimotor embodiments, embodiments can also trigger conceptual knowledge (Barsalou, 2005; Barsalou, et al., 2003; Niedenthal, et al., 2005).
5.2.3 Evidence for situated conceptualisation. Results of a number of studies are consistent with various elements of situated conceptualisation: including background setting in cognition (Vallée-Tourangeau, Anthony, & Austin, 1998), action inferences (Glenberg & Kaschak, 2002), introspective state inferences (Wu & Barsalou, 2009), and dynamical simulations (Gaillard & Urdapilleta, 2011; McCloskey & Glucksberg, 1978). The following paragraphs will review one study related to background setting and two studies suggesting dynamical simulation in situated conceptualisation.

A linguistic study presented 10 categories, including two taxonomic categories (e.g., vehicle) and eight ad hoc categories (e.g., things people keep in their pockets), one at a time for 90s each and asked for items to be produced for each (Vallée-Tourangeau et al., 1998). The authors classified the responses into one of three categories: “unmediated responses” in which the items came to mind automatically, “semantic strategy” in which items were assessed according to clusters in a taxonomy, and the “experiential strategy” in which items were retrieved from experiences, including background information. Findings suggested that the experiential strategy was used 52% of the time, the semantic strategy was used 28% of the time, and unmediated responses occurred 21% of the time, suggesting that categories were conceptualised in a background setting.27

The argument for dynamical simulation in situated conceptualisation makes a number of predictions, including that concepts should vary between individuals and within an individual across time and that representations of a concept should differ depending on the situation, or anticipated situation (Barsalou, 2003, 2005). A linguistic study was conducted in which two groups sorted food labels into piles and provided a rationale for each piles’ category membership over two sessions separated by 14 days (Gaillard & Urdapilleta, 2011). Findings suggested that approximately half of the rationales provided differed between the two sessions and approximately one-third of the rationales differed between participants,28 implying that concepts vary between individuals and within individuals across time. Similarly, another linguistic study found that when basic level categories were assigned to superordinates in two sessions separated by a month, 22% of the basic level categories changed superordinate

27 For “common categories” (see Vallée-Tourangeau et al., 1998 for definition).
28 No difference in number of piles within or between participants.
membership (McCloskey & Glucksberg, 1978), implying that concepts vary within individuals across time.

5.3 Manipulation and Behavioural Realisation of Simulation

5.3.1 Triggering simulation. According to Barsalou (1999) simulation can be triggered via any modality (e.g., visual, auditory, motor etc.). Studies 2 and 3 of the present project focussed primarily on a visual trigger of simulation as well as the combination of visual and motor triggers. For the purposes of the present project the visual trigger was operationalised as photographic images and the motor trigger (also referred to as enactment) was operationalised as a postural enactment in studies 2 and 3.

Modal activity, such as that of visual perception or motor movement, can trigger simulation via their shared neural substrate, which is implicated in Perceptual Symbol Systems theory by its posited neural underpinnings (see Section 5.1.1, p. 57; Barsalou, 1999; Gallese & Lakoff, 2005; Simmons & Barsalou, 2003). This assumption implies that visual perception and motor movement can trigger the simulation of embodiments and consequently conceptual simulation through the inference process via pattern completion (Barsalou, et al., 2003). For example, considering the relationship between the up bodily state and the concept of power; visually perceiving or enacting a congruent bodily state (e.g., looking up) during processing of the concept (e.g., power) should trigger simulation of the embodiment and consequently the concept, thus facilitating conceptual simulation; while visually perceiving or enacting an incongruent bodily state (e.g., looking up) should interfere with conceptual simulation. Empirical studies which have attempted to investigate simulation in the processing of conceptual knowledge have used visual primes and covert motor primes (prominent examples include Chandler & Schwarz, 2009; Glenberg & Kaschak, 2002; Jostmann, et al., 2009; Meier, et al., 2007; Schubert, 2005; Schubert & Koole, 2009; Wilkowski, et al., 2009).

An example of a study which employed a visual prime to trigger simulation examined the influence of hot vs. temperature neutral background images on the identification of angry and sad faces (Wilkowski, et al., 2009, Study 5). Findings implied that the “hot” background visually primed the anger concept, which led to the faster identification of angry faces compared to sad faces against the “hot” background. This study suggests that visual primes can trigger cognitive simulation.

29 Through the inference process via pattern completion
An example of a study which utilised covert bodily manipulation in triggering simulation examined the influence of the motor movement of raising the middle finger (i.e., “giving the finger”) in the processing of the hostility concept by having an ambiguously described fictional character rated on a scale of “hostility” while the index or middle finger was raised (Chandler & Schwarz, 2009). Findings revealed that the motor movement led to ratings of the character as more hostile, suggesting that the motor movement of raising the middle finger primes the hostility concept. This study implies that motor movement can trigger cognitive simulation.

5.3.2 Simulation strength. Although not explicitly proposed by Perceptual Symbol Systems theory, its neural underpinnings imply that the combination of two simulation triggers may allow for the manipulation of the strength of the triggered simulation. For example, during the processing of a concept (e.g., power) via one of its embodiments (e.g., looking up), triggering simulation of the embodiment via visual perception (e.g., visually triggering looking up by presenting a photograph of a person looking up) and motor movement (e.g., enacting looking up) should facilitate simulation of the concept compared to triggering simulation of the embodiment via visual perception or motor movement in isolation.

The combination of two simulation triggers allows for further inferences to be drawn about the cognitive processes involved in conceptual knowledge. Connectionist derived amodal accounts can feasibly argue that a visual perception or a motor movement can trigger a node (e.g., looking up), which via its link to a concept (e.g., power) may facilitate related conceptual processing. An important step in this process is that the visual or motor prime is transduced, thus stripping it of its perceptual component, leaving only the amodal looking up component, which activates the node (Pylyshyn, 1984; A. J. Wells, 1998). Consequently, it seems unlikely that an amodal looking up node would be influenced by motor priming in addition to visual priming, since it does not discriminate according to perceptual and/or motor features of the activation. Thus, joint visual and motor priming of “looking up” would result in the same transduced, amodal looking up component which triggers the looking up node, whether they occur together or in isolation.

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30 A cover story was used to get participant to raise their finger.
31 Importantly, they also confirmed that the embodiment did not affect the concept of hostility via negative affect, which is an important consideration for any study which assesses the effect of embodiment on a concept which has a positive or negative valence.
In comparison, since modal accounts, such as Perceptual Symbol Systems theory, do not posit transduction of perceptual states, joint visual and motor priming of a congruent embodiment (e.g., looking up) should augment conceptual processing (e.g., of power concept) compared to visual or motor priming of the embodiment in isolation (Barsalou, 1999; Gallese & Lakoff, 2005; Simmons & Barsalou, 2003). This was the primary purpose of utilising the motor prime in the present project.

### 5.3.3 Behavioural realisation of simulation

Numerous studies have suggested that priming an embodiment of a concept can trigger conceptual simulation (prominent examples include Chandler & Schwarz, 2009; Glenberg & Kaschak, 2002; Meier, et al., 2007; Schubert, 2005; Wilkowski, et al., 2009). Since Perceptual Symbol Systems theory is underpinned by the grounded cognition assumption that simulating and doing share a neural substrate, Barsalou et al. (2003, p. 77) suggest that simulations can in turn become “realised as behaviours”. For example, when a concept (e.g., power) is simulated, traces of physical behaviour (e.g., physically looking up or introspections of pride) may follow simulation (Barsalou, et al., 2003). A number of findings have suggested that simulation may indeed be realised behaviourally (Bargh, et al., 1996; Hung & Labroo, 2011; Jostmann, et al., 2009; Oosterwijk, Rotteveel, Fischer, & Hess, 2009; Schubert & Koole, 2009; Wilkowski, et al., 2009, Study 4).

A property generation study underpinned by Perceptual Symbol Systems theory contended that disappointment led to a slumped posture (Oosterwijk, et al., 2009). Consistent with their hypothesis, the authors found that during the generation of disappointment words, posture height decreased. Importantly, it was also found that feelings of disappointment increased after the generation of disappointment related words, suggesting that the entire situated conceptualisation of disappointment was being simulated during the property generation task. Thus, Oosterwijk, et al. (2009, p. 457) concluded that their study provides “evidence for the claim that the activation of conceptual knowledge about emotion can instantiate spontaneous simulations at a behavioural level”.

Although Barsalou et al.’s (2003) contention regarding the behavioural realisation of simulation centres on motor simulations, it is implied that any aspect of a conceptual simulation may be realised behaviourally (as suggested by the findings of Hung & Labroo, 2011; Jostmann, et al., 2009; Schubert & Koole, 2009; Wilkowski, et al., 2009, Study 4). Thus, for the purposes of the present project the definition of behaviour will be extended to the behavioural realisation of any modal aspect of a
simulation (including introspection; e.g., the feeling of pride when the concept power is simulated).

5.4 Online and Offline Cognition in Perceptual Symbol Systems Theory

Perceptual Symbol Systems theory posits that embodiments are directly involved in both online and offline cognition (Barsalou, 1999; Niedenthal, et al., 2005). According to Barsalou (1999, 2008a), Gallese (2003), and Niedenthal, et al. (2005), embodiments allow for effective interaction with the environment by representing concepts in their presence during online cognition. For example, if a ball is perceived to be travelling along a trajectory by a fielder in a cricket game and is occluded during its trajectory, the fielder is still able to tell when and where it will appear when it comes out of occlusion, thus allowing the fielder to catch it. Perceptual Symbol Systems theory implies that the fielder’s ability is based on a simulation of the object’s trajectory and is dependent on what the perceiver believes the object to be. For example, if the fielder, for some reason believed the object was a softball, a different trajectory would be simulated (Reed & Vinson, 1996). This suggests that embodiments (in the example case, spatial) of concepts (in the example case, a cricket ball) are important in aiding interaction with the environment in online cognition.

However, it is important to note that if bottom-up sensory information conflicts with embodiments of the concept, they constitute new knowledge acquired and are added to the simulator (Barsalou, 1999). In the example provided above, if the cricket ball’s trajectory was different to what the fielder simulated, and the ball was actually a cricket ball, this new spatial information would be added to the putative “cricket ball simulator”.

Perceptual Symbol Systems theory posits that in offline cognition, embodiments allow for representation of referents when they are not present (Barsalou, 1999, 2008a). Just thinking about a concept is proposed to produce embodied states as if the cogitator were actually there with the referent (Barsalou, 2003; Barsalou, et al., 2003). As offline cognition relies on simulations of embodiments of a referent, they are totally dependent on stored modality-specific interactions which would have been acquired previously during online processing of the referent (Niedenthal, et al., 2005).

The proposed importance of embodiments in offline cognition is consistent with findings of a study in which a cartoon was viewed then described after a break with gesturing restricted (Rauscher, Krauss, & Chen, 1996). It was found that the prevention
of gesture resulted in a significantly slower description of spatial elements of the cartoon, suggesting that blocking the embodiment impaired access to the conceptual elements of the representation. Therefore, it can be implied that the restriction of gesture also restrained the simulation of gesturing and thus the conceptualisation of spatial elements of the cartoon.

5.5 Abstract Concepts in Perceptual Symbol Systems Theory

5.5.1 Definitions. A distinction is often made between concrete and abstract concepts. Concrete concepts are usually defined as entities which are perceivable to the senses and abstract concepts as those which are not (Wiemer-Hastings, Krug, & Xu, 2001). This definition is appropriate in some cases, such as *tree*, which is clearly a concrete concept and *truth*, which is clearly an abstract concept. However, the case of emotion and “emotion-related” concepts such as *anger* is not so clear-cut. These concepts can be perceived internally by the agent but not necessarily externally (Wiemer-Hastings, et al., 2001). Thus, they are qualitatively different to concrete concepts, prompting some authors to suggest that they constitute a separate group of concepts (Altarriba, Bauer, & Benvenuto, 1999). However, due to their spatially unconstrained and non-purely physical nature they can also be considered abstract concepts (as suggested by Barsalou & Wiemer-Hastings, 2005).

For the purposes of the present project concrete concepts were defined as purely physical and spatially constrained (e.g., *chair, tree*) while abstract concepts were defined as neither purely physical nor spatially constrained (e.g., *anger, democracy*; Barsalou & Wiemer-Hastings, 2005; Jefferies, Patterson, Jones, & Lambon Ralph, 2009). There has been much empirical work consistent with the grounded cognition account of concrete conceptual processing (Estes, Verges, & Barsalou, 2008; Tucker & Ellis, 1998). Thus, there is a general consensus that theories underpinned by grounded cognition, including Perceptual Symbol Systems theory, provide a comprehensive account of concrete conceptual knowledge, but they have been criticised for their accounts of abstract conceptual knowledge (Dove, 2009; Meteyard, et al., 2012).

32 However, it is important to note that abstract concepts such as *anger* not only have both an introspectively and proprioceptively (e.g., faster heartbeat) perceivable nature but also may have sensorimotor constituents (e.g., red face). Although it is primarily their introspective nature which Perceptual Symbol Systems theory uses to represent abstract concepts.

33 However, it is important to note that abstract concepts such as *anger* not only have both an introspectively and proprioceptively (e.g., faster heartbeat) perceivable nature but also may have sensorimotor constituents (e.g., red face). Although it is primarily their introspective nature which Perceptual Symbol Systems theory uses to represent abstract concepts.
5.5.2 Perceptual Symbol Systems theory account of abstract concepts. The major criticism of Perceptual Symbol Systems theory’s argument for the representation of abstract concepts is that since abstract concepts only have, at best, modest sensorimotor properties, they cannot be represented by a system in which only simulations of sensorimotor experience can be used for representation (Mahon & Caramazza, 2008). However, Barsalou (1999) argues that his putative introspective system, which he considers a major component of the sensorimotor system in Perceptual Symbol Systems theory, is the primary means of abstract concept representation. The putative introspective system includes representational states, cognitive operations, emotions, affect, and moods which are stored as perceptual symbols and used to represent concepts as embodiments (Barsalou, 1999; Barsalou & Wiemer-Hastings, 2005). Findings from a lexical decision study were consistent with Barsalou’s argument for the introspective representation of abstract concepts, concluding that emotional content is a type of experiential information which plays a crucial role in representation and processing with respect to the abstract/concrete distinction (Kousta, Vigliocco, Vinson, Andrews, & Del Campo, 2011).

Barsalou (1999) presents a three step argument for the introspective representation of abstract concepts: firstly, similar to situated conceptualisation, the abstract concept is “framed against the background of a simulated event sequence” (Barsalou, 1999, p. 600); secondly, selective attention focuses on the core content of the abstract concept; and finally, focal elements of the simulation that constitute the core representation of the abstract concept can be extracted, which primarily include, but are not limited to introspective properties. Barsalou (1999) uses this account to demonstrate how abstract concepts such as *truth*, *negation*, and *disjunction* are conceptualised. The following paragraphs will focus on testable predictions from Perceptual Symbol Systems theory about the properties of abstract concepts.

Firstly, abstract concepts share situational content with concrete concepts (Barsalou & Wiemer-Hastings, 2005). Although a concrete concept, such as *hammer*, can be represented by its head and handle, this does not amount to a complete concept of a hammer. A complete *hammer* concept requires the representation of a board, nails, the swing of the hammer and even the affective response to hammering a nail in a board, thus a situated conceptualisation. The situation is even more important for abstract concepts because they *cannot* be represented on their own (Barsalou & Wiemer-Hastings, 2005).
Secondly, the difference in the representation of abstract and concrete concepts, is in the situational focus (Barsalou & Wiemer-Hastings, 2005). In the hammer example used above, the situational focus would be primarily on the entity of the hammer. In contrast, for an abstract concept such as anger, the situational focus would be primarily on introspective states such as emotions and moods as well as events and social interactions within the situated conceptualisation.

5.5.3 Evidence for the Perceptual Symbol Systems theory account of abstract conceptual knowledge. Perceptual Symbol Systems theory predictions regarding abstract concepts were tested in a property generation study by Barsalou and Wiemer-Hastings (2005). Responses were codified into four major property categories: taxonomic, entity, situational, and introspective. Taxonomic properties were defined as those related to the taxonomy to which a concept belongs. Entity properties were defined as components intrinsic to the concept. Situational properties were defined as those related to a situation in which a concept would occur. Introspective properties were defined as properties related to a person’s mental state in relation to the concept. Consistent with the first prediction, findings suggested that a comparable number of situational features were produced for both concrete and abstract concepts. Findings were also consistent with the second prediction since more entity features were produced for concrete concepts and more introspective features for abstract concepts.

However, Barsalou and Wiemer-Hastings’ (2005) study did not consider the question of whether introspective states can be simulated. Indeed, there is little direct evidence for the simulation of introspective states. One neuroimaging study examined the simulation of abstract concepts via introspective states by assessing neural activation when a judgement was made regarding whether a name of an abstract concept applied to a consequently presented picture (Wilson-Mendenhall, Simmons, Martin, & Barsalou, in press). For example, the word ‘convince’ was presented for five seconds, followed by a picture of a politician speaking to a crowd (versus a picture of a park). The authors’ rationale was that access to conceptual knowledge about the word ‘convince’ would be used to verify whether it was related to the picture or not. They predicted that if

34 For example, a synonym (e.g., ‘automobile’ for the concept car) or an ontological property (e.g., ‘animal’ for the concept cat).
35 For example, an internal surface property (e.g., ‘juicy’ for the concept watermelon) or an entity behaviour (e.g., ‘barks’ for the concept dog).
36 For example, a participant (e.g., ‘children’ for the concept toy) or an action (e.g., ‘eaten’ for the concept apple).
37 For example, an emotion (e.g., ‘happy’ for the concept vacation) or an evaluation (e.g., ‘I like’ for the concept chocolate). All examples from Barsalou and Wiemer-Hastings (2005).
simulation was occurring during this process, the relevant brain areas (e.g., those representing social interaction for the concept *convince*) should activate during processing. Results aligned with their predictions, thus suggesting that not only are abstract concepts conceptualised primary by introspections, but they may also be simulated, as predicted by Perceptual Symbol Systems theory.

**5.6 Chapter Summary**

This chapter outlined features of Perceptual Symbol System theory, followed by an extension emphasising the situated nature of perceptual symbol systems. Three different aspects pertaining to conceptual knowledge were then described in relation to Perceptual Symbol Systems theory, including: the manipulation and behavioural realisation of simulation, offline and online cognition, and the embodiment of abstract concepts. In summary, Perceptual Symbol Systems theory proposes that conceptual knowledge is underpinned by modally represented “perceptual symbols” forming “embodiments” which are grouped into “simulators” according to referents which they represent. These simulators are then able to perform different “simulations” of the represented concept by reactivating the embodiments via perceptual symbols according to the contextually determined goals and needs of the cogitator in both offline and online conditions; furthermore, it was proposed that simulations may be behaviourally realised. Perceptual Symbol Systems theory also proposes that simulations can be triggered by activity in any modality and it was proposed that combining triggers from different modalities may influence the strength of the simulation. Finally, it was argued that the perceptual symbol system can represent abstract concepts primarily via the proposed “introspective system” (Barsalou, 1999, 2002; Barsalou, et al., 2003; Barsalou, et al., 2008).

Perceptual Symbol Systems theory (Barsalou, 1999) was chosen for the present project since it allowed for examination of the abstract *heal* concept according to its hypothesised “embodiments” in linguistic, offline, and online conditions. Furthermore it allowed for the investigation of the influence of combining triggers from different modalities on the strength of simulation. Finally, Perceptual Symbol Systems theory proposes the possibility of simulations being realised at the behavioural level which when applied to the *heal* concept, has the potential to help illuminate understanding of the placebo phenomenon (to be detailed in Chapter 7, p. 82).
6. Language and Situated Simulation

Barsalou’s (1999) initial contention was that a perceptual symbol system alone could constitute a fully functional cognitive system. Similarly, other theories of cognition, whether underpinned by amodal (including linguistic), statistical, or modal representations, have assumed that only one of these types of representation underlies knowledge (Barsalou, 1999; Fodor, 1975; Landauer & Dumais, 1997; McClelland & Rumelhart, 1986). Both Dove (2009) and Machery (2007) have rejected this “representational monism” and have argued that a complete cognitive system could, and may in fact be “representationally plural”. Dual Code Theory (Paivio, 1971, 1986) and the Lexical Hypothesis (Glaser, 1992) are examples of theories which posit representationally plural cognitive systems. Dual Code Theory posited that its putative linguistic and perceptual systems process conceptual meaning and the Lexical Hypothesis contended that its putative “shallow” and “deep” processing systems were underpinned by amodal representations.

Similarly, Barsalou, et al. (2008) reconceptualised the role of perceptual symbol systems in cognition as one of two systems which constitute a fully functional cognitive system – in what they termed the “Language and Situated Simulation” theory. For the present project it is important to consider the specific task demands which ought to stimulate the perceptual symbol system and how the perceptual symbol system and the linguistic system interact, since the linguistic medium can be a trigger for simulation (via auditory or visual modalities).

6.1 Language and Situated Simulation Theory

Language and Situated Simulation theory postulates that cognition is constituted of two separate but cooperative systems (Barsalou, et al., 2008). The first of these putative systems is a linguistic system, which is concerned with shallow processing tasks. The second system is the perceptual symbol system, which is experiential and situated in nature and concerned with deeper conceptual processing (as described in Chapter 5; Barsalou, et al., 2008). The two systems are proposed to have different means of representing and processing data but are closely coupled and work in parallel (Barsalou, et al., 2008). As displayed in Figure 6, when a word is perceived (in any modality) both systems activate immediately, but importantly, the linguistic systems activation peaks first (Barsalou, et al., 2008). This is because representations of
linguistic forms are more similar to presented words than are simulations of their
referents (as based on the encoding specificity principle of Tulving & Thomson, 1973).

As a word is recognised, the linguistic system activates associated linguistic
forms which can alone be sufficient for shallow processing tasks (Barsalou, et al.,
2008). According to Language and Situated Simulation theory, the activation of
linguistic forms is sufficient for a shallow processing task such as word association, in
which lexical associates of concepts are produced. Importantly, the associates are called
“linguistic forms” because they do not contain any meaning in themselves, only surface
properties (e.g., statistical relations, sound similarity, etc.). Once these associates are
activated they support a number of shallow processing strategies which allow for
accurate performance with minimal processing (Barsalou, et al., 2008). This prediction
aligns with the findings of a number of lexical decision studies which have suggested
that activation of a word’s meaning is shallow when the word is read in the context of
nonwords which violate phonological and orthographic rules. However, the activation
of a word’s meaning is deeper when the word is read in the context of nonwords which
satisfy phonological and orthographic rules (Joordens & Becker, 1997; Stone & Van
Orden, 1993; Yap, Balota, Cortese, & Watson, 2006). Studies such as these suggest that
when linguistic forms and associated statistical information are sufficient for adequate
performance, no retrieval of conceptual meaning is necessary.

Although it is proposed that the linguistic system is concerned with shallow
processing and the perceptual symbol system with deep processing, many tasks require
both systems (Barsalou, et al., 2008). As linguistic forms are triggered, they activate
referent simulations which in turn activate linguistic forms from within the situated
simulation (Barsalou, et al., 2008). In a task requiring both systems, one may dominate
momentarily, followed by the other, perhaps cycling many times, with both systems
being active simultaneously at many points (Barsalou, et al., 2008). However, Barsalou,
et al. (2008) do not comment on the timeframe of this cycling and whether produced
responses are completely dependent on the active system or whether they are due to the
initial focus on linguistic responses, followed by the simulated responses.

The abovementioned descriptions of the linguistic and perceptual symbol
systems include simplifications that require qualification. Firstly, both systems are
modal and distributed since linguistics may be auditory, visual, or tactile and perceptual
symbols are grounded in modal systems of the brain (Barsalou, et al., 2008). Secondly,
it is assumed that the operation of each system is not rigid, but dynamic and dependent
on current context (Barsalou, Breazeal, & Smith, 2007). Finally, the term “linguistic system” applies to the system that processes linguistic forms, not the system that processes linguistic meaning. Although meaning is a central part of language, Language and Situated Simulation theory’s structure contrasts linguistic forms and linguistic meaning as processed in the linguistic system and the perceptual symbol system, respectively. Since it is hypothesised that words are only linked to each other via statistical associations, they have no inherent conceptual meaning and only obtain conceptual meaning via their links to relevant modal simulations in the perceptual symbol system (Barsalou, et al., 2008). This is what differentiates the linguistic system posited in Language and Situated Simulation theory from systems described in various linguistic, amodal accounts (Burgess & Lund, 1997; Landauer & Dumais, 1997).

![Figure 6](image)

*Figure 6.* Illustration of the operation of Language and Situated Simulation, demonstrating how the linguistic (L) and situated simulation (SS) systems activate in response to a word. The height, width, shape, and offset of the two distributions are assumed to vary in response to different words and task conditions. Despite these variations, the L system is always assumed to peak before the SS (diagram from Santos, Chaigneau, Simmons, & Barsalou, 2011, p. 6).

### 6.2 Evidence for Language and Situated Simulation Theory

#### 6.2.1 Evidence for separate deep and shallow processing systems

In order to examine whether the perceptual symbol system is primarily utilised for deep processing and the linguistic system is primarily utilised for shallow processing, a study was conducted in which two groups read the word for a concept (e.g., *chair*), and then verified whether a subsequently presented property (e.g., ‘seat’) was true of the concept (Solomon & Barsalou, 2004). The groups were presented with the same “true properties” but with different “false properties”. One group was presented with false properties which were related to the concept but not true of them (e.g., ‘table’ for the concept *chair*) and the other group was presented with properties which were not related
at all to the concept (e.g., ‘feathers’ for the concept chair). It was predicted that the unrelated false properties group would utilise only the linguistic system for all their responses because true properties were linguistically related to the concept while false properties were not. On the other hand, it was predicted that those in the related false properties group would use the perceptual symbol system because both true and false properties were linguistically related to the concept, only differing in that true properties were also conceptually related to the concept while false properties were not. In line with predictions, it was found that the associative strength between concept and property words predicted response time and error in the unrelated false properties group while perceptual variables predicted response time and error in the related false properties group. These findings suggested that the linguistic system is primarily utilised for shallow processing while the perceptual symbol system is primarily utilised for deep, conceptual processing (Barsalou, et al., 2008; Solomon & Barsalou, 2004).

In order to provide neural corroboration for the aforementioned study, it was replicated utilising a neuroimaging task (Kan, et al., 2003). It was predicted that if the related false properties group were simulating, their left fusiform gyrus (an area previously found to be involved in visual simulation; Thompson-Schill, Aguirre, D'Esposito, & Farah, 1999), should be activated, while this pattern of activation was not hypothesised for the unrelated false properties group, since it was predicted that they were not simulating. Findings aligned with these predictions providing further evidence that the perceptual symbol system is primarily utilised for tasks which demand deep conceptual processing.

6.2.2 Evidence for separate linguistic and perceptual symbol systems. Little research has directly examined the predictions made by Language and Situated Simulation theory. However, one study attempted to do so by utilising a word association/property generation paradigm in which properties were to be generated verbally for presented concept words (the cue; Santos, et al., 2011). Two experiments were conducted using this paradigm: one required the generation of word associates for the concept and the other required the generation of properties typically true of the concept’s instances. According to Language and Situated Simulation theory, it was hypothesised that responses would originate from both the linguistic and perceptual symbol systems in both experiments and that since the linguistic system peaks before

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38 It can be argued that table and chair are conceptually related, but in the context of what was being asked of the participants in this particular task, it would not be.
the perceptual symbol system in response to a lexical cue, on average, earlier responses should originate from the linguistic system, while later responses should originate from the perceptual symbol system (see Santos, et al., 2011 for classes and examples of words which were hypothesised to originate from the linguistic and perceptual symbol systems, respectively). Findings of both studies were consistent with the authors’ hypotheses and led them to conclude that “responses appear to originate in two systems during property generation to word cues….initially, properties originate in word association, but then increasingly originate in situated simulation” (Santos, et al., p. 33).

In order to provide corroboration for some of the assumptions of the abovementioned study, it was partially replicated utilising neuroimaging (Simmons, et al., 2008). The study consisted of two scanning sessions, the first at which a property generation task was performed in which responses were to be generated in the mind for concepts which were visually presented inside the scanner. The second session consisted of two tasks: a word association task and “situation imagination task”. The word association task required word associates to be generated in the mind in response to a different set of concepts to the property generation task. The situation imagination task required relevant situations to be generated in the mind according to the presentation of yet another set of concepts.

As expected, the word association task activated left hemisphere language areas, including Broca’s area, while the situation imagination task activated bilateral posterior areas, typically involved in mental imagery. Most importantly, it was found that the property generation task performed in the first week scanning session contained activations found in both the word association and situation imagination tasks and more specifically that the activations found in the word association localiser task were seen earlier in the property generation task than the activations found in the situation imagination task. Together, the abovementioned studies suggest that a fully functional cognitive system consists of a linguistic system and a perceptual symbol system. Furthermore, both studies suggest that earlier responses originate from the proposed linguistic system while later responses originate from the putative perceptual symbol system.

39 Responses hypothesised to originate from the linguistic and perceptual symbol systems describe things that are more likely to have originated in the hypothesised systems. However, it is also possible that words such as hive, which is listed as a linguistic associate, could have resulted from a situated simulation. Thus, findings should be interpreted with caution.
6.3 Chapter Summary

Language and Situated Simulation theory has important theoretical and methodological implications for the present project. It predicts that the cognitive system consists of two separate but cooperating systems with two different processing natures: the linguistic system, which is early peaking and primarily utilised for shallow processing tasks, and the perceptual symbol system, peaks later and is primarily utilised for deep processing tasks (Barsalou, et al., 2008). This has significant implications for Perceptual Symbol Systems theory impact on the perceptual symbol system, since the perceptual symbol system itself must be conceptualised as system which is only utilised when required, rather than a comprehensive cognitive system in itself. Therefore, it is methodologically important to ensure that deep processing is employed when examining the perceptual symbol system (Solomon & Barsalou, 2004).

7. Heal, Perceptual Symbol Systems Theory, and the Placebo Effect

The focal concept of the present project was heal, which was selected since it is an abstract concept examinable in linguistic, offline, and online forms. The concept therefore provides a meaningful test of Perceptual Symbol Systems theory. Conversely, Perceptual Symbol Systems theory was ideal for explication of the heal concept since it directly addresses the problem of the embodiment of abstract concepts. By positing modal grounding of concepts, a Perceptual Symbol Systems theory understanding of heal has the potential to shed light on how mental states can be physically realised, with potential implications for the poorly understood placebo phenomenon in medicine.

In order to examine whether heal can be usefully viewed from a Perceptual Symbol Systems theory perspective its embodiments must be explored; and for the purposes of the present project one had to be selected for experimental manipulation. Furthermore, the present project attempted to draw further inferences about the processes underlying conceptual knowledge by investigating potential individual differences in the chosen embodiment of heal.

The following sections detail an operationalisation of the heal concept from a Perceptual Symbol Systems theory perspective, followed by a detailed analysis of how heal is embodied in the “up bodily state” and potential individual differences in this embodiment. The chapter concludes with a proposal regarding how conceptualising heal from an embodied perspective provides a potentially illuminating account of the placebo phenomenon.
7.1 Operationalisation of Heal from a Perceptual Symbol Systems Perspective

7.1.1 Embodiments of the heal concept. The heal concept has not previously been investigated from a Perceptual Symbol Systems perspective, thus there was no Perceptual Symbol Systems theory outline of how the heal concept is embodied. Therefore, it was necessary to draw inferences from Conceptual Metaphor Theory and nonempirical literature which have examined the heal concept. This literature suggests that embodiments of the heal concept may include: the “up bodily state”, the “visual perception of light”, and “introspections of positive emotion” (Lakoff & Johnson, 1980; Schoeneman, Schoeneman, & Stallings, 2004; Toombs, 1988).

Although Perceptual Symbol Systems theory provides no explicit guidelines regarding how the heal concept is embodied, it does provide guidelines regarding how different types of concepts are embodied. Therefore, in order to operationalise heal from a Perceptual Symbol Systems theory perspective it was firstly important to determine what type of concept it is. As detailed in Section 5.5 (p. 73), concrete concepts are considered to be relatively physical and spatially constrained (e.g., chair, tree) while abstract concepts are considered not purely physical nor spatially constrained (e.g., anger, democracy; Barsalou & Wiemer-Hastings, 2005; Jefferies, et al., 2009). Perceptual Symbol Systems theory contends that the situational focus for concrete concepts is on entity properties, while the situational focus for abstract concepts is on introspective states (Barsalou & Wiemer-Hastings, 2005).

In Perceptual Symbol System theory terms, heal can be considered an abstract concept. However, heal is not a pure abstract concept like truth, which is completely nonphysical and thus not perceivable to the senses (Wiemer-Hastings, et al., 2001). Along with concepts such as anger and revenge, heal is a unique “emotion-related” abstract concept, since it can be perceived internally and also has sensorimotor constituents (Wiemer-Hastings, et al., 2001).

7.1.2 The nature of the heal concept in relation to its embodiments. There are three important aspects of the heal concept which may influence its theorised embodiments. Firstly, the heal concept has a unique temporal dimension. This is best explained in comparison to a similar emotion-related abstract concept, such as anger. Before a person is angered and before a person is healed, they are in a different state to the respective concept (e.g., before anger a person is calm and before healing a person is unwell). Thus, both anger and heal are similar at this temporal stage of their respective experiences.
The uniqueness of the *heal* concept occurs between the next two temporal stages. When a person is *getting angry* their embodiments are very similar or the same as when they are *angered*. In both cases a person may have emotions related to anger, be red in the face, and be physically heated (Lakoff, 1987; Lakoff & Johnson, 1980; Wilkowski, Meier, Robinson, Carter, & Feltman, 2009). However, it can be argued that when a person is *healing*, their embodiments are different to when they are *healed*. When a person is healing, they are still likely to be somewhat unwell and thus enacting a down bodily state, and still having negative emotions (see Section 7.1.4, p. 86); whereas when a person is healed they are more likely to enact an up bodily state, and have positive emotions. Thus, it is important to note that when the *heal* concept is referred to throughout the course of the present thesis and project, it is referring to the final temporal stage of healing, that of having been healed.

Secondly, there are two distinct types of healing: *physical* healing and *psychological* healing (Bakal, Steiert, Coll, & Schaefer, 2006). Intuitively, these two types of healing appear conceptually quite different, thus it would seem unlikely that they may share the same embodiments. However, it is argued that the experiential embodiments of both physical and psychological healing are similar. In terms of the up bodily state embodiment, when someone is physically healed they can “get up and play again”, and when psychologically healed they can “get up and about more (social events, etc.)” (Kirmayer, 2008; Lakoff & Johnson, 1980). In relation to light, when a person is physically healed they open their eyes or may even come out of a “blackout” which implies the perception of light, and when psychologically healed they may have more exposure to light because they are more likely to get out of the house (Haynes, Ancoli-Israel, & McQuaid, 2005). Finally, in relation to positive emotion, when a person is physically healed they feel joyful and happy, while psychological healing is based on increasing positive emotion (Fosha, 2004). Thus, these embodiments of the *heal* concept can be applicable to both physical and psychological healing.

Finally, it can be argued that since Perceptual Symbol Systems theory posits that embodiments are underpinned by experience and different people having different experiences, that the embodiments of *heal* may not be common to everyone. However, Barsalou (1999, 2005) argues that humans acquire similar simulators of shared common experiences of the concept (e.g., generally everyone feels positive emotions, and are more up and about when they are healed) due to the similar nature of people’s bodies, world, and culture (see Section 5.1.5, p. 62).
7.1.3 Heal as embodied in the up bodily state. According to Perceptual Symbol Systems theory, since heal is considered an abstract concept, the introspective embodiment (positive emotion) would be the strongest embodiment of heal (see Section 5.5.2, p. 74). However, manipulating positive emotion would have to be elicited indirectly (e.g., via elicitation of a smile) in a behavioural study, thus it was not considered suitable for the present project.

Since light and the up bodily state were both sensorimotor embodiments, there were no theoretical grounds to favour one over the other; consequently a decision was made between the remaining embodiments of heal according to their method of manipulation. Due to its perceptual nature, light could only have been manipulated visually; for example, by altering light levels in the testing room or the colour of test stimuli, such as font colour. Alternatively, although bodily state is a motor embodiment it was possible to manipulate it visually, by presenting a photograph of a person looking up vs. down and via motor movement, by covertly having participants tilt their head up vs. down. This dual method of manipulation was considered important in order to draw further inferences about the proposed simulation underlying conceptual knowledge (see Section 5.3.2, p. 70).

Thus, the up bodily state was considered preferable to the light embodiment because it was experimentally easier to covertly manipulate. Thus, the up bodily state was selected as the embodiment of heal to be manipulated in studies 2 and 3 of the present project.\textsuperscript{40} A number of authors have considered the up bodily state an important dimension of healing or recovery from illness (Lakoff & Johnson, 1980; Toombs, 1988). It has been noted in particular that the loss of upright posture is an important aspect of illness related to helplessness and loss of autonomy, thus implying that regaining the up bodily state signals a return to health (Toombs, 1988).

The up metaphor has been well researched under the Conceptual Metaphor Theory framework and has been found to relate to concepts of power (Schubert, 2005), God (Meier, et al., 2007), non-depression (as opposed to depressed being down; Meier & Robinson, 2006), happiness (Lakoff & Johnson, 1980), and positive affect/valence (Crawford, Margolies, Drake, & Murphy, 2006; Meier & Robinson, 2004). These studies interpreted their findings according to Conceptual Metaphor Theory, but often

\textsuperscript{40} However, it must be noted that according to the inference process via pattern completion framework of Perceptual Symbol System theory, the up bodily state should activate the other embodiments of the heal concept (Barsalou, 2005).
operationalisation of the *up* metaphor included the up bodily state. Thus, these findings may have been a result of the simulation of the up bodily state embodiment rather than activation of the *up* metaphor.

This brings about the important question of what is meant by the “up bodily state”. In healing, the up bodily state can be the whole body in an upright position, as opposed to a stooped or lying down position (which are common to sickness) or simply the head lifted up skywards, as is experienced when healed, as opposed to down at the ground, as is experienced when in pain or during illness (Crawford, 2009; Lakoff & Johnson, 1980). Studies 2 and 3 of the present project manipulated the latter due to its relative methodological ease.

7.1.4 Caveats of heal as embodied in the up bodily state. A number of caveats regarding the *heal* concept as embodied in the up bodily state should be noted. Firstly, some embodiments are a part of the situated conceptualisation of more than one concept. The up bodily state is one such embodiment which is a part of not only the *heal* concept but also *power, God, non-depression, happiness,* and *positive valence* (Crawford, et al., 2006; Lakoff & Johnson, 1980; Meier, et al., 2007; Meier & Robinson, 2006; Schubert, 2005). Perceptual Symbol Systems theory postulates that the concept which is activated by an embodiment is determined by the context (Barsalou, 2003). For example, the up bodily state embodiment will trigger the inference process via pattern completion for *heal* in the context of pain, whereas the same up bodily state embodiment will trigger the inference process via pattern completion for *God* in the context of a church.

Secondly, the common dimension among almost all of the abovementioned concepts which potentially involve “up” is positive valence. Thus, it may be that these concepts are linked to “up” because of their innate positive valence and not because of their experiential underpinning by the up bodily state. It is acknowledged that positive valence is an important component of the *heal* concept and that it may account for some of the relationship between *heal* and the up bodily state embodiment. However, studies examining the relationship between *God* and *up* (Meier, et al., 2007) and *power* and *up* (Schubert, 2005) have suggested that the relationship between the respective concepts and “up” is separate from valence. Furthermore, examining the up bodily state embodiment as opposed to the positive emotion embodiment allows for greater confidence in separating the *heal* concept from positive valence since the positive emotion embodiment is intuitively more closely associated with positive valence than
the up bodily state embodiment. Therefore, it is assumed that positive valence may account for some of the relationship between the up bodily state embodiment on the heal concept; however, this will not be explored in the present project.

Finally, it is important to consider whether the opposite of the up bodily state embodiment, the “down bodily state” embodiment, is an illness (which is considered the opposite of heal) embodiment, and whether it plays a role in interfering with access to the heal concept in its own right as opposed to being due to its inverse relationship to the up bodily state embodiment of heal. There has been little empirical work conducted on the down bodily state embodiment in relation to any type of illness concept. However, one study found that higher depressive symptoms were associated with a bias towards lower (down) spatial attention targets compared to higher spatial targets, suggesting that the down bodily state may be an illness embodiment in its own right and thus may directly interfere with access to the heal concept (Meier & Robinson, 2006).

An even more compelling case for the down bodily state embodiment interfering with access to the heal concept arises from the shared neural substrate between simulating and doing (Barsalou, 1999; Gallese & Lakoff, 2005; Simmons & Barsalou, 2003). When accessing the heal concept, simulation of the up bodily state embodiment takes place in the sensorimotor system. This simulation should be interfered with if there is a visual perception of an incongruent state (e.g., observing someone in the down bodily state) or to an even greater degree if an incongruent bodily state is additionally enacted (see Section 5.3.2, p. 70). This is argued to occur whether or not the incongruent embodiment is related to the opposite of the concept being simulated (e.g., illness in the case of heal) or not. Thus, the down bodily state, whether or not it is an illness embodiment in its own right, should interfere with access to the heal concept.

7.2 Individual Difference Factors in the Embodied Heal Concept

There have been numerous studies suggesting that individual differences in expertise may affect the ability to simulate the expert domain (examples include Beilock, Lyons, Mattarella-Micke, Nusbaum, & Small, 2008; Calvo-Merino, Glaser, Grèzes, Passingham, & Haggard, 2005; Lyons, et al., 2010) and that individual differences in particular domains (e.g., empathy) affect the ability to simulate the mental states of others (e.g., pain, Jackson, Meltzoff, & Decety, 2005). Furthermore, Barsalou (1999, p. 599) argues that “different individuals represent the same concept differently because their perceptual symbols become tuned to somewhat different physical
environments” and these different environments are determined on an individual basis. Thus, there are grounds to suggest that individual differences may exert some influence on the putative process of simulation.

It can be argued that three individual difference factors warrant investigation as potentially influencing the embodiment of *heal* in the up bodily state. The first of these factors is cultural background. The embodiments of *heal* are assumed to be universal according to the Perceptual Symbol Systems theory assumption that humans share a similar body structure, world, and culture (Barsalou, 1999, 2005). Although the up bodily state, light, and positive emotion may be common embodiments of the *heal* concept for people of a western background, they may not apply as easily to people of an eastern background. In the Buddhist tradition, pain is to be experienced calmly, without emotional appeal, and is also seen as a source of power and honour (L. M. Chen, Miaskowski, Dodd, & Pantilat, 2008; Sharts-Hopko, 2003). This conceptualisation of pain is likely to have an impact on the experience of healing and thus also on embodiments of the *heal* concept.

Secondly, it has been suggested that the entrenchment of a situated conceptualisation in memory is dependent on the frequency at which that situation is experienced with the same embodiments (Barsalou, 2005; Barsalou, et al., 2003). Thus, the experience of more ailments, and therefore more healing, may lead to a better entrenched situated conceptualisation of *heal*.

The final factor is the intensity, and thus “quality” of healing experiences. Situated conceptualisations are composed of embodiments derived from perceptual attention (Barsalou, 1999, 2005). Consequently, the experience of more intense and higher quality perceptions of pain, and thus healing, are more likely to lead to a higher quality conceptualisation of *heal*. For example, two people may have experienced a broken leg, but one may have experienced more pain, and thus a perceived greater degree of healing than the other. In phenomenally perceiving a greater degree, and thus a higher quality of healing, this person’s *heal* concept may be of greater quality and depth than the person who did not perceive as much pain or healing.

Empirical investigations of embodied cognition do not usually focus on individual differences, instead opting for experimental procedures which involve manipulation of the environment whilst treating all participants as identical (e.g., Chandler & Schwarz, 2009; Meier & Robinson, 2004; Wilkowski, et al., 2009). Although experimental manipulation is an effective method of investigating the
embodiment of putatively embodied concepts, it would be potentially illuminating to measure plausible individual difference variables, and test how they moderate the main effects manipulated in experimental designs. In the present three-study project, individual difference factors were investigated in relation to the main effects identified in two of the studies, and for clarity results are presented as a separate investigation.

7.3 Understanding the Placebo Effect via the Embodied Heal Concept

7.3.1 Current accounts of the placebo effect and the Cartesian problem. The “placebo effect” has been recognised in medicine since 400BC (Hippocrates, 1923 in Di Blasi, Harkness, Ernst, Georgiou, & Kleijnen, 2001) with the first scientific definition published in a medical dictionary in 1811 (Moerman, 2002). It has been defined as “a genuine psychological or physiological effect, in a human or another animal, which is attributable to receiving a substance or undergoing a procedure, but is not due to the inherent powers of that substance or procedure” (Stewart-Williams & Podd, p. 326). The most influential theories of the placebo effect include classical conditioning and response expectancy (Stewart-Williams & Podd, 2004).

Classical conditioning was initially conceived as a noncognitive, automatic, and implicit process in which the association of a neutral stimulus (e.g., inert pill) with an unconditioned stimulus (e.g., active drug) which elicits an unconditioned response (e.g., relief from ailment), leads the neutral stimulus to become a conditioned stimulus, at which point it acquires the capacity to elicit a response similar or related to the unconditioned response (J. B. Watson, 1924). Thus, classical behaviourism explains the placebo effect as a learned response underpinned by associations between contextual factors (e.g., pills, procedures) and active medications or procedures leading to the contextual factors exhibiting an effect in isolation (Ader, 1997).

The most prominent theory of the placebo effect is response expectancy theory, which is defined as “expectancies of the occurrence of nonvolitional responses” (Kirsch, 1985, p. 1189). Response expectancy theory argues that the expectation of the pill to cure (nonvolitional response) leads to healing, despite the inert nature of the pill. Response expectancies in experimental studies are usually manipulated by verbal suggestion, but can also be produced by classical conditioning (De Jong, Van Baast, Arntz, & Merckelbach, 1996; Montgomery & Kirsch, 1996). Thus, it is not clear whether it is verbally suggested expectancy, conditioned beliefs, or both which cause the placebo effect.
Both these interpretations of the placebo effect are plagued with the Cartesian problem of how a mental state, formed as an expectancy or conditioned belief (e.g., pill will heal), can lead to changes in physical state (Frenkel, 2008). Some authors have argued that the neurophysiological realisation of these mental states can account for changes in physical states (Benedetti, Carlino, & Pollo, 2011; Campbell, 2009). If, as hypothesised by Perceptual Symbol Systems theory, mental states are inherently grounded in modal states, then the activation of physical states becomes theoretical plausible since it can be argued that modal states can be physically realised while mental states cannot. A number of studies have suggested that the simulation of conceptual knowledge (i.e., a mental state) can be behaviourally realised (i.e., physical states; see Section 5.3, p. 69). Thus, conceptualising heal as an embodied concept has the potential to illuminate the placebo effect by bridging the Cartesian divide.

### 7.3.2 How the embodied heal concept can illuminate the placebo effect.

Perceptual Symbol Systems theory can be used to generate an interpretation of the placebo effect underpinned by the embodied heal concept. According to this perspective, conditioned associations and expectancies (e.g., beliefs regarding contextual factors) are aspects of the situated conceptualisation linked to the heal concept. When simulated, any one of these contextual factors may activate simulation of the heal concept through the inference process via pattern completion, which may consequently trigger the perception of healing. However, the heal concept can also be activated via simulation of its noncontextual embodiments (i.e., the up bodily state, light, positive emotion), thus eliminating the need for a “placebo” (i.e., contextual factors).

Perceptual Symbol Systems theory implies that accessing the heal concept involves simulation of the embodiments which constitute the concept (Barsalou, et al., 2003). It can be argued that during a situation in which healing is required (e.g., when in pain) most natural embodiments are incongruent with healing. For example, during a painful experience a down bodily state is naturally enacted along with negative emotions and closed eyes (leading to a perception of darkness), thus interfering with access to the heal concept (Lakoff & Johnson, 1980; Schoeneman, Schoeneman, & Stallings, 2004; Toombs, 1988). However, visually priming an embodiment of heal, such as the up bodily state, during a situation in which healing is required (e.g., when in pain) triggers simulation of the heal concept and may consequently trigger the perception of healing (i.e., the behavioural realisation of heal - the perception of
introspections related to healing; see Figure 7 and Section 5.3.1, p. 69). On the other hand, visually priming an incongruent embodiment of heal, such as the down bodily state, during a situation in which healing is required (e.g., when in pain) may interferes with simulation of the heal concept and may diminish the perception of healing.

Furthermore, the addition of a congruent motor prime to the visual prime should further augment access to the simulated concept and consequently enhance its behavioural realisation (Barsalou, 1999; Gallese & Lakoff, 2005; Simmons & Barsalou, 2003). For example, enacting the up bodily state in addition to visually priming the up bodily state during a situation in which healing is required (e.g., when in pain) should augment access to the heal concept and may further enhance the perception of healing (see Figure 8 and Section 5.3.2, p. 70). On the other hand, the addition of an incongruent motor prime to the visual prime should further interfere with access to the simulated concept and consequently further diminish its behavioural realisation. For example, enacting the down bodily state in addition to visually priming the down bodily state during a painful experience should interfere with access to the heal concept and may further diminish the perception of healing.

This embodied account of the placebo phenomenon does not claim to explain the entire placebo response. However, the embodied account may be an important alternative explanation of how mental states can be translated into physical states in the placebo effect and how the perception of healing can be triggered without the need for a placebo (i.e., contextual factors).

*Figure 7. Hypothesised process during simulation illustrating how visual priming of the up bodily state embodiment can facilitate simulation of the heal concept. Context (diamonds), primes (thick solid rectangles), hypothesised neural states (solid rectangles), explanations between states (dashed rectangles), and outcome (solid ovals).*
7.4 Chapter Summary

This chapter focussed on operationalising the heal concept from a Perceptual Symbol Systems theory perspective and detailing how this may illuminate the placebo phenomenon. Since Perceptual Symbol Systems theory has no guidelines regarding the specific embodiments that might be important to concepts, Conceptual Metaphor Theory as well as nonempirical examinations of the heal concept were used to generate three potential embodiments. The up bodily state embodiment of heal was selected as the focus for studies 2 and 3 of the present project due to its methodological advantage. This was followed by the detailing of three potential individual differences factors hypothesised to influence the embodiment of heal in the up bodily state. Finally, the question of how the embodied heal concept could illuminate understanding of the placebo effect was discussed.

8. Aims and Hypotheses

8.1 Project Summary

The meta-aim of the present project was to examine the embodied heal concept across multiple conditions (i.e., linguistic, offline, and online) in order to provide a comprehensive examination of Perceptual Symbol Systems theory and to illuminate the
poorly understood placebo phenomenon in medicine. The project consisted of three experimental studies and an individual differences investigation of the \textit{heal} concept. The Perceptual Symbol System theory argument for simulation sat at the centre of these studies and was explored experimentally in a linguistic task (Study 1), in offline (Study 2) and online (Study 3) conditions, and via investigation of individual differences factors in studies 2 and 3. From the findings of these studies inferences were drawn regarding the nature of conceptual knowledge, embodied cognition, and more specifically Perceptual Symbol Systems theory and the \textit{heal} concept.

\section*{8.2 Study 1 Aims and Hypotheses}

Study 1 had three aims. The first was to test the Language and Situated Simulation theory prediction that the shallow processing linguistic system is accessed first, followed by the deeper processing perceptual symbol system. The second was to test the Perceptual Symbol Systems theory prediction that abstract concepts are primarily conceptualised by introspections (e.g., emotions) while concrete concepts are primarily conceptualised by entity properties (e.g., texture). The final aim was to provide validation for the type of lexical stimuli (introspective words) utilised in Study 2.

Study 1 was a word association/property generation study. Responses were generated for six concepts, which were then coded as within subjects factors of latency of response category (linguistic, taxonomic, simulated), property (entity, introspective, situational, miscellaneous) and concept (abstract, concrete). Figure 9 presents a diagrammatic representation of the design for Study 1.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{study1_diagram.png}
\caption{Diagrammatic representation of Study 1 design. Studies (dashed rectangles), putative processes (dashed ovals), and independent variables (solid rectangles).}
\end{figure}
It was specifically predicted that:

- Lexical associates will be produced earlier than simulated responses across concept types (H1). The latency of taxonomic responses was also explored. 
  Rationale: According to Language and Situated Simulation theory, responses from the linguistic system are produced before responses from the perceptual symbol system.

- Introspective properties will be identified more commonly for abstract compared to concrete concepts while (H2a) entity properties will be identified more commonly for concrete compared to abstract concepts (H2b). The identification of situational properties across both concept types was also explored. 
  Rationale: According to Perceptual Symbol Systems theory, the situational focus for abstract and concrete concepts is primarily on introspective features and entity properties, respectively.

Furthermore, the *heal* concept was examined separate from the other five concepts across analysis of both hypotheses in order to validate that *heal* can be simulated according to Perceptual Symbol System theory assumptions and is primarily conceptualised by its introspective features. This was also expected to help validate the introspective words used in Study 2.

### 8.3 Study 2 Aims and Hypotheses

There were three aims for Study 2. The first was to empirically investigate the putative embodiment of the *heal* concept in the up bodily state in an offline condition. 

The second was to examine the influence of adding a motor prime to the visual prime in manipulating the strength of the putative simulation. The final aim was to use *heal* specific data drawn from the study to generate testable hypotheses and models about the types of systems used in conceptual knowledge for future research.

Study 2 was a mixed design, experimental study which involved determining whether words presented following primes (determined by the *direction* and *strength* of the trial) were associated with the target word ‘heal’. The independent variables were: 

- direction (up vs. down), which was measured within subjects and operationalised in viewing a photograph of a person in an up bodily state (for the *up* condition) and in viewing a photograph of a person in a down bodily state (for the *down* condition; see Section 12.3.3, p. 134 for photographs); and 
- strength (visual prime vs. visual + motor primes) which was measured between subjects and operationalised in viewing a
photograph of a person in an *up/down* bodily state (for the *visual* condition) and in viewing a photograph of a person in an *up/down* bodily state and enacting the *up/down* bodily state (for the *visual + motor* condition). The dependent variable was response latency.\(^{41}\) Figure 10 presents a diagrammatic representation of the design for Study 2.

*Figure 10.* Diagrammatic representation of design for Study 2. Study (dashed rectangles), putative processes (dashed ovals), outcome variables (thick solid rectangles), methods of manipulation (solid ovals), and independent variables (solid rectangles).

It was specifically hypothesised that:

- Simulation of the *up* bodily state will allow for facilitation of conceptual processing related to the *heal* concept compared simulation of the *down* bodily state (H3). Rationale: According to Perceptual Symbol Systems theory, concepts are embodied via their experience and when embodiments are simulated, they trigger simulation of the concept via the inference process of pattern completion. The literature suggests that *heal* is partially embodied in the *up* bodily state.

- An interaction between direction (*up* vs. *down*) and strength (*visual* vs. *visual + motor*) equivalent to that displayed in Figure 11 will be found (H4). Rationale: The combination of congruent activity from two (or more) modalities should augment the strength of the simulation. Thus, motor priming of the *up* bodily state embodiment in addition to visually priming the *up* bodily state embodiment should facilitate processing related to the *heal* concept compared to only visual priming of the *up* bodily state embodiment. Whereas motor priming of the *down* bodily state in addition to visual priming of the *down* bodily state embodiment should interfere with processing related to the *heal* concept compared to only visual priming of the *down* bodily state embodiment.

\(^{41}\) Error rate was a confound check for the dependent variable.
8.4 Study 3 Aims and Hypotheses

There were three aims for Study 3. The first was to empirically investigate the putative embodiment of the *heal* concept in the up bodily state in an *online* condition. The second and third aims were the same as those of Study 2 (see Section 8.3, p. 94).

Study 3 was a *between* subjects, experimental study which involved reporting perceived healing whilst looking at a photograph (determined by the *direction* and *strength* of the trial) on a projector (determined by the *direction* and *strength* of the condition) following a “cold pressor task”. The independent variables were direction (up vs. down; see Section 8.3, p. 94 for operationalisation) and strength (visual prime vs. visual + motor primes; see Section 8.3, p. 94 for operationalisation). The dependent variables were healing sensation and healing affect. Figure 12 presents a diagrammatic representation of the design for Study 3.

*Figure 12. Diagrammatic representation of design for Study 3. Study (dashed rectangles), putative processes (dashed ovals), outcome variables (thick solid rectangles), methods of manipulation (solid ovals), and independent variables (solid rectangles).*
It was specifically hypothesised that:

- Simulation of the up bodily state will result in a more pronounced perception of (a) physical healing and (b) affect related to healing compared to simulation of the down bodily state (H5). Rationale: Same as H3 (see above). Additionally, simulation of a concept may be realised at the behavioural level. Thus, simulation of the heal concept may trigger the perception of healing (i.e., perception of introspections related to healing).

- An interaction between direction (up vs. down) and strength (visual vs. visual + motor) for perception of (a) physical healing and (b) affect related to healing equivalent to that displayed in Figure 13 would be found (H6). Rationale: Same as H4 (see above). Additionally, simulation of a concept may be realised at the behavioural level. Thus, simulation of the heal concept may trigger the perception of healing.

![Figure 13. Expected interaction effect between direction and strength for Study 3 (H6).](image)

8.5 Individual Differences Aims and Hypotheses

The individual differences investigation aimed to offer a secondary, novel method of drawing inferences regarding the simulation process putatively taking place in studies 2 and 3. The aim was to assess three individual differences factors proposed to influence embodiment of the heal concept in the up bodily state by examining whether they moderate the main effects from studies 2 and 3. Specific hypotheses will be detailed in Chapter 18 (p. 189) once findings of studies 2 and 3 are established.
The individual differences investigation was a mixed design with direction (up vs. down) as the within subjects factor and cultural background (Western vs. Eastern)/frequency of pain experiences (more vs. less)/intensity of pain experiences (high vs. low) as the between subjects factors (in separate analyses). The dependent variable was response latency. Figure 14 presents a diagrammatic representation of the design for the individual differences investigation.

![Diagram](image)

**Figure 14.** Diagrammatic representation of design for the individual differences investigation. Studies (dashed rectangles), putative processes (dashed ovals), outcome variables (thick solid rectangles), methods of manipulation (solid ovals), and independent variables (solid rectangles).

On the condition that findings from Studies 2 and 3 are consistent with Perceptual Symbol Systems theory, it was hypothesised that:

- Cultural background will moderate the main effects of Study 2 (H7a) and Study 3 (H7b). Rationale: Perceptual Symbol Systems theory posits that embodiments are derived from experiences, and experiences vary between cultures. Since people from an Eastern cultural background may view pain as a source of power and honour (see Section 7.2, p. 87), the embodiment of the *heal* concept in the

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42 Error rate was a confound check for the dependent variable.
up bodily state will not be as pronounced for participants from an Eastern cultural background compared to participants from a Western cultural background.

- Frequency of pain experiences will moderate the main effects of Study 2 (H8a) and Study 3 (H8b). Rationale: More pain experiences were assumed to be equivalent to more healing experiences. Since more experiences of healing were proposed to lead to a more entrenched situated conceptualisation of heal, the embodiment of the heal concept in the up bodily state will be more pronounced for those with more healing experiences compared to those with less healing experiences.

- Intensity of pain experiences will moderate the main effects of Study 2 (H9a) and Study 3 (H9b). Rationale: Intensity of pain experiences were assumed to be equivalent to intensity of healing experiences. Since higher intensity healing experiences were proposed to be associated with a higher quality conceptualisation of heal, the embodiment of the heal concept in the up bodily state was predicted to be more pronounced for participants reporting high intensity healing experience compared to participants reporting low intensity experiences of healing.

II. STUDY 1

9. Method for Study 1

9.1 Sample Demographics

Twenty-four participants formed the total sample for Study 1. This sample consisted of 13 males (54.2%) and 11 females (45.8%) with a mean age of 28.92 years (SD = 9.59). Eighteen (75.0%) participants primary language was English and six participants were bilingual (25.0%), none (0.0%) reported English as their second language.

9.2 Operationalisation of Effects

9.2.1 Latency of response category effect. Latency of response category was a within subjects variable referring to the latency of responses for linguistic, taxonomic, and simulated coded responses (according to the Language and Situated Simulation Coding Scheme). The latency of response category effect was operationalised as the
difference in response latencies between the linguistic, taxonomic, and simulated responses.

The predicted latency of response category effect would be observed if the average latency of linguistic responses is significantly shorter than that of simulated responses.

9.2.2 Property effect. Property was a within subjects variable referring to the percentage of responses coded as entity, introspective, or situational (according to the Perceptual Symbol Systems Concept Properties Coding Scheme) across concept. The property effect was operationalised as the difference in percentage of responses coded as entity, introspective, or situational across concept.

There was no hypothesised property effect independent of the concept effect.

9.2.3 Concept effect. Concept was a within subjects variable referring to the percentage of responses coded according to the Perceptual Symbol Systems Concept Properties Coding Scheme for abstract and concrete concepts. The concept effect was operationalised as the difference in percentage of responses coded according to the Perceptual Symbol Systems Concept Properties Coding Scheme for abstract and concrete concepts.

There was no hypothesised concept effect independent of the property effect.

9.2.4 Property by Concept interaction effect. The property by concept interaction effect was operationalised as the percentage of responses coded as entity, introspective, or situational (according to the Perceptual Symbol Systems Concept Properties Coding Scheme) for abstract and concrete concepts. The property by concept interaction effect was operationalised as the difference in percentage of responses coded as entity, introspective, or situational between abstract and concrete concepts.

The predicted interaction effect would be observed if, on average, significantly more introspective properties are identified for abstract concepts compared to concrete concepts and significantly more entity properties are identified for concrete concepts compared to abstract concepts according to the Perceptual Symbol Systems Concept Properties Coding Scheme.

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43 Only responses coded as “simulated” according to the Language and Situated Simulation Coding Scheme were used in the analysis of the property by concept hypotheses (see Section 9.5.2, p. 103).
9.3 Materials

9.3.1 Word stimuli. Three concrete words (chair, dog, tree) and three abstract words (anger, democracy, heal) were selected as concepts for Study 1. The MRC Psycholinguistic database (Coltheart, 1981a, 1981b) provided a measure of “concreteness” derived from the merging of three sets of norms (Gilhooly & Logie, 1980; Paivio, Yuille, & Madigan, 1968; Toglia & Battig, 1978). Concreteness values ranged from 158 to 670 ($M = 438$, $SD = 120$) with higher values indicating higher concreteness.

The concreteness rating for the three concrete words were 606 (chair), 610 (dog), and 604 (tree) with a mean of 606.67 ($SD = 3.06$). The concreteness rating for the three abstract words were 315 (anger), 298 (democracy), and 417 (heal) with a mean of 343.33 ($SD = 64.66$). The concrete words were significantly more concrete than the abstract words ($t(2.009) = 7.08$, $p < .05$).

9.4 Procedure and Apparatus

Participants were recruited through the “Facebook” social networking site or via word of mouth. Upon arrival, participants were seated at a small desk in a silent testing room at Swinburne University of Technology, Victoria, Australia. They were then provided with the “information sheet” and the “informed consent” document (see Appendix B). Participants were asked to sign the informed consent document once they had read the information sheet and agreed to participate. The information sheet contained information regarding the purpose of the study, experimental procedures, privacy, confidentiality and disclosure of information, study results and outcomes, ethical guidelines, and complaint procedures. After giving consent, participants were allocated a unique code number which linked their questionnaire and recorded task data whilst maintaining their anonymity. Participants were then asked to fill out the pen-and-paper questionnaire which collected demographic information including: age, gender, and primary language.

The investigator then sat on the opposite side of the desk facing the participant and read the following task instructions (edited version from Barsalou & Wiemer-Hastings, 2005, p. 139);

*The general purpose of this experiment is to study people’s knowledge about the world. Our specific purpose here today is to learn more about people’s understanding of*
specific concepts. Before we go any further, let me stress that there are no correct responses to the questions that I am about to ask you. Instead, what we’re doing here is performing a scientific experiment, where the purpose of this experiment is to understand how normal people like yourself think about various concepts. Here’s what you can do to help us learn more about this. In a moment, when I ask you about a concept, please say the very first thoughts as they come to mind. Please keep responding with any thoughts that continue to come to mind, until I ask you to stop. As stated in the information statement, your responses will be recorded for analysis.

Responses were recorded on a mobile phone recording application (Samsung Galaxy S mobile phone, “Voice Recorder” application). The six concept words were read out one by one in the following order: chair, anger, dog, democracy, tree, heal. Participants were given one minute to provide responses for each concept and 10s between concepts. The following instructions were read before each concept (edited version from Barsalou & Wiemer-Hastings, 2005, p. 139):

Please say your thoughts, as they come to mind.
What words and characteristics come to mind when you think of: [CONCEPT NAME]

The study was approved by the Swinburne University Human Research Ethics Committee.44

9.5 Coding Schemes

9.5.1 Language and Situated Simulation Coding Scheme. The Language and Situated Simulation Coding Scheme45 (see Appendix C) was used in Study 1 to examine the latency of response category hypothesis (H1). The Language and Situated Simulation Coding Scheme employs a hierarchical system to sequentially code responses. Firstly, if a response is linguistically related to the concept, it is coded as a linguistically-related response; consideration of other possible coding categories proceeds no further. If a response does not fall into the linguistic response category, it is evaluated for taxonomic response category membership. If a response is taxonomically related, it is coded as a taxonomically-related response; consideration of other possible

44 Ethics clearance and statement of compliance for studies 1, 2 and 3 are provided in Appendix R.
45 Which was that which was used by Santos, et al. (2011).
coding categories proceeds no further. Finally, if a response does not fall into a linguistic or taxonomic coding category, it is coded as simulated response. The specific categories for linguistic and taxonomic responses were not used in coding for Study 1.

Santos, et al. (2011) reported inter-rater reliabilities of 76.0% and 77.0% for the coding scheme as judged by two separate raters in their two experiments. Due to time and resource constraints of the present project only a subset of four participants’ responses were coded by an independent rater, suggesting moderate inter-rater reliability of 88.6% (Cohen’s $\kappa = 0.57$; interpretation according to Landis & Koch, 1977).

9.5.2 Perceptual Symbol Systems Concept Properties Coding Scheme. The Perceptual Symbol Systems Concept Properties Coding Scheme (see Appendix D) was used in Study 1 to examine the property by concept hypotheses (H2a and H2b). Only responses that were coded as “simulated” according to the Language and Situated Simulation Coding Scheme were used in the analysis of the property by concept hypotheses. Previous research coded responses into one of the five general categories, including: taxonomic, entity, situational (called “setting/event” in Barsalou and Wiemer-Hastings, 2005), introspective, and miscellaneous. The Perceptual Symbol Systems Concept Properties Coding Scheme omitted the taxonomic category and coded those responses as miscellaneous because they were considered theoretically unimportant. Furthermore, the specific categories used in the abovementioned studies were not used in Study 1.

Wu and Barsalou (2009) reported inter-rater reliabilities of 91.0% and 92.0% for the coding scheme as judged by two separate raters in their two experiments. For the present study, four participants’ responses were coded by an independent rater suggesting good inter-rater reliability of 77.2% (Cohen’s $\kappa = 0.65$; interpretation according to Landis & Koch, 1977).

9.6 Data Analytic Approach

9.6.1 Calculation of latency of response category variables. All responses were coded according to the Language and Situated Simulation Coding Scheme and with a latency value (in seconds) between 1 and 60, according to when the response was...
verbalised in the allotted 60s for each concept word. Following data coding, mean latencies for each Language and Situated Simulation response category (linguistic, taxonomic, simulated) were calculated for each of the six concepts for each participant.\textsuperscript{48} Finally, mean latencies for each Language and Situated Simulation response category (linguistic, taxonomic, simulated) were calculated for each participant, across the six concepts, forming the three latency of response category variables.

\textbf{9.6.2 Calculation of property variables.} Property types for each of the six concepts were then calculated as a percentage of total responses. Following this, six concept type/property type variables were created: concrete/entity, concrete/situational, concrete/introspective, abstract/entity, abstract/situational, and abstract/introspective.\textsuperscript{49} Each concrete variable was created by adding the respective property type across the chair, dog, and tree words (divided by three and multiplied by 100) and each abstract variable was created by adding the respective property type across the anger, democracy, and heal words (divided by three and multiplied by 100). This produced a measure of the average percentage of each property type for concrete and abstract concepts.

Only responses that was coded as “simulated” according to the Language and Situated Simulation Coding Scheme used in the analysis of the property by concept hypotheses.

\textbf{9.6.3 Data screening method.} The grouped data screen began with a screening for univariate outliers. Univariate outliers were considered as cases with “very large” standardised scores (Tabachnick & Fidell, 2007). Tabachnick and Fidell suggest that univariate outliers can be defined as standardised residual values outside the “z-score” range of -3.29 and 3.29.

A number of within subjects ANOVA assumptions were then tested prior to the analyses including: normality, linearity, and sphericity. Normality was assessed using standardised “skewness” and “kurtosis” values for each of the variables. Skewness describes how evenly the data is distributed across the variable while kurtosis describes

\textsuperscript{48} A grouped data screen assessing univariate outliers for each concept was conducted in order to assess any concept specific outliers in the variables according to the method outlined in Section 9.6.3 (p. 104). Based on this method, there were three outliers identified. Two outliers belonged to the taxonomic group (for anger and heal, from same participant) and one belonged to the linguistic group (for democracy). These three cases were excluded from the analysis.

\textsuperscript{49} Responses coded under the property type “miscellaneous” were not included because they were considered unimportant for examination of the relevant hypothesis.
how “peaked” or “flat” the distribution is (Tabachnick & Fidell, 2007). Standardised scores for each variable were obtained by dividing the skewness or kurtosis score by its standard error (Tabachnick & Fidell, 2007). Tabachnick and Fidell suggest that a variable is not normal if the standardised skewness and/or kurtosis score lies outside the range of -3.29 and 3.29. Linearity was assessed by inspecting the Q-Q plots for deviations from normality, as indicated by the line of best fit. Variables were considered nonlinear if they deviated significantly from the line of best fit. The sphericity assumption was assessed according to Mauchley’s W, which examines whether difference scores of paired levels of the repeated measures factor have equal population variance (Tabachnick & Fidell, 2007).

10. Results of Study 1

The chapter begins with a brief description of all Study 1 responses according to the two coding schemes employed. This is followed by sections detailing the analyses for the latency of response type (H1) and property by concept (H2) hypotheses, respectively (see Section 8.2, p. 93 for operationalised hypotheses).

10.1 Exploration of Responses

Table 2 displays results of the crosstabulation of all responses according to the two coding schemes.
### Table 2
*Crosstabulation of responses according to coding schemes*

<table>
<thead>
<tr>
<th>LASS Coding Scheme</th>
<th>Perceptual Symbol Systems</th>
<th>Concept Properties</th>
<th>Coding Scheme</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Entity</td>
<td>Introspective</td>
<td>Situational</td>
<td>Miscellaneous</td>
</tr>
<tr>
<td>Linguistic</td>
<td>82 (4.15)</td>
<td>6 (0.30)</td>
<td>35 (1.77)</td>
<td>38 (1.92)</td>
</tr>
<tr>
<td>Taxonomic</td>
<td>9 (0.46)</td>
<td>5 (0.25)</td>
<td>14 (0.71)</td>
<td>129 (6.53)</td>
</tr>
<tr>
<td>Simulated</td>
<td>433 (21.92)</td>
<td>188 (9.52)</td>
<td>1014 (51.34)</td>
<td>22 (1.11)</td>
</tr>
<tr>
<td>Total</td>
<td>524 (26.53)</td>
<td>199 (10.08)</td>
<td>1063 (53.82)</td>
<td>189 (9.57)</td>
</tr>
</tbody>
</table>

N = 24

*Note.* - LASS = Language and Situated Simulation
- Percentage of total in parentheses

Table 3 and Table 4 display results of the crosstabulation of responses to concrete and abstract concepts according to the two coding schemes, respectively.

### Table 3
*Crosstabulation of responses to concrete concepts according to coding schemes*

<table>
<thead>
<tr>
<th>LASS Coding Scheme</th>
<th>Perceptual Symbol Systems</th>
<th>Concept Properties</th>
<th>Coding Scheme</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Entity</td>
<td>Introspective</td>
<td>Situational</td>
<td>Miscellaneous</td>
</tr>
<tr>
<td>Linguistic</td>
<td>79 (6.84)</td>
<td>0 (0.00)</td>
<td>25 (2.16)</td>
<td>31 (2.68)</td>
</tr>
<tr>
<td>Taxonomic</td>
<td>7 (0.61)</td>
<td>0 (0.00)</td>
<td>9 (0.78)</td>
<td>114 (9.87)</td>
</tr>
<tr>
<td>Simulated</td>
<td>330 (28.57)</td>
<td>22 (1.90)</td>
<td>534 (46.23)</td>
<td>4 (0.35)</td>
</tr>
<tr>
<td>Total</td>
<td>416 (36.02)</td>
<td>22 (1.90)</td>
<td>568 (49.18)</td>
<td>149 (12.90)</td>
</tr>
</tbody>
</table>

N = 24

*Note.* - LASS = Language and Situated Simulation
- Percentage of total in parentheses
Table 4
*Crosstabulation of responses to abstract concepts (including heal) according to coding schemes*

<table>
<thead>
<tr>
<th>LASS Coding Scheme</th>
<th>Entity</th>
<th>Introspective</th>
<th>Situational</th>
<th>Miscellaneous</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linguistic</td>
<td>3 (0.37)</td>
<td>6 (0.73)</td>
<td>10 (1.22)</td>
<td>7 (0.85)</td>
<td>26 (3.17)</td>
</tr>
<tr>
<td>Taxonomic</td>
<td>2 (0.24)</td>
<td>5 (0.61)</td>
<td>5 (0.61)</td>
<td>15 (1.83)</td>
<td>27 (3.29)</td>
</tr>
<tr>
<td>Simulated</td>
<td>103 (12.56)</td>
<td>166 (20.24)</td>
<td>480 (58.54)</td>
<td>18 (2.20)</td>
<td>767 (93.54)</td>
</tr>
<tr>
<td>Total</td>
<td>108 (13.17)</td>
<td>177 (21.59)</td>
<td>495 (60.37)</td>
<td>40 (4.88)</td>
<td>820 (100.00)</td>
</tr>
</tbody>
</table>

*N = 24*

*Note.* -LASS = Language and Situated Simulation

-Percentage of total in parentheses

Table 5 displays results of the crosstabulation of responses to the *heal* concept according to the two coding schemes.

Table 5
*Crosstabulation of responses to the heal concept according to coding schemes*

<table>
<thead>
<tr>
<th>LASS Coding Scheme</th>
<th>Entity</th>
<th>Introspective</th>
<th>Situational</th>
<th>Miscellaneous</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linguistic</td>
<td>1 (0.40)</td>
<td>2 (0.79)</td>
<td>4 (1.58)</td>
<td>3 (1.19)</td>
<td>10 (3.95)</td>
</tr>
<tr>
<td>Taxonomic</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>2 (0.79)</td>
<td>0 (0.00)</td>
<td>2 (0.79)</td>
</tr>
<tr>
<td>Simulated</td>
<td>15 (5.93)</td>
<td>90 (35.57)</td>
<td>125 (49.41)</td>
<td>11 (4.35)</td>
<td>241 (95.26)</td>
</tr>
<tr>
<td>Total</td>
<td>16 (6.32)</td>
<td>92 (36.36)</td>
<td>131 (51.78)</td>
<td>14 (5.53)</td>
<td>253 (100.00)</td>
</tr>
</tbody>
</table>

*N = 24*

*Note.* -LASS = Language and Situated Simulation

-Percentage of total in parentheses
Figure 15 diagrammatically compares results (in percentage of total) from linguistic and simulated responses for entity and introspective properties between all concepts and concrete, abstract, and heal concepts separately.

As displayed in Table 2, there was a higher proportion of simulated compared to linguistic responses across all concepts, according to the Language and Situated Simulation Coding Scheme. A higher proportion of simulated responses were of situational properties compared to entity and introspective properties, according to the Perceptual Symbol Systems Concept Properties Coding Scheme. Thus, the coding schemes are consistent. As displayed in Tables 3, 4, and 5, respectively, the above two points were applicable for concrete and abstract concepts as well as for the heal concept alone. Thus, simulated properties were common to all tested concepts.

As shown in Tables 3 and 4, abstract concepts differed from concrete concepts in having a slightly higher proportion of simulated vs. linguistic properties and a slightly higher proportion of introspective compared to entity properties. Thus, although simulated features were common to both abstract and concrete concepts, the two types of concepts could be differentiated on the basis of more introspective properties in abstract compared to concept concepts and more entity properties in concrete compared to abstract concepts.

As displayed in Table 5, heal resembled the average abstract concept in having a higher proportion of simulated responses compared to linguistic responses and a higher
proportion of introspective properties compared to entity properties. Thus, it was concluded that heal could be considered an appropriate example of an abstract concept according to the Language and Situated Simulation Coding Scheme and the Perceptual Symbol Systems Concept Properties Coding Scheme.

10.2 Analysis of Latency of Response Category (H1)

A single factor (Latency of Response Category) within subjects ANOVA was conducted to examine the latency of response category (H1; see Section 8.2, p. 93 for description of hypothesis).

10.2.1 Data screen. According to the data screen method outlined in Section 9.6.3 (p. 104), there were no outliers; however the linguistic and taxonomic variables were positively skewed. Due to the proportionate nature of the variables, it was deemed inappropriate to transform them and thus the boxplot outliers for the variables were replaced with the group means. Consequently, all three variables were normal and linear. The sphericity assumption was violated (Mauchley’s W(2) = .39, p < .001), thus the Greenhouse-Geisser correction statistic was utilised.

10.2.2 Sample characteristics. No participants were removed from the final analysis, thus the final sample were the same 24 who participated in the study (see Section 9.1, p. 99 for sample characteristics).

10.2.3 Hypothesis testing. The single factor (Latency of Response Category) within subjects ANOVA revealed a significant main effect ($F(1.243, 28.587) = 5.22, p < .05$, partial $\eta^2 = 0.19$). Inspection of the graph, shown as Figure 16, suggested that linguistic associates ($M = 19.15, SD = 5.24$) were produced earlier than simulated responses ($M = 23.65, SD = 2.76$) but not taxonomic responses ($M = 18.71, SD = 9.44$).

Further analyses in the form of three paired samples $t$-tests comparing the three property types were conducted. Results suggested that, as expected, linguistic responses were produced significantly earlier, on average, than simulated responses ($t(23) = -5.04, p < .001$). Furthermore, taxonomic responses were produced significantly earlier, on average, than simulated responses ($t(23) = -2.78, p < .05$). However, no difference was found between latencies for linguistic associates and taxonomic responses ($t(23) = .20, p = .84$).

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50 Two outliers belonged to the linguistic group and one belonged to the taxonomic group. These three cases were replaced by the group mean rather than being excluded since exclusion would have reduced numbers for the final analysis.
10.2.4 Exploration of heal concept. In order to explore whether the heal concept behaves like a standard concept in terms of latency of response categories it was extracted from the other five concepts and compared to them. Lexical associates were produced earlier, on average, than simulated responses for the heal concept ($M = 17.45$, $SD = 9.46$, $n = 7$; $M = 23.96$, $SD = 6.18$, $n = 24$) and for the other five concepts ($M = 20.66$, $SD = 8.59$, $n = 23$; $M = 23.46$, $SD = 3.08$, $n = 24$). These findings are displayed in Figure 17, below.
A 2 (Concept Type: heal, others) by 2 (Response Type: linguistic, simulated)
within subjects ANOVA revealed no significant main effects for concept type ($F(1, 6) = 1.53, p = .26, \text{partial } \eta^2 = 0.20$) or response type ($F(1, 6) = 0.88, p = .39, \text{partial } \eta^2 = 0.13$) and no interaction effect ($F(1, 6) = 0.13, p = .73, \text{partial } \eta^2 = 0.02$). These findings suggest that the heal concept behaves like other concepts in terms of latency of response categories.

10.3 Analysis of the Property by Concept Hypotheses (H2a and H2b)

A 2 (Concept) by 3 (Property) within subjects ANOVA was conducted to examine the property by concept hypotheses (H2a and H2b; see Section 8.2, p. 93 for description of hypotheses).

10.3.1 Data screen. According to the data screen method outlined in Section 9.6.3 (p. 104), there were no outliers; however the concrete/introspective variable was positively skewed. Due to the proportionate nature of the variable, it was deemed inappropriate to transform it and thus the boxplot outlier for the concrete/introspective variable was replaced with the group mean. The variable was found to be normal and linear after this adjustment. The sphericity assumption was met for the current analysis ($Mauchley’s \ W(2) = .81, p > .105$).

10.3.2 Sample characteristics. No participants were removed from the final analysis, thus the final sample were the same 24 who participated in the study (see Section 9.1, p. 99 for sample characteristics).

10.3.3 Hypothesis testing. Concept by property means and standard deviations are displayed in Table 6. A 2 (Concept) by 3 (Property) within subjects ANOVA revealed a significant interaction effect between concept type and property type ($F(2, 46) = 43.59, p < .001, \text{partial } \eta^2 = 0.66$). Inspection of the graph, shown as Figure 18, suggested that introspective and situational properties were identified more commonly for abstract compared to concrete concepts while entity properties were identified more commonly for concrete compared to abstract concepts.

Further analyses in the form of three paired samples t-tests comparing the three property types were conducted. Results suggested that, as expected, there were significantly more introspective properties identified for abstract compared to concrete concepts ($t(23) = -13.71, p < .001$) and significantly more entity properties identified for

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51 Assumptions were assessed according to Section 9.6.3 (p. 104) and all were met.
52 One boxplot outlier whose value was 10 was replaced with the group mean value of 4.77 in order to maintain the participant’s data in the analysis.
concrete compared to abstract concepts ($t(23) = 6.09, p < .001$). Furthermore, there were significantly more situational properties identified for abstract compared to concrete concepts ($t(23) = -2.76, p < .05$).

Table 6

Means and standard deviations for concrete and abstract word types and entity, situational and introspective property types

<table>
<thead>
<tr>
<th>Property</th>
<th>Concrete % Mean (SD)</th>
<th>Abstract % Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity</td>
<td>30.23 (13.04)</td>
<td>15.70 (11.18)</td>
</tr>
<tr>
<td>Introspective</td>
<td>1.77 (2.58)</td>
<td>22.04 (7.82)</td>
</tr>
<tr>
<td>Situational</td>
<td>44.43 (12.99)</td>
<td>52.66 (15.24)</td>
</tr>
</tbody>
</table>

$N = 24$

![Figure 18](image)

*Figure 18.* Mean number of entity, situational and introspective property types for concrete and abstract concepts. Error bars represent one standard error around the mean.

10.3.4 Exploration of *heal* concept. In order to explore whether the *heal* concept behaves like the other two abstract concepts in terms of introspective and entity properties produced, it was extracted and compared to them. Means and standard deviations for the percentage of entity and introspective properties for *heal, anger,* and *democracy* concepts are displayed in Table 7 and in Figure 19, below.
Table 7
Means and standard deviations for the percentage of entity and introspective properties for heal, anger, and democracy concepts

<table>
<thead>
<tr>
<th>Concept</th>
<th>Heal % M (SD)</th>
<th>Anger % M (SD)</th>
<th>Democracy % M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity</td>
<td>6.15 (8.38)</td>
<td>11.27 (13.68)</td>
<td>29.67 (25.28)</td>
</tr>
<tr>
<td>Introspective</td>
<td>39.64 (22.75)</td>
<td>20.69 (15.63)</td>
<td>5.78 (14.29)</td>
</tr>
</tbody>
</table>

N = 24

Figure 19. Means and standard deviations for the percentage of entity and introspective properties for heal, anger, and democracy concepts. Error bars represent one standard error around the mean.

A 3 (Abstract Concept Type: heal, anger, democracy) by 2 (Property Type: entity, introspective) within subjects ANOVA revealed no significant main effect for property type ($F(1, 23) = 3.82, p = .06, \text{partial } \eta^2 = 0.14$), but a significant main effect for abstract concept type ($F(2, 46) = 3.45, p < .05, \text{partial } \eta^2 = 0.13$) and a significant interaction effect ($F(2, 46) = 51.42, p < .001, \text{partial } \eta^2 = 0.69$).\(^{53}\)

Assumptions were assessed according to Section 9.6.3 (p. 104) there were two outliers whose values were replaced by the group mean (from democracy/introspective whose value was 60 was replaced with the group mean value of 23.11 and from anger/entity whose value was 57.14 was replaced with the group mean value of 16.91). The democracy/introspective variable was positively skewed. Due to the proportionate nature of the variable, it was deemed inappropriate to transform it and thus the boxplot outlier for the concrete/introspective variable was replaced with the group mean (37.50 replaced by group mean value of 23.11). The variables were found to be normal and linear after these adjustments. The sphericity assumption was met for the current analysis (Mauchley’s W(2) = .85, $p > .168$).\(^{53}\)
Paired samples t-tests revealed significant differences between introspective and entity properties in the heal concept ($t(23) = -6.40, p < .001, n = 24$), the anger concept ($t(23) = -2.73, p < .05, n = 24$), and the democracy concept ($t(23) = 4.40, p < .001, n = 24$).

These findings suggest that as expected of abstract concepts, the heal concept behaves like the anger concept in terms of producing more introspective properties, on average, than entity properties. However, the heal concept did not behave like the democracy concept, which contrary to expectations, produced more entity properties, on average, than introspective properties.

10.4 Chapter Summary

Study 1 findings suggested that: as expected, lexical associates were produced significantly earlier, on average, than simulated responses across concept types (H1) and introspective properties were identified significantly more commonly for abstract compared to concrete concepts while (H2a) entity properties were identified significantly more commonly for concrete compared to abstract concepts (H2b).

As hypothesised, it was also found that lexical associates were produced earlier, on average, than simulated responses for the heal concept. As expected of abstract concepts, more introspective properties, on average, than entity properties were produced for the heal concept and the anger concept, however contrary to expectations more entity properties, on average, than introspective properties were produced for the democracy concept.

11. Discussion of Study 1

Study 1 was conducted as a linguistic assessment of a set of assumptions of Language and Situated Simulation theory and Perceptual Symbol Systems theory. The first aim of Study 1 was to examine the Language and Situated Simulation theory assumption that the human cognitive system consists of an early activated linguistic system and a late activated perceptual symbol system. The second aim of Study 1 was to examine whether, as predicted by Perceptual Symbols Systems theory, abstract concepts are conceptualised primarily via introspections and concrete concepts are conceptualised primarily via entity properties. The final aim of Study 1 was to compare the heal concept to other concepts in order to demonstrate that it behaves in the same way as a typical concept according to assumptions of Language and Situated Simulation
theory and similarly to other abstract concepts according to predictions derived from Perceptual Symbol Systems theory.

These aims, along with the Study 1 hypotheses, were derived explicitly from Language and Situated Simulation theory and Perceptual Symbol Systems theory. Therefore, these interpretations will be privileged in the current discussion, although other interpretations will also be explored.

11.1 The Language and Situated Simulation System

11.1.1 Language and Situated Simulation theory interpretation of findings.

Findings were consistent with the hypothesis that lexical associates will be produced earlier, on average, than simulated responses. Language and Situated Simulation theory proposes that responses to a property generation/word association task, do not originate from an amodal system, but from either a modal, linguistic system or a modal, perceptual symbol system (Barsalou, et al., 2008). Language and Situated Simulation theory makes two major predictions about the relationship between the two systems in cognition. Firstly, the linguistic system is concerned with shallow processing tasks which do not require access to representations, whereas the perceptual symbol system is concerned with deeper, conceptual tasks requiring representations (Barsalou, et al., 2008). Secondly, in reference to a word presented in any modality, both systems are immediately activated, but the linguistic system peaks first, followed by the perceptual symbol system, due to the similarity between linguistic forms and presented words (according to assumptions of the encoding specificity principle of Tulving & Thomson, 1973).

The Study 1 finding that lexical associates were produced earlier, on average, than simulated responses aligned with the latter prediction made by Language and Situated Simulation theory regarding the hypothesised relationship between the two systems. From this finding it was inferred that the linguistic system is activated earlier than the perceptual symbol system in conceptual processing.

This finding aligns with an earlier word association and property generation study which also suggested that linguistic responses were produced significantly earlier than simulated responses (see Section 6.2, p. 79 for details of Santos et al., 2011). However, Study 1 differed in two aspects which reflect extensions to the Santos, et al.’s (2011) study. Firstly, Study 1 combined word association and property generation tasks by asking participants to provide words and characteristics which came to mind when
thinking of the concept. In combining the two tasks and corroborating the finding that lexical associates are produced significantly earlier, on average, than simulated responses, Study 1 suggested that the instructions provided in a word association/property generation task do not influence the type and latency of responses produced. Whether asked to produce words, characteristics, or words and characteristics, lexical responses are produced earlier than simulated responses, suggesting that the linguistic system is accessed first, followed by the perceptual symbol system, as predicted by Language and Situated Simulation theory.

Secondly, Santos et al. (2011) allowed three seconds response time in their word association task and 15s response time in their property generation task, while Study 1 allowed for one minute response time. Language and Situated Simulation theory literature does not outline specific latencies at which linguistic processing ends and perceptual symbol system processing begins. However, according to Santos, et al.’s findings, linguistic and simulated responses were apparent within three seconds for word association tasks (average of 1.74 responses) and 15s for property generation tasks (average of 5.87 responses). Thus, it was inferred that the linguistic system was active earlier than the perceptual symbol system over these shorter timeframes. The average number of responses in the one minute allotted by Study 1 was 13.73 and Santos, et al.’s finding that lexical associates are produced significantly earlier than simulated responses was corroborated. Thus, it was inferred that the Language and Situated Simulation theory assumption that the linguistic system is activated earlier than the perceptual symbol system remains valid across longer timeframes.

There are two possible mechanisms which might explain these findings using Language and Situated Simulation theory. One is that presentation of a concept generates linguistic and simulated responses rapidly (e.g., within few seconds), but only linguistic responses are verbalised initially due to their perceived closer relationship to the concept in form (Tulving & Thomson, 1973). An alternative explanation is that when given a longer amount of time, both systems slow down. Thus, when a concept is presented, linguistic responses are generated within 10-20s and simulated responses only occur after that time. Since the design of Study 1 does not allow for illumination of this process and Language and Situated Simulation theory does not comment on this process, it remains an issue for future research to address.

An exploration of the latency of taxonomic responses suggested that they were produced significantly earlier than simulated responses. Language and Situated
Simulation theory predicts that taxonomic responses will fall in between linguistic and simulated responses since they are viewed as residing in conceptual systems but are also often linguistically memorised during childhood (Barsalou, et al., 2008; Kalénine, et al., 2009; Loukachevitch, 2011; Sachs, Weis, Krings, Huber, & Kircher, 2008). A major issue in interpreting taxonomic responses in relation to the perceptual symbol system is that it is unclear how they are realised in simulations. Theoretically, a superordinate taxonomical category, such as “animal” in relation to the concept dog, is unlikely to be simulated as it is not a concrete part of the concept, nor does it co-occur with the concept in a situated simulation. On the other hand, co-ordinate (e.g., cat) or subordinate (e.g., collie) taxonomical categories could potentially be simulated since a cat could be involved in a situated simulation with a dog and a dog could be simulated as a collie (Barsalou, et al., 2008). Santos et al.’s (2011) task, which examined subcategories of taxonomic responses, suggested a trend towards this pattern in finding that superordinate responses were produced as early as linguistic responses, whereas co-ordinate and subordinate responses were produced as late as simulated responses.

Finally, comparison of the heal concept to the other five concepts suggested that it behaved in a similar manner to a typical concept, according to Language and Situated Simulation theory, in terms of producing lexical associates earlier, on average, than simulated responses. Since it was assumed, according to Language and Situated Simulation theory, that lexical associates and simulated responses originate from the putative linguistic and perceptual symbol systems, respectively, it was inferred that the heal concept can be simulated.

11.1.2 Alternative interpretations. The finding that lexical associates were produced earlier than simulated responses can be interpreted according to Language and Situated Simulation theory; however other interpretations are also possible. These interpretations should be considered provisional since the latency by response category hypothesis was derived explicitly from Language and Situated Simulation theory.

Study 1 asked “what words and characteristics come to mind when you think of: [CONCEPT NAME]”. The word “words” is commonly used in the instructions for word association tasks which are, in Language and Situated Simulation theory terms, shallow processing tasks which may only require the linguistic system, whereas the word “characteristics” is commonly used in the instructions for property generation tasks which are, in Language and Situated Simulation theory terms, deeper processing tasks which additionally require the perceptual symbol system (Santos, et al., 2011).
The fact that the instructions used in Study 1 mentioned words before characteristics may have triggered either a nonconscious or conscious generation of “words” (i.e., linguistic associates) before “characteristics” (i.e., simulated responses). Thus, these responses may have originated from a single system, ordered only according to instructions the task rather than the responses’ system of origin.

However, previous research suggests that this interpretation is less likely than the Language and Situated Simulation theory interpretation. Santos, et al.’s (2011) study separated word association and property generation studies by asking participants “for the following word, what other words come to mind immediately…[CONCEPT WORD]” (p. 95) and “think of (and verbally produce) the characteristics typically true of the concept…[CONCEPT WORD]” (p. 102), respectively. They found that linguistic responses occurred earlier than simulated responses in both word association task and property generation tasks, suggesting that responses produced in Study 1 are more likely ordered due to their system of origin rather than task instructions.

Language and Situated Simulation theory posits that both the linguistic and perceptual symbol systems are modal and that the linguistic system is void of conceptual meaning and only simulations within the perceptual symbol system contain conceptual meaning (Barsalou, et al., 2008). However, the finding that lexical associates were produced earlier than simulated responses can also be interpreted in terms of the Lexical Hypothesis or Dual Code Theory (Glaser, 1992; Paivio, 1971, 1986).

Both the Lexical Hypothesis and Language and Situated Simulation theory posit two cognitive systems, namely, a linguistic system concerned with shallow processing and a conceptual system concerned with deeper processing (Glaser, 1992). The primary point of difference between the two theories is that the Lexical Hypothesis considers the conceptual system as amodal in nature while Language and Situated Simulation theory considers the conceptual system as modal in nature (Barsalou, et al., 2008; Glaser, 1992).

Study 1 provides no direct evidence to favour a modal interpretation of the proposed systems, thus they could be interpreted as being amodal in nature. However, a number of neuroimaging studies suggest that a modal interpretation is more likely (Kan et al, 2003; Simmons et al., 2008, see p. 76 and p. 81 respectively for study details). Both these studies suggest that the conceptual system is modal since simulated responses were correlated with activation of brain areas which have been proposed to be involved in mental imagery (bilateral posterior areas) and visual simulation (left
fusiform gyrus). However, the interpretation of neuroimaging studies are derived from the assumptions of the theories they examine and both abovementioned studies examined a modal account of conceptual processing, thus their conclusions should be interpreted with caution.

Study 1 findings are also consistent with Dual Code Theory (Paivio, 1971, 1986). Both Language and Situated Simulation theory and Dual Code Theory posit two cognitive systems, namely, a linguistic system and a perceptual system. However, the theories differ in that Dual Code Theory proposes that both perceptual and linguistic systems process conceptual knowledge while Language and Situated Simulation theory proposes that only the perceptual system deals with conceptual processing (Barsalou, et al., 2008; Paivio, 1971, 1986).

Study 1 does not provide evidence that the linguistic system does not process conceptual meaning. However, it has been argued that theories which rely on amodal symbols, such as Dual Code Theory, are susceptible to the symbol grounding problem (see Section 2.5, p. 17; Glenberg, 1997; Glenberg & Robertson, 2000; Pecher & Zwaan, 2005). The symbol grounding problem is a longstanding philosophical problem which is still debated in the literature and remains unresolved. Thus until this problem is addressed, the finding that lexical associates are produced earlier than simulated responses can be interpreted according to either Language and Situated Simulation theory or Dual Code Theory.

11.2 Perceptual Symbol Systems Theory of Abstract Concepts

11.2.1 Perceptual Symbol Systems theory interpretation of findings. Since abstract concepts typically lack sensorimotor properties, it has been argued that modal theories of cognition, such as Perceptual Symbol Systems theory, cannot account for abstract conceptual knowledge (Mahon & Caramazza, 2008). However, Perceptual Symbol Systems theory contends that the content of abstract concepts can be simulated primarily due to their introspective content (Barsalou, 1999). Study 1 findings were consistent with the hypotheses that introspective properties will be identified more commonly for abstract compared to concrete concepts while (H2a) entity properties will be identified more commonly for concrete compared to abstract concepts (H2b).

Study 1 findings were also consistent with the findings of a number of studies cited in the literature. Firstly, the present findings partially replicate findings of a property generation study which utilised three abstract concepts and three concrete
concepts (and three “intermediate” concepts) finding that more introspective features were produced for abstract than for concrete concepts and that more entity features were produced for concrete compared to abstract concepts (Barsalou & Wiemer-Hastings, 2005).

Secondly, Study 1 findings were consistent with findings of a “feature generation task” which compared the content of 18 abstract and 18 concrete concepts. This study added the generation of contextual features to properties, finding that abstract concepts are anchored in situations and produced introspectively derived responses, whereas more intrinsic properties were produced for concrete concepts (Wiemer-Hastings & Xu, 2005).

Finally, Study 1 findings aligned with the findings of a study which focussed on the specific introspection of emotion in abstract concepts (Kousta, et al., 2011). The present findings aligned with the authors’ conclusion that affective content explains the differences in processing between concrete and abstract concepts, leading them to suggest that emotion is an often neglected experiential component involved in the representation of abstract concepts.

A key assumption of Perceptual Symbol Systems theory’s view of abstract conceptual knowledge is that abstract concepts can be embodied and simulated, primarily through their introspective properties (Barsalou, 1999). Perceptual Symbol Systems theory proposes that abstract concepts are embodied against a background situation from which selective attention focuses on the core content and extracts this information, which primarily consists of, but is not limited to introspective states (Barsalou, 1999). During simulation the whole situation is retrieved, from which the introspective states can be extracted. This differs slightly to the simulation of concrete concepts, since they can be simulated in isolation via their intrinsic embodiments (e.g., entity properties) which can theoretically be simulated without a background situation, although this is uncommon (Barsalou, 1999; Barsalou & Wiemer-Hastings, 2005). The Study 1 finding that introspective properties were identified more commonly for abstract compared to concrete concepts was consistent with this prediction.

The processing difference between the two types of concepts is known as the “concreteness effect”, which is the commonly found cognitive advantage for concrete concepts over abstract concepts. Imageability and context availability are the dominant theories of the concreteness effect (see Kousta et al. 2011). Kousta et al. found an “abstractness effect” (an advantage for abstract concepts over concrete concepts) which was explained by affect, when imageability and context availability were held constant.
There are a number of issues for clarification in the Perceptual Symbol System theory interpretation of Study 1 findings. Firstly, the introspective system is a hypothetical system proposed by Perceptual Symbol Systems theory to be a part of the sensorimotor system (Barsalou, 1999). Furthermore, the hypothesised ability of the introspective system to simulate has not been articulated as well as the proposed ability of the sensorimotor system to simulate (Barsalou, 1999). Thus, whether the introspective properties found to primarily constitute abstract concepts in Study 1 can be simulated remains an issue. The crosstabulations performed on Study 1 responses between the two coding schemes (see Section 10.1, p. 105) suggest that introspective responses arise primarily from the perceptual symbol system; however, this conclusion is inferred from the assumption of Language and Situated Simulation theory that a perceptual symbol system actually exists. Thus, further research is required to illuminate this question.

Secondly, whether the introspective properties found to constitute abstract concepts in Study 1 constitute core or peripheral content of these concepts is debatable. Perceptual Symbol Systems theory proposes a situationally underpinned representation of concepts rather than a core content representation (Barsalou & Wiemer-Hastings, 2005). Core content theories include those of exemplars and prototypes, which contend that concepts are underpinned by a small set of essential intrinsic properties, which commonly exclude introspective and situational information (Markman & Ross, 2003). The higher percentage of situational properties across all concept types found in Study 1 suggests that concepts may be situationally represented rather than being underpinned by a set of core intrinsic properties. However, Perceptual Symbol Systems theory suggests that the focus within these situational representations for abstract concepts is on introspective states, while for concrete concepts is on entity properties (Barsalou, 1999). Thus, although Perceptual Symbol Systems theory does not propose a “core-peripheral” representation akin to that of exemplars and prototypes, the focus within a situated representation can be considered a “core” element which differs between abstract and concrete concepts.

Study 1 found that situational properties were the most prevalent property type produced across both types of concepts, and that there were a higher percentage of situational properties produced for abstract compared to concrete concepts. This is seemingly inconsistent with Perceptual Symbol Systems theory, since all concepts types are proposed to be represented against a situational background (Barsalou, 1999).
However Perceptual Symbol Systems theory proposes that situational content is more *important* for abstract concepts compared to concrete concepts since abstract concepts cannot be simulated in isolation while concrete concepts can, via their entity properties (although this would be uncommon; Barsalou & Wiemer-Hastings, 2005). This may have been reflected in this Study 1 finding, however further research is required to reconcile the inconsistencies in findings between Study 1 and previous research (Barsalou & Wiemer-Hastings, 2005) on this issue.

Finally, Study 1 findings suggested that the *heal* concept behaved as predicted by a Perceptual Symbol Systems theory account of an abstract concept. The *anger* concept behaved in a similar manner, however, contrary to expectations, entity properties were identified more commonly than introspective properties for the *democracy* concept. These findings suggest that the Perceptual Symbol Systems theory proposal that abstract concepts are constituted primarily of introspective properties may only apply to “emotion-related” abstract concepts. Again, further research is required to illuminate this speculative interpretation.

**11.2.2 Alternative interpretations.** The Study 1 finding that introspective properties were identified more frequently for abstract compared to concrete concepts while entity properties were identified more frequently for concrete compared to abstract concepts can be interpreted via Perceptual Symbol Systems theory, however other interpretations are possible. These interpretations should be considered provisional, since the property by concept hypotheses were derived explicitly from Perceptual Symbol Systems theory.

The first of these alternate interpretations is via the context availability model which proposes that all concept types are processed and represented in a single verbal code (Schwanenflugel, 1991). The model follows amodal, connectionist principles, contending that a word’s meaning is accessed via connections to a network of associated semantic information which is high in situational content\(^{55}\) (Schwanenflugel, 1991; Schwanenflugel & Shoben, 1983). The core of the model is that processing of both abstract and concrete concepts rely on the accessibility of contextual information via either the cogitator’s prior knowledge or from the dynamic environment (Schwanenflugel, Harnishfeger, & Stowe, 1988).

\(^{55}\) Referred to by Schwanenflugel and colleagues as “contextual content”.
Proponents of the model have produced empirical evidence aligning with the model’s proposition that concrete concepts are processed more efficiently than abstract concepts because of their stronger and denser associations with contextual knowledge, but that contextual information is more important to the processing of abstract concepts (Schwanenflugel, et al., 1988; Schwanenflugel & Shoben, 1983; Wattenmaker & Shoben, 1987). Study 1 findings suggesting a higher percentage of situational properties for both types of concepts compared to entity or introspective properties and a higher percentage of situational properties for abstract compared to concrete concepts provide further evidence for the context availability model. The context availability model would consider entity and introspective responses as extraneous, semantically associated information within the amodal network.

Secondly, Study 1 findings could be interpreted according to Dual Code Theory (Paivio, 1971, 1986). According to Dual Code Theory, concrete concepts are proposed to draw information from both systems, whereas abstract concepts only draw information from the linguistic system. Thus, in accord with Perceptual Symbol Systems theory, Dual Code Theory would propose that entity (and situational) properties originate from the perceptual system. However, in line with context availability theory, Dual Code Theory would consider introspective properties as semantically associated information within the amodal, linguistic network. Thus, both context availability theory and Dual Code Theory posit that abstract concepts originate from an amodal, linguistic system (Kousta, et al., 2011; Paivio, 1986). This contention aligns with neuroimaging evidence suggesting that linguistic areas are more active during comprehension of abstract concepts, while perceptual areas are more active during comprehension of concrete concepts (Sabsevitz, Medler, Seidenberg, & Binder, 2005).

It has been acknowledged that introspection is a poorly understood process, especially its neural mechanisms (Barsalou, 1999). Nevertheless, it forms a key element in Perceptual Symbol Systems theory’s proposal regarding the representation and simulation of abstract concepts. A number of authors have detailed issues and reinterpretations of the introspective system. Firstly, it has been argued that although introspections may be important for the processing of abstract concepts, viewing introspection as a higher order perception does not exclude amodal symbols, since the complex judgements involved in introspection may require amodal symbols. Thus,
introspection is only a perceptual simulation associated with forming a judgement and the judgement requires amodal symbols (Dove, 2009).

Secondly, in a commentary on the original Perceptual Symbol Systems article, Newton (1999) contended that introspections are better conceptualised in a perceptual symbol system as proprioceptive cues that go along with introspections rather than as an isolated component of a perceptual symbol system. For example, on seeing an object, awareness is not only of the visible features of the object, but of the proprioceptive sensations of focusing the eyes and orienting the body toward the object which arguably produce the introspection.

Thirdly, in another commentary on the Perceptual Symbol Systems article, Toomela (1999) suggested that introspective phenomena arise through interactions of more basic systems, such as perception and language, rather than constituting a type of perceptual subsystem in itself. In response to these issues and reinterpretations, Barsalou (1999) argued that all sorts of internal events such as hunger, fatigue, and emotion are experienced; thus there is no need to ground them in more externally-oriented events. Furthermore, he argued that if the representation of mental states is removed, it would be difficult to explain such phenomena as metacognition. Finally, regarding the mechanisms which represent mental states, he argued that they are the same mechanisms which represent external events. In order to resolve these issues further research is required to clarify whether or not introspections can be simulated and also whether different types of introspections (e.g., emotions and representational states) have different levels of simulatability.

11.3 Limitations

Study 1 had a number of limitations. The first was related to the proposed shallow processing nature of the word association/property generation task. Language and Situated Simulation theory proposes that the putative linguistic system handles tasks in which shallow processing is sufficient and conceptual meaning is not required (Barsalou, et al., 2008). Since word association/property generation seems to only require shallow processing, it is plausible that all responses to this task may originate from the linguistic system. However, it can be argued that even word association tasks may adopt the perceptual symbol system if the amount of time allocated for responses exhausts the linguistic systems capabilities. Since the amount of time allocated in Study
1 was four times that allocated in previous research (Santos, et al., 2011) it was assumed that both systems were recruited by the task.

The second and third limitations were related to the validity of the Language and Situated Simulation System Coding Scheme. The second limitation was related to the hierarchical nature of coding, which meant that responses were first assessed for linguistic relatedness, followed by taxonomic relatedness, and finally simulation (see Section 9.5.1, p. 102). This logistically efficient coding rule was problematic since words such as ‘fruit’ for the concept tree would be coded as linguistic when they are equally likely to have been a simulated response (since fruit comes from a tree, as opposed to the word ‘fruit tree’). Thus, the hierarchical coding rule may have led to a number of simulated responses being coded as linguistic responses. This may have confounded response coding in favour of Language and Situated Simulation System theory assumptions since most responses were made early in the allotted minute and the ambiguous responses were coded as linguistic, thus possibly giving the impression that linguistic responses were made earlier than simulated responses.

The third limitation was related to the qualitative nature of the Language and Situated Simulation System Coding Scheme. This was reflected in words such as ‘hive’ for the concept bee being coded as a linguistic response since its possible origination in the perceptual symbol system was deemed “statistically less likely” than its possible origination in the linguistic system, according to the authors of the scale (Santos, et al., 2011, p. 91). Thus, responses differed on likelihood of originating from the coded system but this was not reflected in the coding, since the coding system was dichotomous rather than continuous. Future studies could consider coding responses on a continuous scale based on the likelihood that they originated from one system or the other. This may provide a more accurate assessment of this aspect of Language and Situated Simulation System theory.

The fourth limitation was the limited number of concepts used in Study 1. Study 1 utilised six words whereas previous studies examining Language and Situated Simulation and Perceptual Symbol Systems theories via word association and property generation tasks have utilised between 16 and 30 words (Santos, et al., 2011; Simmons, et al., 2008). Due to the longer response time given to participants in Study 1 it was logistically difficult to include a larger number of words. However, future studies should consider utilising a larger number of words in order to increase the reliability of the data.
The fifth limitation was related to the difference in word types utilised as concrete and abstract words. The three concrete words were nouns and two of the three abstract words (anger and heal) were verbs; these two words demonstrated a different pattern of results to democracy, which is a noun, and demonstrated a similar pattern of results to the concrete words (see Section 10.3.4, p. 112). Thus, the differences in properties found between abstract and concrete words may have been due to the noun word type producing more entity properties and the verb word type producing more introspective properties. The findings of the present study would have been stronger if all three concrete words and all three abstract words were verbs. Future research should clarify this issue by examining the differences in properties generated for concrete and abstract verbs.

The sixth limitation was that it was not made clear to participants whether the concept word ‘heal’ was to be considered as a transitive verb (e.g., I heal somebody) or an intransitive verb (e.g., I healed after losing a loved one/breaking a leg). Future research should extend the present study by making clear to participants that heal is to be considered an intransitive verb as the two verb types may produce different types of responses.

The final limitation was related to the nature of the abstract concepts utilised. Study 1 considered abstract concepts as those with a spatially unconstrained and non-purely physical nature. Although they match this definition, some authors have argued that “emotion-related” concepts, such as anger and heal, should not be considered abstract concepts since they can be perceived internally (Altarriba, et al., 1999). Along similar lines, numerous authors have considered the abstract/concrete distinction as a continuum rather than a dichotomy (Altarriba, et al., 1999; Della Rosa, Catricalà, Vigliocco, & Cappa, 2010; Wiemer-Hastings, et al., 2001). The finding that the “pure” abstract concept democracy behaved differently to the “emotion-related” abstract concepts anger and heal (see Section 10.3.4, p. 112 for details) is consistent with this argument. Future research should consider examining properties of different types of abstract concepts or analysing abstract and concrete concepts on a concreteness/abstractness continuum.

11.4 Suggestions for Future Research

A number of possible extensions to Study 1 as well as areas for future research which can be anchored in the Study 1 findings should be noted. There have now been
two studies (Study 1 of the present project and that of Santos, et al., 2011) which have been consistent with Language and Situated Simulation theory’s putative early activated linguistic and late activated perceptual symbol systems. Although further studies are required to corroborate these findings, future research can start to consider a number of new questions about Language and Situated Simulation theory and extend the findings of Study 1.

The first area for future research could involve extending Study 1 by utilising pictures as stimuli instead of words. This would be difficult in a word association or property generation task but a recent neuroimaging study provides a demonstration of how such a task could be conducted (Wilson-Mendenhall, Simmons, et al., in press). The task consisted of a stimuli word (abstract in their case) followed by a picture, at which point a decision has to be made regarding whether the word applies to the picture. Future studies could utilise such a neuroimaging task to examine whether the linguistic system still activates before the simulation system. It is predicted that, according to the theories of content addressability and encoding specificity, the perceptual target stimuli may cause the putative simulation system to peak before the hypothesised linguistic system.

One of the most intriguing findings from Study 1 was that the putative early peaking of the linguistic system and the late peaking of the simulation system applied to longer time frames than addressed in previous research (Santos, et al., 2011; Simmons, et al., 2008). A second area for future research could be to corroborate this finding by conducting a neuroimaging study over this longer timeframe in order to examine how the two systems interact. Questions regarding whether a single, longer cycle occurs or multiple short cycles with a focus on verbalising linguistic responses early and simulated responses later could be illuminated.

A third area for future research could be to extend Study 1 findings by examining different types of introspective properties. There are numerous arguments against the modal nature and simulatability of introspections (see p. 123 for details). It is possible that these arguments may be valid for some types of introspections and not others. Perceptual Symbol Systems theory posit three types of introspective states: emotion, cognitive operations, and representative states (Barsalou, 1999). Future studies should consider sub-coding introspective properties and examining which types of abstract concepts consist of each of the introspective properties.
The fourth area for future research could be to extend Study 1 by manipulating situational content and the use of pictorial stimuli or deeper processing paradigms. Study 1 findings suggest that there is a higher percentage of situational content produced for abstract compared to concrete concepts. Thus, it would be interesting to examine differences in responses when situational content is provided to participants along with the concept. This could be achieved by priming cue words with situational content. Furthermore, differences between a study which found perceptual area activation for abstract concepts (Wilson-Mendenhall, Simmons, et al., in press) and a study which found linguistic area activation for abstract concepts (Sabsevitz, et al., 2005), suggest that task conditions may affect the simulation of abstract concepts. Thus future research, aided by neuroimaging, could investigate how changing lexical stimuli to pictorial stimuli, or creating more challenging task conditions affects areas of activation during the processing of abstract concepts.

11.5 Implications

A number of theoretical and practical implications can be drawn from the findings of Study 1. The first implication is regarding the need for caution in the interpretation mechanisms underlying word association and property generation tasks. Word association tasks have commonly been considered as solely linguistically-driven (H. H. Clark, 1970). However, findings of Study 1 suggested that simulation is also involved in word association. This is also consistent with studies which have suggested that occlusion influenced word association and that simulation influenced property verification, even when task conditions favoured word association (Solomon & Barsalou, 2004; Wu & Barsalou, 2009). On the other hand, latency of response category findings of Study 1 suggest that property generation, which is primarily considered a conceptual task, also includes linguistically originated responses. This is also consistent with the findings of a study which suggested that word association influenced property verification even when task conditions favoured simulation (Solomon & Barsalou, 2004).

Secondly, Study 1 findings imply that rather than, or in addition to using the predominant linguistic or concrete transference methods of teaching abstract concepts to children (Newby & Stepich, 1987; Tennyson & Park, 1980), it may be beneficial to use situational and introspective techniques. In addition to focussing on word associations and concrete analogies of abstract concepts, children may benefit from situating abstract
concepts, as well as learning emotions, comparisons, and other introspective domains related to abstract concepts.

Finally, Study 1 findings imply that concepts (in particular heal) are partly simulated, which is a core assumption of studies 2 and 3 of the present project. Furthermore, Study 1 findings imply that abstract concepts, and in particular the heal concept, can be embodied and simulated according to their introspective nature. This implication is particularly important to Study 2 since it utilised introspective words to examine the heal concept.

11.6 Chapter Summary

In summary, Study 1 found that linguistic associates of concepts were produced earlier on average than simulated responses. This finding was consistent with the cognitive system proposed by Language and Situated Simulation theory, in which a shallow processing linguistic system and a deep processing perceptual symbol system are activated in response to a presented word (in any modality) with the linguistic system peaking first, followed later by the perceptual symbol system. Furthermore, Study 1 found that introspective properties were produced more commonly for abstract compared to concrete concepts and that entity properties were produced more commonly for concrete compared to abstract concepts. This finding was consistent with the Perceptual Symbol Systems theory proposal that abstract concepts are primarily conceptualised via introspective properties (and concrete concepts are conceptualised primarily via entity properties). Finally, according to Language and Situated Simulation and Perceptual Symbol Systems theories, exploration of the heal concept suggested that it can be simulated, primarily via its introspective properties.

Study 1 succeeded in its aims of examining the Language and Situated Simulation theory assumption that the shallow processing linguistic system is accessed first, followed by the deeper processing perceptual symbol system; examining the Perceptual Symbol Systems theory prediction that abstract concepts are primarily conceptualised via introspections while concrete concepts are primarily conceptualised via entity properties; and providing validation for the introspective lexical stimuli utilised in Study 2.
III. STUDY 2

12. Method for Study 2

12.1 Sample Demographics

Studies 2, 3, and the individual differences investigation utilised the same group of participants. The sample consisted of 60 university students/staff including 30 (50.0%) males and 30 (50.0%) females, with a mean age of 29.38 years ($SD = 11.41$). Within the sample there were 30 (50.0%) participants of a Western cultural background, 26 (43.3%) participants of an Eastern cultural background, and 4 (6.7%) participants with a mixed cultural background. Thirty-three (55.0%) participants reported English as their first language, 21 (35.0%) reported English as their second language, and 6 (10.0%) reported that they were bilingual.

Participants who had cardiovascular or pain-related medical conditions or a history of frostbite, fainting, seizures, or Reynaud’s syndrome (discolouration of fingers, toes, etc.) were excluded from the study to ensure safe administration of the cold pressor task utilised in Study 3.

The sample was randomly divided into two groups in order to examine the effect of prime strength. One formed the visual group while the other formed the visual + motor group.

12.2 Operationalisation of Effects

12.2.1 Direction effect. Direction was a within subjects variable referring to the up vs. down direction across strength groups (see Section 8.3, p. 94 for operationalisation of direction). The direction effect was operationalised as the difference in response latencies between up and down conditions across strength.

The predicted direction effect would be observed if response latencies were significantly shorter in the up condition compared to the down condition across strength groups.

12.2.2 Strength effect. Strength was a between subjects variable referring to the visual versus visual + motor groups across direction conditions (see Section 8.3, p. 94 for operationalisation of strength). The strength effect was operationalised as the difference in response latencies between the visual and visual + motor groups across direction.

There was no hypothesised strength effect independent of the direction effect.
12.2.3 Direction by Strength interaction effect. The direction by strength interaction effect was operationalised as the difference in slopes between the visual and visual + motor groups for up and down conditions.

The predicted interaction effect would be observed if akin to that in Figure 11 (p. 96).

12.3 Materials

12.3.1 Online questionnaire. A questionnaire collecting demographic information including: age, gender, primary language, cultural background, affect, pain coping style (see Appendix E for affect and pain coping style measure details), and pain experience\(^\text{56}\) was developed and made accessible online using the Opinio survey software package (Object Planet, Oslo, Norway; see Appendix F for questionnaire). The online questionnaire also contained a short questionnaire asking participants to rate their preference for four types of music (rock, pop, classical, and jazz) on a 5-point scale ranging from 1 (totally dislike) to 5 (like a lot), which was used to aid in the deception used in the study (see Section 12.4.2, p. 135).

12.3.2 Lexical stimuli. Study 2 required the generation of a list of words related to heal and a list of word unrelated to heal. It was important that the two sets of words were matched for length, familiarity, and linguistic relationship to heal.

Since this was the first study to examine the heal concept using lexical stimuli there were no validated word lists for ‘heal’ available. Therefore, based on the investigators judgement, 36 words related to heal and 36 words unrelated to heal were selected from various thesauruses ("Online Thesaurus," n.d.; Thesaurus.com," n.d.; Visual Thesaurus," n.d.) and word lists ("Feeling words," n.d.; Henning, n.d.; List of Feeling Words," 2000; A to Z of positive words," n.d.).

In order to validate the investigator’s choice of words, 19 people were asked to rate each of the 72 words on a scale from 1 (not related at all) to 10 (highly related) based on the word’s relationship to the heal concept (e.g., if the word describes heal or describes how you feel when you are “healed”). A Wilcoxon signed-rank test revealed that the mean rating for the group of words assumed to be related to heal was 7.78 (SD

\(^{56}\) Detailed in Section 19.3 (p. 191).
and for the group of words assumed not related to heal was 2.35 (SD = 2.21) and that this difference was significant (Z = -21.24, p < .001).

The 36 “heal concept” and 36 “non-heal concept” words were then spilt into two groups, forming two 18 word “heal concept” groups and two 18 word “non-heal concept” groups (see Appendix G for word groups) in order to counterbalance the presentation of the words in the up and down conditions of the priming task (as further explained on p. 139). The four groups were matched for word length, word frequency, and their linguistic relationship to the word ‘heal’.

12.3.2.1 Word length. It is common practice in lexical processing experiments to match word stimuli for approximate length (i.e., number of letters; Hulme, Surprenant, Bireta, Stuart, & Neath, 2004). Simple reaction times to visual word stimuli have been found to increase with word length (Brennan & Cullinan, 1976). Furthermore, lexical decision response latencies have been found to be influenced by the number of letters in presented words (Lavidor, Ellis, Shillcock, & Bland, 2001). Word lists utilised for Study 2 were matched for length.

12.3.2.2 Word frequency/familiarity. The frequency with which a word occurs in a given language is widely believed to affect the latency with which a word can be recognised and a response made (Monsell, 1991). It has been found that words which occur more commonly in language are processed faster and more accurately than those which occur less commonly (Monsell, 1991). It is assumed that this effect is related to the familiarity of the word (McDonald & Shillcock, 2001).

For the present study, word frequency was determined using the WordCount™ (Harris, 2003) website which presents 86,800 of the most frequently used words in the English language and ranks them in order of commonness. All WordCount data is from the British National Corpus®, which is a collection of samples of written and spoken language from a wide range of sources, designed to represent an accurate cross-section of current English usage.

12.3.2.3 Words’ nonconceptual, lexical relationship to the concept. This possible confound was specific to Study 2 since Language and Situated Simulation theory assumes that conceptual meaning is represented in the perceptual symbol system rather than the linguistic system (Barsalou, 1999; Barsalou, et al., 2008). Study 2

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57 Data was screened prior to analyses. After an initial screening of individual word rating data, 69 responses were found to be outliers and deleted. A Wilcoxon signed-rank t-test was utilised in place of a paired samples t-test due to non-normality in the data.
examined conceptual processing through the evaluation of whether words were related to the target concept (heal) or not. Therefore, the only variation between words related to the target concept and those which are not should be in their conceptual relationship, and not in their lexical relationship. Specifically, words related to the target concept and those which are not should be matched for their linguistic relationship to the target concept. Latent Semantic Analysis allows for the analysis of the linguistic relationship between words (see Landauer & Dumais, 1997 for detailing of Latent Semantic Analysis).

The linguistic relationship between the word ‘healed’ and the “heal concept” and “non-heal concept” words used in Study 2 was determined using a calculator on a Latent Semantic Analysis website (Laham, 1998; Landauer & Dumais, 1997). The calculator computed the linguistic/semantic relationship between words according to Latent Semantic Analysis (see Appendix G for results).

Table 8 presents the means and standard deviations of the four groups of words for the abovementioned variables. A one-way ANOVA revealed no significant differences between the four groups of words in: word length ($F(3,68) = 1.06, p > .05$), word frequency ($F(3,68) = 0.33, p > .05$), or their linguistic relationship to the word ‘healed’ ($F(3,68) = 0.13, p > .05$). It was therefore concluded that the four groups were suitable for use in Study 2.

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58 Data was screened prior to analyses. Due to a positive skewness of the word frequency data, a $\log_{10}(x)$ transformation was applied to produce normality.
Table 8
Word stimuli characteristics: word length, word frequency, and linguistic relationship to ‘heal’ descriptive data

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Heal concept words 1</th>
<th>Heal concept words 2</th>
<th>Non-heal concept words 1</th>
<th>Non-heal concept words 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Word length</td>
<td>8.22 (2.58)</td>
<td>7.17 (2.28)</td>
<td>8.28 (2.05)</td>
<td>8.39 (2.43)</td>
</tr>
<tr>
<td>Word frequency</td>
<td>3.76 (0.73)</td>
<td>3.73 (0.69)</td>
<td>3.90 (0.45)</td>
<td>3.86 (0.45)</td>
</tr>
<tr>
<td>Linguistic relationship to ‘heal’</td>
<td>0.10 (0.08)</td>
<td>0.10 (0.06)</td>
<td>0.11 (0.07)</td>
<td>0.11 (0.06)</td>
</tr>
</tbody>
</table>

N = 18 words per group

12.3.3 Visual prime stimuli. Study 2 utilised photographic visual stimuli as primes (see Figure 20). Visual primes were used instead of linguistic primes (e.g., words ‘up’ and ‘down’) since they have been suggested to be more likely to activate the perceptual symbol system as opposed to the linguistic system (Barsalou, et al., 2008).

(a) (b) (c) (d)

Figure 20. The four photographic visual stimuli used as primes in Study 2. The female photographs were used for female participants and the male photographs were used for male participants.

12.4 Procedure and Apparatus

12.4.1 Recruitment. Participants recruited for studies 2 and 3 were either staff or students of Swinburne University of Technology, Victoria, Australia. Participants were recruited via poster advertisements. The poster contained study information such as reimbursements, eligible age range, location of the study, exclusion criteria (for Study 3 only), an internet link to the study information page, and the investigator’s email address. The poster asked potential participants to read the study information page
and email the investigator with three preferred testing dates and times if they were eligible and would like to participate. The study information page included a more detailed description of the study procedure. The investigator replied back to the potential participants with a time and date suitable for testing, which they were asked to confirm via email. If potential participants did not confirm the time and date via email or did not turn up to the testing session, their email address was discarded. The reimbursement offered to participants for the 60 minute testing session was a $20 gift voucher.

12.4.2 Deception. Studies 2 and 3 required mild deception. Withholding aims and hypotheses in order to minimise conscious or nonconscious biasing of results (by distracting participants from the major predictor variables) is common throughout the experimental embodied cognition literature (Bargh, et al., 1996; Schubert, 2004; Schubert & Koole, 2009). This type of “cover story” deception has been successful and with no reported ill effects on participants (Schubert, 2004). Studies 2 and 3 were advertised to participants as aiming to examine “the effect of music on cognition and pain perception” so that participants would be distracted from the direction and strength aspects of the task. If participants queried these aspects of the task, they were told that the up vs. down photographs and bodily movements were secondary interaction variables. During the study, all participants were told that they were in the “control” condition, and thus no music was played in the background. Due to the possibility that participants may tell their friends, who may be involved in the study later, about the true aims of the study, the true aims were not revealed to any participants at the end of the testing session. Instead, all participants were emailed out a debrief statement (see Appendix H) at the completion of all data collection. Studies 2 and 3 (as well as the individual differences investigation) were approved by the Swinburne University Human Research Ethics Committee.59

12.4.3 Study procedure and apparatus. Upon arrival at the testing room, participants were seated at a desk and provided with a hard copy of the information sheet and the informed consent document (see Appendix I). After giving consent, participants were allocated a unique code number which was used to link their online questionnaire and task data whilst maintaining their anonymity. Participants were then seated in front of a computer and asked to complete the online questionnaire battery.

59 Ethics clearance and statement of compliance for studies 1, 2 and 3 are provided in Appendix R.
Study 2 utilised a protocol developed using the Inquisit software package (Millisecond Software, Seattle, WA, USA). The priming paradigm included the lexical (Section 12.3.2, p. 131) and visual stimuli described above (Section 12.3.3, p. 134). After completing the task, participants were given their $20 gift voucher. At the end of all data collection, participants were sent out the debrief statement (see Appendix E) via email. The overall primary study procedure is displayed in Figure 21.

12.4.4 Study 2 protocol. Participants were given a computer keyboard and seated in front of a blank white wall onto which the priming task was projected. The distance between the participant and the wall was 1.5m and the projection was 2m x 1m, which allowed for the vertical centre of the projection to be approximately at the eye line of the participant (adjusted for their height).

Some aspects of the priming task differed between the strength groups. In the visual group, a fixation point (+) appeared in the middle of the projection for two seconds after which one of the visual prime stimuli was displayed for two seconds. This
was followed by the target word, which was displayed in the middle of the projection until the participant responded.

Participants in the visual group were asked to look at the fixation point and then at the visual prime which followed. They were then asked to respond to the following target word “as quickly and accurately as possible” by pressing $p$ if the word was related to the heal concept or $o$ if it was not ($q$ and $w$ keys were used for left handed participants). After responding, participants were asked to once again look at the fixation point, ready for the next trial. See Figure 22 for a schematic representation of a trial in the visual condition.

In the visual + motor group, a fixation point (+) appeared in the middle of the projection for two seconds after which one of the visual prime stimuli was displayed for two seconds. This was followed by the target word, which was displayed either at the top or bottom of the projection until the participant responded. The position of the target word was congruent with the direction in which the person in the visual prime was looking.

*Figure 22. Example of single “up” trial in visual condition of Study 2.*
Participants in the *visual + motor* group were asked to look at the fixation point and then at the visual prime and tilt their head either up or down (to focus on the top or bottom of the projection) according to the direction in which the person in the visual stimulus was looking. They were then asked to respond to the following target word, “as quickly and accurately as possible” by pressing *p* if the word was related to the heal concept or *o* if it was not (*q* and *w* keys were used for left handed participants). After responding, participants were asked to tilt their head back to the centre of the projection to the fixation point, ready for the next trial. See Figure 23 for a schematic representation of a trial in the *visual + motor* condition.

*Figure 23. Example of single “up” trial in visual + motor condition of Study 2.*

Before the experimental stage, participants were asked to complete a practice stage which used the *anger* concept (and words either related or not related to the *anger* concept) in place of the *heal* concept. It was explained to the participants that “anger concept words” are words that describe emotions and feelings related to the experience of being angry. This stage was designed to customise participants to “concept-related” and “non-concept related” words, response keys, and to the head movements required in
the visual + motor condition. The practice stage consisted of 20 trials (10 “anger concept” words and 10 “non-anger concept” words). The investigator stayed in the room for the practice task in order to provide guidance if required.

Participants then completed the experimental stage without the investigator present in the room. All instructions regarding response keys and head movements were repeated to the participant including the information that “heal concept words” are words that describe emotions and feelings (affect based introspections) related to the experience of having been healed. All information provided to the participants for both the practice and experimental stages were displayed on the projection in the stage introductions.

The experimental stage consisted of 72 trials (36 “heal concept” words and 36 “non-heal concept” words). Half the heal concept words and half the non-heal concept words were presented in the up condition and the other half of each set were presented in the down condition. The sets of heal concept and non-heal concept related words presented in each direction condition were counterbalanced between participants. For both the practice and experimental stages the background colour of the projection was white and words appeared in black (font: Arial, 80pt on projector).

12.5 Methodological Considerations

12.5.1 Definition of conceptual processing. It is important to note that the current project defined ‘conceptual processing’ as the ability to make a decision related to the concept; that is to make a decision about whether heal words and non-heal words are related to the heal concept or not (which was assumed to be faster in the up condition compared to the down condition) rather than only the ability to identify heal words faster (in the up condition compared to the down condition). The former definition of conceptual processing is based on Perceptual Symbol Systems theory in which activating an embodiment of a concept makes the concept more accessible in the mind. Consequently, all decisions about the heal concept including both whether a heal word is related to the heal concept and whether a non-heal word is related to the heal concept will be processed at the same speed in the up condition compared to the down condition.

According to the ‘decision making’ definition of conceptual processing the content of the words must be a factor in the analysis since it hypothesises a difference in processing speed between heal and non-heal words. However, according to the former
definition, the content of the words need not be a factor in the analysis since it hypothesises that the processing speed of the decision will be the same for both heal and non-heal words.

When utilising the ‘decision making’ definition of conceptual processing it is extremely important that the heal and non-heal words are matched in all aspects (e.g., for length, familiarity, and importantly their linguistic relationship to ‘heal’) except for their experiential relationship to the concept. This is in order to make the decision involved in the task valid (i.e., to make it as much about the experiential relationship between the word and the concept as possible – according to Perceptual Symbol Systems theory).

12.5.2 The nature of priming in grounded cognition tasks. Four decades after Meyer and Schvaneveldt’s (1971) seminal experiment on semantic priming, cognitive studies have established that cues (e.g., word or pictures) which are related to targets can facilitate their processing. The most common priming paradigm involves the presentation of a cue, or prime, requiring no response, after which a target is presented (McNamara, 2004; Neely, 1999). In such a paradigm, the prime is implicit and is often presented below conscious awareness (Schacter, Dobbins, & Schnyer, 2004). A number of different priming paradigms have been employed, including: semantic/conceptual priming, in which the prime and the target are conceptually related; associative priming, in which the target has a high probability of appearing with the prime, and is associated with it, but not conceptually related to it; perceptual priming, in which the prime and target are similar in physical form; and spatial priming, which is different from the other three types of priming in that the prime is not a word or picture but an attentional cue related to the target (Ferrand & New, 2003; Mangun & Hillyard, 1991; Vaidya, Monti, Gabrieli, Tinklenberg, & Yesavage, 1999).

All priming paradigms involve components of perception, cognition, and motor movement. The aforementioned types of priming have commonly been studied and interpreted according to the computational theory of mind framework. According to grounded cognition, motor movement is a constituent of perception and both these domains are directly involved in cognition. Priming studies underpinned by the grounded cognition paradigm have found that motor movement can prime, or be primed by concepts (examples include Borghi, Glenberg, & Kaschak, 2004; Schubert & Koole, 2009). Considering priming according to a grounded cognition framework requires a
reconceptualisation of some central components of priming and a blending of some of the priming paradigms mentioned above.

The inference process via pattern completion proposition of Perceptual Symbol Systems theory is crucial to the grounded priming paradigm. The prime was a photograph of a person looking up or down, which was assumed to trigger simulation of the movement. Following the prime, a word related or unrelated to the heal concept was presented for evaluation. According to Perceptual Symbol Systems theory, it was predicted that simulation of the up bodily state activated the heal concept through the inference process via pattern completion, thus allowing for facilitation of processing of words related and unrelated to heal compared to simulation of the down bodily state.

12.5.3 Reaction time as a measure of cognition. Reaction time and accuracy (or “error rate”) are the most common outcome variables of priming tasks (Slocomb & Spencer, 2009). Due to the subjective nature of the choice reaction time task used as part of the Study 2 priming paradigm, reaction time was the major outcome variable while accuracy was used only to ensure that participants understood the words in the task (i.e., all participants must achieve >70% accuracy to be included in the analysed sample). Thus, the main assumption of the Study 2 grounded cognition priming paradigm was that reaction time is a measure of conceptual processing. For an accurate measure of conceptual processing through reaction time, it was important to consider possible confounding factors in reaction time tasks.

According to the reaction time literature (Sanders, 1998; Sternberg, 1998) a number of variables were considered in the design of the Study 2 choice reaction time task, including: fatigue, practice effects, motivation, and stimulus sequencing. Firstly, to reduce fatigue, trial blocks were relatively short, with inter-trial intervals of two to three seconds. Secondly, participants were informed when maximum concentration levels were required. Thirdly, although practice effects cannot be eliminated completely, they are known to decelerate, therefore a relatively high number of practice trials were administered in order to provide a more accurate measure of cognition via reaction time. Fourthly, to keep motivation constant between participants, clear instructions were provided (see Section 12.4.4, p. 136 for task instructions). Finally, it has been observed that when there are several types of stimuli, reaction time will be faster where there is a sequence of several identical stimuli than when the different types of stimuli appear in random order. This is called the “sequential effect” and was controlled in Study 2 by using random sequencing of task stimuli.
Since age and gender have been found to influence reaction time they were matched between the Study 2 groups. Choice reaction time has been found to shorten from infancy, reaching its peak in the late 20s then increasing slowly until the 50s and 60s and then increasing faster into the 70s and beyond (Der & Deary, 2006; Luchies, et al., 2002). In relation to gender, studies have suggested that in almost every age group, males have faster reaction times than females (Adam, et al., 1999; Der & Deary, 2006).

12.6 Data Analytic Approach

12.6.1 Data screen method. Participants who did not achieve an accuracy rate of >70% were excluded from the analysis. Prior to conducting the mixed design ANOVA, a data screen was performed on latency values to ensure reliability of both raw individual data and grouped data and to ensure that all assumptions for a mixed design ANOVA were met.

Before assessing grouped data, all raw individual data was screened for missing values. Each participant’s raw data was then separately screened for univariate outliers according to the z-score range (see Section 9.6.3, p. 104). Using the screened data set, latency means for each direction condition were calculated for each participant in order to perform a grouped data screen.

The grouped data screen began with a screening for univariate outliers in the direction variables between the strength groups using the z-score range (see Section 9.6.3, p. 104). A number of mixed design ANOVA assumptions were then tested prior to the analysis including; normality, linearity, sphericity, homogeneity of variance, and homogeneity of covariance matrices. Levene’s test of the equality of error variances was used to test the homogeneity of variance assumption and Box’s M was used to test the homogeneity of covariance matrices assumption (see Section 9.6.3, p. 104 for normality, linearity, and sphericity assumption examination).

13. Results of Study 2

The chapter details the analyses for the direction hypothesis (H3) and the interaction hypothesis (H4) of Study 2 (see Section 8.3, p. 94 for hypotheses).

13.1 Analysis of Direction (H3) and Interaction (H4) Hypotheses

A 2 (Direction) by 2 (Strength) mixed ANOVA was used to examine the direction (H3) and interaction (H4) hypotheses.
13.1.1 Data screen. One participant was found to have fallen below the cut-off point of 70% correct answers (66% correct answers) and was thus excluded from the analysis. Therefore, 59 participants’ data ($N_{\text{visual}} = 30, N_{\text{visual} + \text{motor}} = 29$) were included in the data screen.

Individual data was screened according to the data screen method outlined in Section 12.6.1 (p. 142). No missing values were found since the Study 2 task was computerised and thus all trials had to be completed before moving on. Forty seven values were considered univariate outliers. Due to the large data set (4,248 values) and a maximum of two outliers per participant, it was deemed appropriate to exclude these values rather than replace them with the participant’s mean score.

Grouped data was screened according to the data screen method outlined in Section 12.6.1 (p. 142). Two values were considered univariate outliers. The two values originated from a single participant in the visual group, for both the up and down direction conditions. It was decided that this participant would be excluded from the analysis, leaving 58 participants ($N_{\text{visual}} = 29, N_{\text{visual} + \text{motor}} = 29$). Both of the direction variables in both strength groups were considered normal and linear. The sphericity assumption was automatically met for the current analysis since the within subject variable (direction) had only two levels (up and down). The homogeneity of variance assumption was met for all within subject conditions and the homogeneity of covariance matrices assumption was also met. After a complete data screen and test of assumptions, 58 participants (29 in each strength group) remained for inclusion in the mixed ANOVA analysis.

13.1.2 Group differences in demographics. Pearson’s Chi Square indicated no significant differences in sex or primary language between the two groups and independent samples t-tests indicated no significant differences in age or affect between the two groups (see Appendix J).

13.1.3 Hypothesis testing. Response latency means and standard deviations for up and down conditions between the strength groups are displayed in Table 9. The analysis revealed a significant main effect of direction ($F(1,56) = 8.40, p < .01, \eta^2 = 0.13$). As expected, response latencies for up trials were significantly shorter than those for down trials, as displayed in Figure 24. Thus, the results were consistent with the hypothesis that priming of the up bodily state will allow for facilitation of conceptual processing related to the heal concept compared priming of the down bodily state (H3).
However, contrary to expectations, the analysis revealed no significant interaction between direction and strength ($F(1,56) = .26, p = .61$). Thus, the results were not consistent with the interaction hypothesis (H4).

Table 9
*Response latency means and standard deviations for up and down conditions between strength groups*

<table>
<thead>
<tr>
<th>Strength</th>
<th>Up Mean (SD)</th>
<th>Down Mean (SD)</th>
<th>Total Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>3119.25 (335.99)</td>
<td>3172.56 (385.16)</td>
<td>3145.97 (356.66)</td>
</tr>
<tr>
<td>Visual + motor</td>
<td>3211.09 (273.77)</td>
<td>3248.53 (320.59)</td>
<td>3229.63 (291.15)</td>
</tr>
<tr>
<td>Total</td>
<td>3165.17 (307.28)</td>
<td>3210.55 (353.31)</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* - All latency values in milliseconds
- Reaction time was calculated by Inquisit from the appearance of the prime rather than the target word thus adding a constant of an extra 2000ms (see Figure 22) to the true reaction time.

![Figure 24](image_url). Mean response latencies for up and down trials across strength groups. Error bars represent one standard error above the mean.
13.2 Chapter Summary

Results of Study 2 revealed significantly shorter response latencies for up trials compared to down trials across the strength groups, suggesting that priming of the up bodily state allowed for facilitation of conceptual processing related to the *heal* concept compared to priming of the down bodily state (H3). However, no interaction effect between direction and strength was found, thus results were not consistent with the interaction hypothesis (H4).

14. Discussion of Study 2

Study 2 was conducted as an empirical investigation of assumptions of Perceptual Symbol Systems theory in relation to the *heal* concept in an offline condition. The first aim of Study 2 was to empirically investigate the putative embodiment of the *heal* concept in the up bodily state in an offline condition. The second aim of Study 2 was to examine the influence of adding a motor prime to the visual prime in manipulating the strength of the putative simulation.

These aims, along with the Study 2 hypotheses, were derived explicitly from Perceptual Symbol Systems theory. Therefore, the Perceptual Symbol Systems theory interpretation will be privileged in the current discussion, although other interpretations will also be explored.

14.1 Perceptual Symbol Systems Theory Interpretation of Findings

14.1.1 Evidence for the direction hypothesis (H3). Study 2 found that priming the up bodily state led to faster processing related to the *heal* concept. This was consistent with a Perceptual Symbol Systems theory account of conceptual knowledge. A number of assumptions were made in order to interpret this Study 2 finding according to Perceptual Symbol Systems theory.

The first assumption for activation of the putative perceptual symbol system was that the task required deep conceptual processing (Barsalou, et al., 2008). If the task did not require deep conceptual processing, it may have been handled solely by the linguistic system (Barsalou, et al., 2008). Study 2 required the categorisation of words as being related to the *heal* concept or not. This could be a simple word association task if the two sets of words were not matched for their linguistic relationship to ‘heal’. Since the word sets were matched, a deeper conceptual processing was assumed to be
required for conceptual categorisation, thus the perceptual symbol system was assumed to be employed.

The second assumption was that the up bodily state is an embodiment of the heal concept. Although Study 2 was the first to empirically assess the relationship between the up bodily state and the heal concept, a number of authors have identified the metaphorical relationship between up and heal (Lakoff & Johnson, 1980; Toombs, 1988). This metaphorical relationship is grounded in experience, suggesting that it originated from experience of the up bodily state during experiences of being healed (Barsalou, 1999; Landau, Meier, & Keefer, 2010; Murphy, 1996). Finally, since the up bodily state can mean an upright, as opposed to a stooped posture, or a tilt of the head up as opposed to down, it was important to consider the best depiction of the up bodily state in relation to heal. It was assumed that both these operationalisations of the up bodily state depict its relationship to heal (see Section 7.1.2, p. 83 for examples of relationship). Thus it was determined, on the basis of relative methodological ease, that an upward head tilt compared to a downward head tilt would best depict the up bodily state in a healing context.

The final assumption was that the methodology employed in Study 2 would elicit simulation of the heal concept via priming of the up bodily state. A number of components constituting this assumption should be noted. Firstly, the photographs utilised as visual primes needed to elicit simulation of the up/down bodily state embodiment. Two photographs of the same person with their head tilted up/down were selected as the stimuli proposed to trigger simulation. Symbols such as up and down arrows were not selected as stimuli due to their generic nature, which would cause them to be more likely to trigger the up concept, which is more closely related to the up metaphor than the up bodily state embodiment (Meier & Robinson, 2004). On the other hand, photographic images were considered more specific than symbols and have been argued to be capable of eliciting simulation (as described in Niedenthal, Mermillod, Maringer, & Hess, 2010; Wilson & Knoblich, 2005). Thus, on viewing a photograph of a person performing an upward head tilt (and additionally enacting an up bodily state for the visual + motor group), it was assumed that an upward head tilt would be simulated.

Secondly, simulation of the up bodily state embodiment was assumed to trigger simulation of the heal concept. The up bodily state embodiment has been proposed to be related to numerous concepts (e.g., God in Meier, et al., 2007; power in Schubert,
2004), which is why the context of Study 2 was important (Barsalou, 2003). According to the putative inference process via pattern completion, simulation of the up bodily state embodiment, in the context of the ‘heal’ word categorisation task, would trigger simulation of the heal concept and consequently facilitate processing related to the heal concept (Barsalou, 2005).

Thirdly, as implied by Perceptual Symbol Systems theory, whether the target word was related to the heal concept or not, it was assumed to be simulated (as suggested by Estes, et al., 2008; Rueschemeyer, Lindemann, Rooij, Dam, & Bekkering, 2010). Finally, in order to categorise the target word as related to, or not related to heal, an assessment of whether the simulated target word was contained within the conceptualisation of heal was assumed to be performed.

In comparison, viewing a photograph of a person performing a downward head tilt (and enacting a down bodily state for the visual + motor group) was assumed to elicit simulation of a downward head tilt. The down bodily state embodiment, in the context of the ‘heal’ word categorisation task, was assumed to interfere with simulation of the heal concept (see Section 7.1.4, p. 86). Consequently, the assessment of whether simulation of the target word was contained within the situated conceptualisation of heal was assumed to be impeded. These three methodological assumptions were proposed to capture the putative relationship between bodily state and the heal concept as operationalised in the design of Study 2.

Thus, Study 2 added to the literature of demonstration studies (prominent examples include Chandler, et al., 2012; Chandler & Schwarz, 2009; Jostmann, et al., 2009; Schubert, 2005) which are consistent with Perceptual Symbol Systems theory by generating data consistent with the hypothesised pathway of: up bodily state prime > simulation of the up bodily state embodiment > simulation of the heal concept > facilitated processing of information related to the heal concept.

14.1.2 Evidence for the interaction hypothesis (H4). Study 2 findings were not consistent with the predicted interaction between direction and strength (H4). This hypothesis was derived from the contention that combining two simulation triggers would influence the strength of the simulation (see Section 5.3.2, p. 70; Barsalou, 1999; Gallese & Lakoff, 2005; Simmons & Barsalou, 2003

Prior research has suggested that motor and visually triggered simulation can facilitate conceptual processing (prominent examples include Chandler & Schwarz, 2009; Glenberg & Kaschak, 2002; Jostmann, et al., 2009; Meier, et al., 2007; Schubert,
2005; Schubert & Koole, 2009; Wilkowski, et al., 2009); however they have always been assessed in isolation from each other. In addition to predicting that a visual perception can trigger a simulation to facilitate conceptual processing, Study 2 predicted that the addition of a motor prime to the visual prime would influence the strength of the triggered simulation. To the best of the author’s knowledge, this was the first study to examine the influence of combined primes on the putative process of simulation.

The absence of a direction by strength interaction effect in Study 2 could be interpreted as evidence against the modal underpinnings of the relationship between the up bodily state and the heal concept. However, before such conclusions can be drawn, an additional Study 2 finding must be considered. Additional Study 2 findings revealed a nonsignificant trend towards a main effect of strength (see Appendix K for statistical analysis). Specifically, a trend was found suggesting shorter response latencies for the visual group compared to the visual + motor group across direction conditions.

It is implied that amodal accounts would predict no difference between the groups since it has been argued that they propose that conceptual processing is derived from the manipulation of amodal symbols which are stripped of their perceptual and motor features, and consequently should not be influenced by an additional motor prime (see Section 5.3.2, p. 70). Therefore, this additional finding is contrary to both amodal and Perceptual Symbol Systems predictions. The finding is most likely due to a methodological limitation of Study 2 in which the visual + motor group had to perform the extra step of tilting their head up or down according to the photograph, which did not have to be performed by the visual group. This step may have been the cause of the delayed response times seen in the visual + motor group compared to the visual group.

Consequently, this Study 2 finding is best interpreted as inconclusive rather than evidence that the relationship between the up bodily state embodiment and the heal concept is not modally underpinned. In fact, the result may be more suggestive of a link between the motor system and cognitive processing. Since the interval times between the stimuli and the target were the same for the two groups, there seems to have been a direct effect of motor movement on cognitive processing, as has been suggested by previous research (Borghi, et al., 2004; Glenberg & Kaschak, 2002), only in the case of Study 2, it was not in the predicted direction.
14.2 Alternative Interpretations

Although Study 2 was the first of its kind to consider the relationship between up and the heal concept, it adds to the empirical literature which has found relationships between putative embodiments and abstract concepts (prominent examples include Chandler & Schwarz, 2009; Hung & Labroo; Jostmann, et al., 2009; Meier, et al., 2007; Meier & Robinson, 2004; Schubert, 2005). Along with the present study, a number of these studies have interpreted their findings according to Perceptual Symbol Systems theory (prominent examples include Chandler & Schwarz, 2009; Schubert, 2005; Schubert & Koole, 2009). However, Study 2 findings, along with the findings of most of the abovementioned studies, could also be interpreted in terms of amodal or Conceptual Metaphor Theory accounts. It is important to note that the following interpretations are provisional, since Study 2 hypotheses were derived explicitly from Perceptual Symbol Systems theory.

14.2.1 Amodal account. According to an amodal framework, the up bodily state and the heal concept would be considered amodal symbols (Fodor, 1975). Amodal symbols often operate within connectionist networks, such as that underpinned by spreading activation theory (A. M. Collins & Loftus, 1975; McClelland & Rumelhart, 1986). According to the Hebbian learning rule, connections between symbols in the network become strengthened when they fire together (Reynolds, et al., 1996). As the link between the up bodily state and the heal concept is proposed as being underpinned by experience, it is likely that their link would be quite strong. Viewing the photograph of the person looking up could be interpreted as having activated the up bodily state node, from which activation spreads to the heal concept, consequently facilitating processing in the up condition. Thus, although Study 2 was framed as a priming task underpinned by grounded cognition, it may have operated in the same manner as a simple semantic priming task.

The Study 2 hypothesis that simulation of the up bodily state will allow for facilitation of conceptual processing related to the heal concept compared simulation of the down bodily state (H3) was not designed to separate the modal vs. amodal accounts of conceptual processing. On the other hand, the interaction hypothesis (H4, see Section 8.3, p. 94 for description of hypothesis) was designed to provide some empirical evidence regarding the putative modal nature of conceptual processing.

The latter hypothesis provides a point of differentiation between amodal and modal theories in its implication that the addition of a motor prime to the visual prime
would influence simulation, but not amodal processing (see Section 5.3.2, p. 70). However, Study 2 did not find the predicted interaction effect; rather than counting as evidence against a modal relationship between the up bodily state and the *heal* concept, a methodological limitation was likely to have rendered the findings inconclusive (see p. 148 for explication of methodological limitation). Overall, Study 2 findings were consistent with the hypothesis that activation of the up bodily state embodiment facilitated processing related to the *heal* concept, but was unable to provide any evidence to suggest that this relationship is not amodal.

**14.2.2 Conceptual Metaphor Theory.** Another alternative interpretation of Study 2 findings is via Conceptual Metaphor Theory (see Section 4.3.2, p. 35 for details of theory; Lakoff & Johnson, 1980, 1999). Since the image schemas posited by Conceptual Metaphor Theory are amodal, the system works in a similar manner to the amodal accounts mentioned above; however, unlike amodal accounts, it has the theoretical framework to predict findings such as those of Study 2, a priori.

Conceptual Metaphor Theory has been differentiated from theories which posit embodied simulation, such as Perceptual Symbol Systems theory, on the basis of their conceptual mechanism (Landau, et al., 2010). Landau, et al. (2010) argued that embodied simulation is an *intra*conceptual mechanism in which modality-specific representations are derived from prior experiences with the concept. In contrast, conceptual metaphor is an *inter*conceptual mechanism in which source concepts (e.g., *up*) are concepts in their own right that can be, but need not be, metaphorically linked to target concepts (e.g., *heal*).

This account seems feasible as it does not argue that conceptual knowledge is derived from metaphor, but only that metaphor can extend understanding of a concept. In this way, Perceptual Symbol Systems theory and Conceptual Metaphor Theory are not mutually exclusive and conceptual processing can involve both methods. However, it is important to consider that the *intra*conceptual mechanism of a perceptual symbol system must form the basis and structure of the concept before the *inter*conceptual mechanism posited by Conceptual Metaphor Theory can elaborate on it. For example, before the relationship between the *warmth* of a cup and *friendliness* can occur, bodily experiences of warmth with friends must develop (e.g., via hugging). Most importantly for Study 2, the relationship between up and the *heal* concept is considered *intra*conceptual since it is derived from experiences of the up bodily state when healed (Kirmayer, 2008; Toombs, 1988).
14.3 Limitations

A number of methodological and theoretical qualifications and limitations in Study 2 should be noted. The qualifications are related to the priming paradigm and are presented in Appendix L. The first limitation was that manipulation checks were not administered as a part of Study 2. Study 2 used a cover story about assessing the effect of music on cognition and explained away the up/down movements as secondary interaction variables. However, unlike previous research (Schubert, 2004, 2005; Schubert & Koole, 2009) manipulation checks were not conducted to assess whether participants had seen through the cover story. Thus, if participants had seen through the cover story and linked the up condition to the heal concept, they may have nonconsciously exhibited a bias towards the expected direction of the findings.

A second limitation was that the effect of positive valence was not controlled for or measured when assessing the relationship between the up bodily state and the heal concept. This was an important limitation since numerous studies have suggested a strong relationship between up and positive valence (Crawford, et al., 2006; Meier & Robinson, 2004). Thus, the relationship between the up bodily state and the heal concept found in Study 2 may have been due to the positive valence inherent in the heal concept (Lakoff & Johnson, 1980). The assessment of valence in relation to the heal concept was outside the scope of Study 2, so it was accepted that at least some of the relationship between the up bodily state and heal may be due to positive valence. However, on the basis of prior research which has assessed the relationship between up and abstract concepts like heal, such as God (Meier, et al., 2007) and power (Schubert, 2005), and found that valence was independent of these concepts, it was considered unlikely that positive valence would account for all of the relationship between the up bodily state and the heal concept.

A third limitation was the absence of a direction control condition in either of the strength groups. Study 2 hypotheses implied that the up bodily state embodiment would facilitate processing related to the heal concept compared to the down bodily state embodiment. Without a direction control condition, Study 2 could not conclude whether the putative up bodily state embodiment facilitated processing related to the heal concept or whether the down bodily state embodiment interfered with processing related to the heal concept. It is theoretically and practically important to ascertain whether it was the up bodily state embodiment, avoiding the down bodily state embodiment, or both which resulted in the facilitation of access to the heal concept.
Previous research has suggested that up facilitated processing of the power concept only when considered relative to down (which was consider as related to powerlessness) as opposed to an absolute relation between the up embodiment and power (Lakens, Semin, & Foroni, 2011). This type of examination is especially important for the heal concept since there is equally as much, or more metaphorical (Lakoff & Johnson, 1980; Schoeneman, et al., 2004) and experiential (Meier & Robinson, 2006) evidence for the relationship between down and illness/pain as for up and heal. The proposed condition would be made possible by adding a photograph of a person looking straight ahead in the centre of the screen for both strength groups. This control condition would allow for conclusions to be drawn about whether it was facilitation, interference, or both which defined the relationship between up, down, and the heal concept.

A fourth limitation was the lack of a validation test of the up bodily state visual primes. A tilt of the head in an upward direction was chosen as the operationalisation of the up bodily state embodiment of the heal concept due to its relative methodological ease compared to standing upright (vs. lying down). However, there was no validation that a tilt of the head upwards reflected the up bodily state related to the heal concept. This is an important consideration for the present study since the up bodily state was not a completely schematized prime but a concrete posture.

A fifth limitation is that in defining conceptual processing as decision making, the type of empirical research used in this project cannot provide evidence against the possibility that all words are facilitated by the up bodily state, instead it only attempts to provide evidence suggesting that the processing of a particular concept is facilitated by the up bodily state. Under this Perceptual Symbol Systems theory based definition of conceptual processing the only way to empirically demonstrate that not all words are facilitated by the up prime is to examine a word which is not related to up (such as anger) and demonstrate that up does not facilitate its processing.

The final limitation was that the design of Study 2 was not able to illuminate the independent effects of visual and motor primes since there was no motor only group. Since amodal accounts can theoretically account for motor movement triggering the up component, but are argued to be unable to account for the influence of visual perception and motor movement compared to motor movement in isolation (see Section 5.3.2, p. 70 for details), the inclusion of a motor only group would allow Study 2 to explain findings had the interaction hypothesis been supported. The proposed motor only group
could involve participants simply asked to look at the top or bottom of the projector screen without a visual prime (i.e., no photograph of person looking up or down) present. If neither the motor only nor visual groups facilitate processing related to the heal concept while the visual + motor group does, this would suggest an advantage for a Perceptual Symbol Systems account of the findings over an amodal account (see Section 5.3.2, p. 70 for details).

14.4 Suggestions for Future Research

A number of possible extensions to Study 2 and areas for future research which can be anchored in the Study 2 findings should be noted. Firstly, Study 2 could be extended and improved by the addition of an extra step to the visual group in order to balance the cognitive load between the two groups. Additional analyses (see Appendix K) suggested that Study 2 findings may have been confounded by the extra motor movement step in the visual + motor group. This may be an intriguing finding if it can be confirmed that it was the motor movement rather than the extra cognitive load tied in with the motor movement that caused the difference in response times between the groups. The addition of a non-motor cognitive step, such as asking the visual group to say what the person in the photograph is doing (e.g., looking up), would balance the cognitive load between the two groups and allow for an accurate examination of whether the addition of a motor prime to the visual prime can influence the proposed simulation process.

Secondly, the design of Study 2 could be tightened by using eye tracking equipment to ensure that participants in the visual group were not moving their eyes from the centre of the screen, as this may be considered a form of motor movement of the up bodily state. Assessing whether participants nonconsciously move their eyes would also be interesting investigation in isolation since numerous studies have suggested that simulation of an embodiment or concept results in nonconscious motor behaviour (Bargh, et al., 1996; Barsalou, et al., 2003; Oosterwijk, et al., 2009).

Thirdly, in order to minimise the limitation related to the positive valence inherent in the heal concept, it would be beneficial for future studies to examine the relationship between the up bodily state, positive valence, and the heal concept. An ingenious way to examine this relationship was devised by Meier et al. (2007) in a study examining the association between up and God. Adapted to Study 2, it would involve presenting the “heal concept” words at the top and bottom of a screen and asking one set
of participants to rate the words on a Likert scale according to their relationship to *heal* and asking another set of participants to rate the words on a Likert scale according to their *valence*. If the relationship between *heal* and the up bodily state is due to inferences related to positive valence, then the manner in which vertical position influences *heal* concept ratings should correlate with the manner in which vertical position influences *valence* ratings. It would be expected that vertical position would affect *heal* concept ratings, but valence ratings of the words would be the same in up and down conditions (for another paradigm see Schubert, 2005, Study 5).

Fourthly, in order to minimise the limitation related to the validation of the tilt of the head up as the up bodily state embodiment related to the *heal* concept, it would be beneficial for future studies to validate these visual primes. This could be achieved by an explicit evaluation of whether the visual primes reflected the up bodily state related to healing such as showing the prime images to participants and asking them to rate the images according to their relationship to *heal*. However, since embodiments are considered to be primarily under the level of conscious awareness this method may not be ideal. A more effective method for an embodiment protocol would be to perform an implicit study akin to Study 2 using the visual primes in the assessment of a concept which already has a strong evidence base regarding its association with the up bodily state (e.g., power).

A fifth extension of Study 2 could utilise incongruent visual and motor primes (e.g., perceiving a photograph of person looking *down* whilst enacting the *up* bodily state) to examine the interaction between visual and motor triggered simulation. This type of incongruent paradigm could be used to illuminate questions regarding whether visually triggered simulations are equivalent to, less powerful, or more powerful than motor triggered simulations, which in turn would add to the Perceptual Symbol Systems theory literature regarding the nature of simulators and simulations (Barsalou, 1999).

A sixth suggested extension of Study 2 is to add up/down arrows in comparison to photographs of people. This distinction may help to tease out whether amodal or modal symbols underpin the relationships between embodiments and concepts, since the use of up/down arrows is more likely to activate up/down image schemas than simulations of up/down embodiments (Landau, et al., 2010; Meier & Robinson, 2004). However, most of these methods hinge on assumptions about what types of stimuli may or may not involve activation of proposed simulations in the modal system.
A seventh extension to Study 2 would be to utilise new imaging technologies to go beyond the abovementioned assumptions and examine exactly which stimuli activate the modal system and which areas of the modal system they activate (examples of neuroimaging embodiment studies include Kan, et al., 2003; Kellenbach, et al., 2001; Simmons, et al., 2008; Wilson-Mendenhall, Barrett, Simmons, & Barsalou, in press; Wilson-Mendenhall, Simmons, et al., in press). Future embodiment research should continue in this direction in order to minimise criticisms regarding methodological assumptions made about activation of the modal system.

Finally, future studies should use Study 2 findings as a foundation to conduct further research into the offline embodiment of the *heal* concept. Since Study 2 findings suggested that there is some relationship between the up bodily state embodiment and the *heal* concept, it would be interesting and practically meaningful to examine whether there exists a similar relationship between the *heal* concept and its other assumed embodiments, such as light and positive emotion (Fosha, 2004; Haynes, et al., 2005; Lakoff, 1987). It would be interesting not only to test their independent relationships to the *heal* concept but also to test their cumulative effects on access to the *heal* concept. This could be achieved by adapting the Study 2 design by additionally presenting the target words in light or dark backgrounds (to examine the proposed “light” embodiment of *heal*). According to the inference process via pattern completion, simulating the up bodily state embodiment in a heal context should facilitate access to the *heal* concept, including all its embodiments (e.g., light), thus the lighter backgrounds should further facilitate processing related to the *heal* concept compared to darker backgrounds.

### 14.5 Implications

A number of implications for future research, and the interpretation of past research based on the findings of Study 2, should be noted. Firstly, a number of studies examining visual effects on conceptual processing involve the potentially confounding factor of a spatial aspect in the presentation of the prime or target (Meier & Robinson, 2004; Schubert, 2005). This spatial factor usually involves a target or prime presented in a high or low spatial position, which is likely to elicit head and/or eye movement. It is difficult for these studies to decipher whether it is this movement or the visually triggered simulation which cause the effect. Thus, it is important, especially for studies which compare visual and motor effects, to follow Study 2 in presenting both prime and target centrally in examining visual effects.
Secondly, a number of studies have suggested that abstract concepts such as valence (Meier & Robinson, 2004), God (Meier, et al., 2007), power (Schubert, 2005), importance (Jostmann, et al., 2009), willpower (Hung & Labroo, 2011), and anger (Wilkowski, et al., 2009) can be embodied according to Perceptual Symbol Systems theory and Conceptual Metaphor Theory. Study 2 adds the heal concept to that list and thus strengthens the evidence base for grounded cognition. The putative embodiment of abstract concepts has important theoretical implications for arguments against modal theories of cognition, such as Perceptual Symbol Systems theory. One of the common criticisms of modal theories is that they are not able to account for abstract concepts (Mahon & Caramazza, 2008). As the findings of Study 2, along with the aforementioned studies suggest, abstract concepts can theoretically be embodied, thus suppressing this criticism.

Thirdly, a practical implication derived from the findings of Study 2 is in the educational domain. If, as Barsalou (1999) contends, infants are able to attend to experiences, integrate them into long-term memory and form simulators before the acquisition of language and abstract thinking, the importance of embodied teaching techniques in these domains is paramount. Based on the Piagetian model of development, many of the current teaching frameworks already include physical and experiential embodied teaching techniques across all modalities (Webb, 1980; Weddle & Hollan, 2010).

However, due to their abstract nature, the teaching of science and mathematics is often restricted to the teaching of symbolic rules and equations (Nathan, Long, & Alibali, 2002). Despite this abstract nature, situated learning theorists have long considered mathematics to be contextually grounded (Lave, 1988; Nunes, 1999). This argument is consistent with empirical research. For example, Nunes’ (1999) study found that Brazilian children who sold candy on the street were competent with currency, despite having difficulties solving word problems with similar calculations required to those they came across on the streets. Along with Nunes’ finding, recent research regarding the embodied nature of numbers (Domahs, Moeller, Huber, Willmes, & Nuerk, 2010; Núñez, 2004; Pecher & Boot, 2011) and perceptual effects on mathematical reasoning (Landy & Goldstone, 2007; R. E. Núñez, Edwards, & Matos, 1999) suggest that even subjects underpinned by abstract concepts such as mathematics and science may benefit from embodied teaching techniques.
14.6 Chapter Summary

In summary, Study 2 findings suggested that priming the up bodily state facilities conceptual processing related to the heal concept. This was consistent with a Perceptual Symbol Systems theory account of conceptual knowledge which implies that simulation of the up bodily state embodiment facilitates processing related to the heal concept compared to simulation of the down bodily state embodiment. However, Study 2 did not find the expected interaction effect between direction and strength.

Study 2 succeeded in its aims of empirically investigating the putative embodiment of the heal concept in the up bodily state in an offline condition and examining the influence of adding a motor prime to the visual prime in manipulating the strength of the putative simulation. Finally, heal specific data drawn from Study 2 was used to discuss testable hypotheses and models about the types of systems used in conceptual knowledge for future research.

IV. STUDY 3

15. Method for Study 3

15.1 Sample Demographics

The sample was the same as Study 2 (see Section 12.1, p. 130). However, the sample for Study 3 was randomly divided into four groups in order to examine the effect of the direction, and prime strength. The groups were: up/visual, up/visual + motor, down/visual, and down/visual + motor.

15.2 Operationalisation of Effects

15.2.1 Direction effect. Direction was a between subjects variable referring to the up vs. down direction across strength groups (see Section 8.4, p. 96 for operationalisation of direction). The direction effect was operationalised as the difference in healing sensation and/or healing affect between up and down groups across strength.

The predicted direction effect would be observed if the change in (i) healing sensation and/or (ii) healing affect are significantly decreased in the up groups compared to the down groups.

15.2.2 Strength effect. Strength was a between subjects variable referring to the visual vs. visual + motor groups (see Section 8.4, p. 96 for operationalisation of
strength). The strength effect was operationalised as the difference in healing sensation and/or healing affect between the visual and visual + motor groups across direction.

There was no hypothesised strength effect independent of the direction effect.

**15.2.3 Direction by Strength interaction effect.** The *direction by strength* interaction effect was operationalised as the difference in slopes between the *visual* and *visual + motor* groups for *up* and *down* groups.

The predicted interaction effect would be observed if akin to that in Figure 13 (p. 97).

**15.3 Materials**

Questionnaire was the same used for Study 2 (see Section 12.3.1, p. 131). Study 3 utilised visual stimuli, the cold pressor task (see Section 15.4.4, p. 159), and visual analogue scales.

**15.3.1 Visual stimuli.** Study 3 utilised a single visual stimulus for each participant. Stimuli were one of the four used as visual primes in the Study 2 (see Section 12.3.3, p. 134).

**15.3.2 Visual Analogue Scale.** Separate pen-and-paper 100mm visual analogue scales were used to measure pain sensation and pain affect (see Appendix M). A number of studies have established the validity and reliability of the pain sensation and pain affect visual analogue scales (Jensen & Karoly, 2001; Price, Bush, Long, & Harkins, 1994; Price, Harkins, & Baker, 1987; Price, McGrath, Rafii, & Buckingham, 1983). Furthermore, visual analogue scales of pain sensation and pain affect have been previously used in studies which have utilised the cold pressor task (Dannecker, George, & Robinson, 2007; Forys & Dahlquist, 2007; Hirsch & Liebert, 1998).

The two scales were presented on either side of an A4 sheet of paper so participants could not visually compare their responses to each of the scales. The endpoints for the pain sensation scale were *no sensation* and *the most intense sensation imaginable*. The endpoints for the pain affect scale were *not bad at all* and *the most intense bad feeling possible for me* (Price, et al., 1994). Participants were asked to mark a point on each of the scales which represented the sensation and affect of their pain at the time of rating. In order to clarify the distinction between the sensory and affective dimensions of pain, standardised instructions were explicated to all participants (see Appendix N, from Price, et al., 1983). Pain sensation and pain affect were scored by measuring the distance from the left endpoint of the scale line to the marked point.
Scores ranged between 0-100mm and higher scores indicated increased pain sensation or pain affect.

15.4 Procedure and Apparatus

15.4.1 Recruitment. Recruitment was the same as Study 2 (see Section 12.4.1, p. 134).

15.4.2 Deception. Deception was the same as Study 2 (see Section 12.4.2, p. 135).

15.4.3 Study procedure and apparatus. Study procedure was the same as that outlined in Section 12.4.3 (p. 135) with the addition of a verbal reminder regarding the exclusion criteria of existing cardiovascular or pain-related medical conditions or a history of frostbite, fainting, seizures, or Raynaud’s syndrome. Participants then completed Studies 2 and 3 consecutively with the order of the studies administered counterbalanced between participants. Participants were assigned to the same strength condition for both studies (e.g., if they were allocated to the visual condition for Study 2 they had to be allocated to either the up/visual or down/visual groups for Study 3).

15.4.4 Study 3 protocol. Participants were seated next to a desk (to their left if right handed or vice versa) in front of a blank white wall onto which the visual stimulus was projected. The distance between the participant and the wall was 1.5m and the projection was 2m x 1m, which allowed for the vertical centre of the projection to be approximately at the eye line of the participant (adjusted for their height).

The cold pressor task apparatus was then set up on the desk with a hand towel placed next to it. The cold pressor task apparatus consisted of a 45cm x 30cm x 15cm plastic container containing 6 litres of water at 6°C. The water was chilled by filling the container with ice until the water temperature at the centre of the container was 6°C when the ice was completely melted. Water temperature was dynamically measured using a digital thermometer.

Participants were then provided with a pen and six sheets of paper to keep on their lap. Each sheet of paper had a pain sensation visual analogue scale on one side and a pain affect visual analogue scale on the other. The task procedure was then explained to the participants, including the difference between pain sensation and pain affect using the standardised instructions (see Appendix N, from Price, et al., 1983). The investigator was in the testing room behind the participant for the duration of the task.
When the task began, participants placed their nondominant hand in the water, wrist deep, fingers outstretched, palm down, and not touching the container. As soon as their hand entered the water they rated their pain sensation and pain affect with their dominant hand (also turning sheet over with dominant hand) then placed that sheet of paper on the ground. They kept their nondominant hand in the cold water for one minute or until they felt that it was unbearable. Between the first rating and removal of their hand from the water they looked at a visual stimulus presented on the projector. When they removed their hand from the water they placed it on the hand towel and immediately completed another rating of pain sensation and pain affect and placed that sheet of paper on the ground. Every 30s after this, for two minutes, participants were prompted to rate their pain sensation and pain affect. Between each rating participants looked at the visual stimulus presented on the projector. A visual depiction of the Study 3 protocol is displayed in Figure 25.

The visual stimulus was constant during the task for each participant but differed between the four groups. In the up/visual group a photograph of a person looking up was displayed in the centre of the projection, which did not require any movement of the head to see it. In the down/visual group a photograph of a person looking down was displayed in the centre of the projection, which did not require any movement of the head to see it. In the up/visual + motor group a photograph of a person looking up was displayed at the top of the projection, which required a tilt of the head upwards to see it. In the down/visual + motor group a photograph of a person looking down was displayed at the bottom of the projection, which required a tilt of the head downwards to see it. The gender of the person in the photograph matched the gender of the participant.
5.5 Methodological Considerations

5.5.1 Cold pressor task as an acute pain induction technique. The cold pressor task is an experimental acute pain induction technique with excellent reliability and validity (Edens & Gil, 1995). It involves placing the forearm/hand in cold water causing localised cold pain which dissipates quickly after withdrawal (Mitchell, MacDonald, & Brodie, 2004; Von Baeyer, Piira, Chambers, Trapanotto, & Zeltzer, 2005). Although the cold pressor task induces only acute pain, it is suggested to be a method that mimics the effects of chronic conditions effectively because of its unpleasantness (Rainville, Feine, Bushnell, & Duncan, 1992). It is commonly utilised in the measurement of pain tolerance in studies examining the effect of analgesics or

![Diagram of the Study 3 protocol](image-url)

*Figure 25. Diagrammatic representation of the Study 3 protocol.*
cardiovascular response to pain (Compton, Charuvastra, & Ling, 2003; Mitchell, et al., 2004). However, the technique has also been utilised in the measurement of recovery from pain, or healing (Burns, et al., 2010; Feldner, et al., 2006; Uman, Stewart, Watt, & Johnston, 2006). Study 3 utilised the cold pressor task in the measurement of recovery from pain, or healing. In order to obtain the most accurate measure of healing a number design decisions were made and a number of possible confounding factors were matched between groups.

Three design decisions made before implementing the task were related to: water temperature, depth of immersion, and time of immersion. Firstly, water temperature in cold pressor task studies generally vary between 0°C and 7°C and it has been found that variations of more than 2°C can cause significant changes in pain responses (Mitchell, et al., 2004). Thus, water temperature was dynamically measured using a digital thermometer prior to the Study 3 cold pressor task.

Secondly, in relation to depth of immersion, it has been found that exposure of the hand to cold results in equal pain intensity as exposure of the forearm (Nielsen-Joseph, Tsao, Joseph & Zeltzer, 2001 as cited in Von Baeyer, et al., 2005). Thus, studies have used both immersions of the hand and forearm in the cold pressor task but due to its methodological ease, immersion of the hand is the recommended practice and was utilised in Study 3 (Von Baeyer, et al., 2005).

Finally, since most studies which utilise the cold pressor task have examined pain tolerance, time of immersion is usually “until unbearable” with a ceiling of five minutes (Mitchell, et al., 2004). It has been found that the mean immersion time at 7°C is approximately 140s for males and 60s for females (Mitchell, et al., 2004). Since Study 3 measured pain recovery rather than tolerance, it was important that participants took their hand out of the water at a specified time, however due to ethical considerations participants were allowed to remove their hand from the water before the pain became unbearable.

A number of possible confounding factors were matched between groups for Study 3 including: gender, mood/affect, pain coping style, and previous pain experiences. Firstly, it has been found that males have longer pain tolerance times than females and that these tolerance times decrease with age to a greater degree in males than in females (Walsh, Schoenfeld, Ramamurthy, & Hoffman, 1989). Secondly, depressed mood or state negative affect has also been found to result in decreased pain tolerance times in studies which have utilised the cold pressor task (Willoughby, Hailey,
Mulkana, & Rowe, 2002; Zelman, Howland, Nichols, & Cleeland, 1991). Thirdly, a number of studies have also shown that pain coping style may influence both pain sensation and pain affect ratings on the cold pressor task (Keogh, Bond, Hanmer, & Tilston, 2005; Keogh & Herdenfeldt, 2002). Finally, although unmeasured in relation to the cold pressor task, previous experiences with pain have been suggested as a possible psychological variable which may influence the pain response (Von Baeyer, et al., 2005).

15.5.2 Measurement of pain. Pain was traditionally conceptualised as a unidimensional physiological phenomenon arising from the stimulation of pain receptors and proportional to the number of receptors stimulated (Hirsch & Liebert, 1998). However, Melzack and Wall’s (1965) influential paper changed this view of pain by augmenting the sensory/physiological dimension with an affective dimension. Properties of pain such as its quality and intensity constitute the sensory dimension while the affective dimension reflects the emotional reaction to the pain experience, or its unpleasantness (Hirsch & Liebert, 1998). Thus, pain is now considered a complex multidimensional phenomenon with sensory/physiological and affective dimensions (Hirsch & Liebert, 1998; Price, et al., 1987).

Although pain sensation and pain affect are highly correlated, it has been argued that they must be assessed separately because pain affect is influenced by contextual and psychological factors outside the domain of sensory experience (Hirsch & Liebert, 1998). This is exemplified by the finding that the sensory dimension of pain associated with childbirth is even greater than that of chronic back or cancer pain; yet the affective unpleasantness of labour pain is only a small fraction of that reported in most chronic pain conditions (Price, et al., 1987). The authors also found that although prepared childbirth training and focused attention substantially reduce the unpleasantness of labour pain, these treatments do little to reduce its intensity. The measurement of sensory and affective dimensions of pain was particularly important to Study 3 since it has been found that cold pressor task-induced pain evokes higher ratings of pain affect compared to pain sensation (Hirsch & Liebert, 1998; Rainville, et al., 1992).

15.5.3 Method of data reduction. To the best of the author’s knowledge, the method of using principal components analysis to reduce a set of highly correlated responses to the same scale over a series of time-points has not been performed before

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60 Pain experience was not matched between the groups but examined as an individual differences factor.
in psychological research. However, principal components analysis is commonly utilised in the signal processing literature to reduce signals which have a recurrent nature, such as the electrocardiogram signal. In applications such as these, principal components analysis is performed on a set of time-sampled electrocardiogram traces with the aim to reduce the correlated electrocardiogram signals into one electrocardiogram signal which describes the data accurately (Castells, Laguna, Sörnmo, Bollmann, & Roig, 2007; Pinheiro, Postolache, & Girão, 2012). The same theoretical logic was used for the data reduction in Study 3 in which the aim was to reduce a set of highly correlated measures of the same construct over time to one measure of the construct which describes the data accurately.

15.6 Data Analytic Approach

15.6.1 Analysis of differences between time-points in pain sensation and pain affect. Prior to any data screening or analyses being conducted, all participants’ pain sensation ratings at the time of withdrawal of hand from water were examined. Since the Study 3 design required that there be adequate room for healing, any participants who had less than moderate pain sensation at the time of withdrawal from hand from water were excluded. As suggested by Collins, Moore, and McQuay (1997) moderate pain was deemed to be a score of 30mm or more on the pain sensation visual analogue scale. Exclusions were not made from the pain affect analyses since the literature on pain affect recovery is too limited to set useful thresholds.

Two single factor (Time-point) within subjects ANOVAs were conducted for pain sensation and pain affect to determine the validity of the data and to determine whether a time-point could be dropped from the analysis due to a lack of change in pain sensation or pain affect from the previous time-point.

15.6.2 Generation of healing sensation and healing affect time-points. Prior to running the principal components analysis, the five pain sensation and five pain affect time-point variables were converted into healing sensation and healing affect variables. In order to do this, the differences between the 30s, 60s, 90s, and 120s time-points and withdrawal of hand from water were calculated for pain sensation and pain affect. It was deemed more appropriate to calculate the difference between withdrawal of hand from water and each time-point than between the time points (i.e., 30s to 60s, 60s to 90s, and 90s to 120s) since the primary aim was to gauge healing after withdrawal of hand from water, rather than between specific time-points. This left eight variables which
described the amount of healing from withdrawal of hand from water to each time-
point. The four healing sensation variables were: $P_{\text{Swithdrawal to 30s}}$, $P_{\text{Swithdrawal to 60s}}$, $P_{\text{Swithdrawal to 90s}}$, and $P_{\text{Swithdrawal to 120s}}$ and the four healing affect
variables were $P_{\text{Awithdrawal to 30s}}$, $P_{\text{Awithdrawal to 60s}}$, $P_{\text{Awithdrawal to 90s}}$, and $P_{\text{Awithdrawal to 120s}}$.

Principal components analysis was chosen in favour of other factor analyses
extraction methods such as maximum likelihood or principal axis factoring due to two
major reasons: firstly, since the aim was to reduce variables based on empirical
association rather than the assessment and analysis of underlying constructs
(Tabachnick & Fidell, 2007) and secondly, because the signal processing applications in
which the current data reduction method has been employed have most frequently
utilised principal components analysis. Furthermore, rotation type was not considered
important since the aim was to reduce the healing sensation variables into one
component and the healing affect variables into one component. However, if two
components were to emerge from the analysis, it was expected that they would be
highly correlated, thus an oblique rotation was utilised (Tabachnick & Fidell, 2007).

As recommended by Tabachnick and Fidell (2007), the number of factors to
extract was determined by comparison of results from four methods: the Minimum
Average Partial test (Velicer, 1976), parallel analysis (Horn, 1965), inspection of the
scree plot, and the Kaiser-Guttman criterion.

Thus, the component scores from the healing sensation principal components
analysis, with a constant$^{61}$ added to make all the scores positive, were used to form the
healing sensation dependent variable. Similarly, the component scores from the healing
affect principal components analysis, with a constant$^{62}$ added to make all the scores
positive, were used to form the healing affect dependent variable.

15.6.3 Data screen method.

15.6.3.1 Analysis of differences between time-points in pain sensation and
pain affect. Prior to conducting the within subjects ANOVAs, a data screen was
performed on pain sensation and pain affect variables at each time-point. The data
screen began with a screening for univariate outliers in each of the 10 time-point
variables using the $z$-score range, as described in Section 9.6.3 (p. 104).

$^{61}$ 2, as lowest negative value was -1.85.
$^{62}$ 2, as lowest negative value was -1.76.
A number of single factor within subjects ANOVA assumptions were then tested prior to the analyses for each of the time-point variables including; normality, linearity, and sphericity as described in Section 9.6.3 (p. 104).

15.6.3.2 Generation of healing sensation and healing affect time-points. Prior to conducting the principal components analysis, a data screen was performed on healing sensation and healing affect variables. The data screen began with a screening for univariate outliers in the healing sensation and healing affect variables using the z-score range, as described in Section 9.6.3 (p. 104). Following this, the grouped data was then screened for multivariate outliers. Multivariate outliers are considered as cases with an unusual group of scores (Tabachnick & Fidell, 2007). Tabachnick and Fidell (2007) suggest calculating Mahalonobis distance for each between subjects group to detect multivariate outliers. Mahalonobis distance values are considered significant at the \( p < .001 \) critical value. The \( p < .001 \) critical value for four variables (healing sensation: \( PS_{\text{withdrawal to } 30s} \), \( PS_{\text{withdrawal to } 60s} \), \( PS_{\text{withdrawal to } 90s} \), and \( PS_{\text{withdrawal to } 120s} \); and healing affect: \( PA_{\text{withdrawal to } 30s} \), \( PA_{\text{withdrawal to } 60s} \), \( PA_{\text{withdrawal to } 90s} \), and \( PA_{\text{withdrawal to } 120s} \)) is 18.467.

A number of other assumptions were then tested prior to the analyses for each of the healing sensation and healing affect variables, including normality and linearity (as described in Section 9.6.3, p. 104). Additionally, principal components analysis requires variables to be linearly correlated with each other, which was tested using Bartlett’s test of sphericity which examines the null hypothesis that there are no correlations amongst the variables and Kaiser-Meyer-Olkin measure of sampling adequacy, which must be > 0.50 (Kaiser, 1974).

15.6.3.3 Hypothesis testing. Prior to conducting the between subjects ANOVAs, a data screen was performed on healing sensation and healing affect variables between the \( up/\text{visual} \), \( up/\text{visual} + \text{motor} \), \( down/\text{visual} \), and \( down/\text{visual} + \text{motor} \) groups. The grouped data screen began with a screening for univariate outliers in healing sensation and healing affect between the four groups using the z-score range, as described in Section 9.6.3 (p. 104). A number of between subjects ANOVA assumptions were then tested prior to the analyses for healing sensation and healing affect, including: normality, linearity, and homogeneity of variance (see Section 9.6.3, p. 104)
16. Results of Study 3

This chapter details the generation of the dependent variables for Study 3, followed analyses for hypotheses 5 and 6 of Study 3, respectively (see Section 8.3, p. 96 for hypotheses).

16.1 Generation of Dependent Variables

16.1.1 Analysis of differences between time-points in pain sensation and pain affect. According to the criterion outlined in Section 15.6.1 (p. 164), four participants were deemed to have had less than moderate pain at the time of withdrawal of hand from water and were thus excluded from all of the pain sensation analyses.

Two single factor (Time-point) within subjects ANOVAs were conducted for pain sensation and pain affect to examine whether there was an overall decrease in pain over the time-points and whether there were significant differences between each of the time-points (withdrawal of hand from water, 30s, 60s, 90s, and 120s).

16.1.1.1 Data Screen. According to the method described in Section 15.6.3.1 (p. 165), three values were found to be univariate outliers. The values came from the pain sensation 120s and the pain affect 90s and 120s and originated from different participants. Each value was replaced by the group mean for the respective variables.

According to the method described in Section 15.6.3.1 (p. 165) the pain sensation 90s and 120s as well as the pain affect 60s, 90s, and 120s were considered to be significantly positively skewed. Due to this non-normality in the data it was deemed appropriate to run a Friedman Test in place of the within subjects ANOVA.

16.1.1.2 Analysis. Pain Sensation. The analysis revealed a significant main effect of time-point ($\chi^2 (4) = 195.98, p < .001$). Post-hoc analysis with Wilcoxon signed-rank tests revealed significant differences between each of the time-points, as displayed in Table 10 and Figure 26, along with their means and standard deviations.
Table 10
Pain sensation means, standard deviations, and Wilcoxon signed-rank test statistics for each time-point

<table>
<thead>
<tr>
<th>Time-point</th>
<th>N</th>
<th>Mean (SD)</th>
<th>Median (IQR)</th>
<th>Z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withdrawal</td>
<td>56</td>
<td>70.50 (18.03)</td>
<td>73.50 (56.00 to 85.00)</td>
<td>-6.43</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>30s</td>
<td>56</td>
<td>35.88 (21.22)</td>
<td>33.50 (18.00 to 55.50)</td>
<td>-5.87</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>60s</td>
<td>56</td>
<td>21.79 (17.63)</td>
<td>18.50 (6.000 to 36.25)</td>
<td>-4.73</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>90s</td>
<td>56</td>
<td>13.75 (15.27)</td>
<td>5.50 (2.00 to 22.20)</td>
<td>-5.23</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>120s</td>
<td>56</td>
<td>7.07 (8.47)</td>
<td>4.50 (1.25 to 8.75)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note - Wilcoxon signed rank test statistics are for difference between time-point and subsequent time-point
- A Bonferroni correction was applied, resulting in a significance level set at $p = .0125$,
- Means and standard deviations in mm

Pain Affect. The analysis revealed a significant main effect of time-point ($\chi^2 (4) = 187.67, p < .001$). Post-hoc analysis with Wilcoxon signed-rank tests revealed significant differences between each of the time-points, as displayed in Table 11 and Figure 26, along with their means and standard deviations.
Table 11
Pain affect means, standard deviations, and Wilcoxon signed-rank test statistics for each time-point

<table>
<thead>
<tr>
<th>Time-point</th>
<th>N</th>
<th>Mean (SD)</th>
<th>Median (IQR)</th>
<th>Z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withdrawal</td>
<td>60</td>
<td>52.87 (27.32)</td>
<td>52.00 (34.00 to 75.75)</td>
<td>-6.61</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>30s</td>
<td>60</td>
<td>24.83 (23.19)</td>
<td>18.00 (5.25 to 43.75)</td>
<td>-5.62</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>60s</td>
<td>60</td>
<td>14.05 (15.37)</td>
<td>8.00 (2.25 to 23.75)</td>
<td>-4.69</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>90s</td>
<td>60</td>
<td>8.60 (11.21)</td>
<td>3.00 (1.00 to 13.00)</td>
<td>-4.74</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>120s</td>
<td>60</td>
<td>3.65 (5.39)</td>
<td>2.00 (0.00 to 5.00)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note - Wilcoxon signed rank test statistics are for difference between time-point and subsequent time-point
- A Bonferroni correction was applied, resulting in a significance level set at $p = .0125$,
- Means and standard deviations in mm

Figure 26. Differences in pain sensation and pain affect between time-points. Error bars represent one standard error.

The initial analyses revealed that there were decreases in both pain sensation and pain affect over the time-points, thus suggesting that all time-points should be used in the data reduction.

16.1.2 Generation of healing sensation and healing affect time-points. The 10 pain sensation and pain affect time-point variables were converted into healing sensation and healing affect variables according to the method described in Section
15.6.2 (p. 164). Inspection of the data for these eight variables revealed 10 cases with negative values ranging between -10 and -30 indicating increased pain sensation/affect rather than healing over time-points. As these values did not fit the trend over time for each of the participants from which the values originated, it was deemed that they were most likely indicative of no change in pain sensation/affect rather than increases in pain sensation/affect. Therefore these 10 values were replaced with the value 0, indicating no change in pain sensation/affect.

16.1.2.1 Data Screen. According to the method described in Section 15.6.3.2 (p. 166), there were no univariate or multivariate outliers found. All of the variables were normal and linear. There were significant intercorrelations between the variables according to Bartlett’s test of sphericity (healing sensation ($\chi^2(6) = 238.42, p < .001$) and healing affect ($\chi^2(6) = 312.95, p < .001$)) and the Kaiser-Meyer-Olkin measure of sampling adequacy (0.75 for healing sensation and 0.77 for healing affect).

16.1.2.2 Principal components analysis.

Healing sensation. Principal components analysis with an oblique rotation was performed on the four healing sensation variables ($PS_{withdrawal \ to \ 30s}$, $PS_{withdrawal \ to \ 60s}$, $PS_{withdrawal \ to \ 90s}$, and $PS_{withdrawal \ to \ 120s}$) for the final sample of 56 participants.

Four components were extracted, however according to all four methods described in Section 15.6.2 (p. 164), only one component was retained (see Appendix O). Loadings of variables on the component, communalities, and Eigenvalues are shown in Table 12. The communality values indicate that all variables loaded well on the single component. The single healing sensation component accounted for 84.1% of the total available variance. As the principle components extraction produced a single component, the oblique rotation employed was not applicable.

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63 2 from $PS_{withdrawal \ to \ 30s}$, 4 from $PA_{withdrawal \ to \ 30}$, 3 from $PA_{withdrawal \ to \ 60}$ and 1 from $PA_{withdrawal \ to \ 120}$. 
Table 12  
*Component loadings, communalities, and Eigenvalues for principal components analysis of the four healing sensation variables*

<table>
<thead>
<tr>
<th>Items</th>
<th>Component loadings</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSwithdrawal to 30s</td>
<td>.85</td>
<td>.72</td>
</tr>
<tr>
<td>PSwithdrawal to 60s</td>
<td>.96</td>
<td>.93</td>
</tr>
<tr>
<td>PSwithdrawal to 90s</td>
<td>.94</td>
<td>.88</td>
</tr>
<tr>
<td>PSwithdrawal to 120s</td>
<td>.92</td>
<td>.84</td>
</tr>
<tr>
<td><strong>Eigenvalue</strong></td>
<td></td>
<td><strong>3.36</strong></td>
</tr>
</tbody>
</table>

*Healing affect.* Principal components analysis with an oblique rotation was performed on the four healing affect variables (*PAwithdrawal to 30s, PAwithdrawal to 60s, PAwithdrawal to 90s, and PAwithdrawal to 120s*) for the final sample of 60 participants.

Four components were extracted, however according to all four methods described in Section 15.6.2 (p. 164), only one component was retained (see Appendix P). Loadings of variables on the component, communalities, and Eigenvalues are shown in Table 13. The communality values indicate that all variables loaded well on the single component. The single healing sensation component accounted for 86.6% of the total available variance. As the principal components extraction produced a single component, the oblique rotation employed was not applicable.
Table 13  
Component loadings, communalities, and Eigenvalues for principal components  
analysis of the four healing affect variables

<table>
<thead>
<tr>
<th>Items</th>
<th>Component loadings</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAwithdrawal to 30s</td>
<td>.83</td>
<td>.69</td>
</tr>
<tr>
<td>PAwithdrawal to 60s</td>
<td>.98</td>
<td>.95</td>
</tr>
<tr>
<td>PAwithdrawal to 90s</td>
<td>.97</td>
<td>.93</td>
</tr>
<tr>
<td>PAwithdrawal to 120s</td>
<td>.94</td>
<td>.88</td>
</tr>
<tr>
<td><strong>Eigenvalue</strong></td>
<td><strong>3.46</strong></td>
<td></td>
</tr>
</tbody>
</table>

The principal components analyses suggested that the four healing sensation variables could be reduced to one healing sensation component and that the four healing affect variables could be reduced to one healing affect component. These components were converted into positive values according to the method described in Section 15.6.2 (p. 164).

16.2 Analysis of Direction (H5a and H5b) and Interaction (H6a and H6b) Hypotheses

Two 2 (Direction) by 2 (Strength) between subjects ANOVAs (one for healing sensation and one for healing affect) were used to examine the direction (H5a and H5b) and interaction (H6a and H6b) hypotheses (see Section 8.4, p. 96 for description of hypotheses).

16.2.1 Data screen. According to the method described in Section 15.6.3.3 (p. 166), there were no univariate outliers found. Healing sensation and healing affect were normal and linear for all groups. The homogeneity of variance assumption was met for all groups.

16.2.2 Group differences in demographics. Pearson’s Chi Square indicated no significant differences in sex or primary language between the four groups and independent samples t-tests indicated no significant differences in age, affect, or pain coping style between the four groups (see Appendix Q).
16.2.3 Hypothesis Testing.

16.2.3.1 Healing sensation. Healing sensation means and standard deviations for the four groups are displayed in Table 14. Contrary to expectations, the analysis revealed no significant main effect of direction ($F(1,56) = .33, p = .57$). Furthermore, results also revealed a significant main effect for strength ($F(1,56) = 4.53, p < .05$, partial $\eta^2 = .08$) suggesting that healing sensation was significantly increased for the visual + motor groups compared to the visual groups.

Thus, the results were not consistent with the hypothesis that priming of the up bodily state would result in a more pronounced perception of physical healing compared to priming of the down bodily state (H5a).

Results also revealed a significant interaction between direction and strength ($F(1,56) = 4.18, p < .05$, partial $\eta^2 = .07$), as shown in Figure 27. Closer inspection of the interaction graph suggested that the direction effect was reversed for the two strength groups. The graph suggested that healing sensation was increased for the up/visual + motor group compared to down/visual + motor group but decreased for the up/visual group compared to down/visual group. Thus, results were not consistent with the interaction hypothesis for healing sensation (H6a).

A post hoc hypothesis was proposed which predicted that joint visual and motor priming of the up bodily state would result in a more pronounced increase in perceived healing sensation compared to joint visual and motor priming of the down bodily state (H5a’).
Table 14
Healing sensation means and standard deviations for up/visual, down/visual, up/visual + motor, and down/visual + motor groups

<table>
<thead>
<tr>
<th>Direction</th>
<th>Up Mean (SD)</th>
<th>Down Mean (SD)</th>
<th>Total Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>153.18 (121.77)</td>
<td>190.49 (103.51)</td>
<td>171.14 (112.78)</td>
</tr>
<tr>
<td>Visual + motor</td>
<td>258.85 (66.94)</td>
<td>192.60 (79.12)</td>
<td>226.87 (79.26)</td>
</tr>
<tr>
<td>Total</td>
<td>207.84 (109.60)</td>
<td>191.58 (89.87)</td>
<td></td>
</tr>
</tbody>
</table>

N = 56 (14 in up/visual group, 15 in up/visual + motor group, 13 in down/visual group and 14 in down/visual + motor group)

Note. Healing sensation measures in mm

Figure 27. Mean healing sensation for up/visual, up/visual + motor, down/visual, and down/visual + motor groups. Error bars represent one standard error.

16.2.3.2 Healing sensation: post hoc Hypothesis 5a’. A one-way ANOVA was conducted to test the hypothesis that joint visual and motor priming of the up bodily state would result in a more pronounced increase in perceived healing sensation compared to joint visual and motor priming of the down bodily state (H5a’).

Results revealed that, as predicted, healing sensation was significantly increased for the up/visual + motor group (M = 258.65, SD = 66.94) compared to down/visual + motor group (M = 192.60, SD = 79.12; F(1,27) = 5.95, p < .05).
16.2.3.3 Healing affect. Healing affect means and standard deviations for the four groups are displayed in Table 15. The analysis revealed no significant main effect of direction ($F(1,60) = 0.00, p = .99$) and no significant interaction between direction and strength ($F(1,60) = 0.22, p = .64$).

Thus, the results were not consistent with the hypothesis that priming of the up bodily state would result in a more pronounced perception of affect related to healing compared to priming of the down bodily state (H5b). Furthermore, results were not consistent with the interaction hypothesis for healing affect (H6b).

Table 15
Healing affect means and standard deviations for up/visual, down/visual, up/visual + motor, and down/visual + motor groups

<table>
<thead>
<tr>
<th>Direction</th>
<th>Strength</th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Up</td>
<td>Down</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td></td>
</tr>
<tr>
<td>Visual</td>
<td>190.62 (107.21)</td>
<td>178.12 (112.16)</td>
<td>184.37 (107.99)</td>
<td></td>
</tr>
<tr>
<td>Visual + motor</td>
<td>209.52 (85.45)</td>
<td>221.74 (97.76)</td>
<td>215.63 (90.43)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>200.07 (95.74)</td>
<td>199.93 (105.73)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N = 60 (15 in each direction/strength group)

Note. Healing affect measures in mm

16.3 Chapter Summary

Results of Study 3 suggested that priming of the up bodily state did not result in a more pronounced perception of (a) physical healing or (b) affect related to healing compared to priming of the down bodily state (H5). Furthermore, Study 3 results were not consistent with the predicted interaction between direction and strength for perception of physical healing (H6a) or affect related to healing (H6b).

However, results were consistent with the post hoc hypothesis that joint visual and motor priming of the up bodily state would result in a more pronounced increase in perceived healing sensation compared to joint visual and motor priming of the down bodily state (H5a').

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64 The analysis also revealed no significant main effect for strength ($F(1,60) = 1.43, p = .24$).
17. Discussion of Study 3

Study 3 was conducted as an empirical investigation of assumptions of Perceptual Symbol Systems theory in relation to the heal concept in an online condition. The first aim of Study 3 was to empirically investigate the putative embodiment of the heal concept in the up bodily state in an online condition. The second aim of Study 3 was to examine the influence of adding a motor prime to the visual prime in manipulating the strength of the putative simulation.

These aims, along with the Study 3 hypotheses, were derived explicitly from Perceptual Symbol Systems theory. Therefore, the Perceptual Symbol Systems theory interpretation will be privileged in the current discussion, although other interpretations will also be explored.

17.1 Perceptual Symbol Systems Theory Interpretation of Findings

17.1.1 Direction and interaction hypotheses (H5a, H5b, H6a, and H6b).

Study 3 findings were not consistent with the prediction that simulation of the up bodily state would result in a more pronounced perception of physical healing or affect related to healing compared to simulation of the down bodily state. Furthermore, findings were not consistent with the predicted interaction between direction and strength for perception of physical healing or affect related to healing.

Study 3 predictions were derived from the argument that the simulation of conceptual knowledge may be realised behaviourally (see Section 5.3.3, p. 71). Perceptual Symbol Systems theory implies that when the up bodily state embodiment is simulated in the context of healing, simulation of the heal concept is triggered via the inference process via pattern completion (Barsalou, 1999, 2003, 2005). This simulation of the heal concept was proposed to have the potential to be realised at the behavioural level (Barsalou, et al., 2003). This aspect of Perceptual Symbol Systems theory has not been well developed in the literature; however there are numerous studies which have suggested that this effect may occur (Bargh, et al., 1996; Hung & Labroo, 2011; Jostmann, et al., 2009; Oosterwijk, et al., 2009; Schubert & Koole, 2009; Wilkowski, et al., 2009, Study 4).

Thus, Study 3 findings were not consistent with the Perceptual Symbol Systems theory derived prediction that simulating the up bodily state embodiment would facilitate the perception of physical healing and/or affect related to healing. Furthermore, findings were not consistent with the predicted interaction between
direction and strength for perception of physical healing or affect related to healing. These findings could be explained by the nonoccurrence of simulation in the online condition or because simulation was not realised at the behavioural level. In the context of Study 2 findings, which suggested that simulation of the up bodily state embodiment triggered simulation of the heal concept, it seems more likely that the latter of these two is a more probable explanation for Study 3 findings from a Perceptual Symbol Systems perspective.

Studies which have examined behavioural realisation of putative simulations have focussed on the behavioural realisation of one embodiment of a putatively simulated concept revealing itself at the behavioural level, rather than the whole concept. For example, one study primed the elderly stereotype and found that this was correlated with a slower speed of walking to the door (Bargh, et al., 1996) and another study found a stooped posture when disappointment words were produced (Oosterwijk, et al., 2009). Alternatively, Study 3 predicted that the concept of heal in its entirety may be realised at the behavioural level, which extends the predictions derived from Perceptual Symbol Systems theory.

17.1.2 *Post hoc hypothesis (H5a’).* Study 3 findings supported the post hoc prediction that joint visual and motor priming of the up bodily state would result in a more pronounced perception of physical healing compared to joint visual and motor priming of the down bodily state. Interpreted according to Perceptual Symbol Systems theory, this finding suggests that joint visual and motor priming triggered simulation of the up bodily state embodiment which triggered simulation of the heal concept, which was realised behaviourally, as indicated by an enhanced perception of physical healing.

Considered in light of the direction and interaction hypotheses (H5a, H5b, H6a, and H6b) the post hoc finding suggests that either the triggering of simulation via visual priming in isolation is not effective in an online condition, since simulation of the up bodily state embodiment via visual priming in isolation did not result in an enhanced perception of healing; or visual priming augmented by motor priming of the up bodily state embodiment allowed for the simulated heal concept to be realised at the behavioural level. Although the former is possible, the latter seems more probable since a similar manipulation was interpreted as having triggered simulation in Study 2 (see

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65 This study did not make their predictions or interpret their findings according to Perceptual Symbol Systems theory; instead it was underpinned by the theory of “ideomotor action”, which is akin to the predictions made by this aspect of Perceptual Symbol Systems theory.
Section 14.1.1, p. 145). Thus, according to Perceptual Symbol Systems theory there are three possible explanations for the latter interpretation of this finding.

Firstly, the qualitative difference between the offline cognitive task of Study 2 and the online cognitive task of Study 3 may offer some insight into the aforementioned finding. The major qualitative difference between offline and online tasks is the type of information available to the participant (Barsalou, 1999; Wilson, 2002). In an offline condition there is little conceptual bottom-up information to consider since the concept is not present, thus it is implied that participants rely primarily on simulation for conceptual knowledge, which is a top-down process (Barsalou, 1999; Wilson, 2002). This may have been the case in Study 2 in which simulation of heal was required to assess whether or not the target word was related to the heal concept.

On the other hand, since the concept is present in the online condition, it provides a considerable amount of conceptual bottom-up information which may compliment top-down processing (Niedenthal, et al., 2005; Wilson, 2002). This may have been the case in Study 3, in which bottom-up healing was occurring dynamically at the same time as top-down simulation of the heal concept. Perceptual Symbol Systems theory proposes that when bottom-up and top-down information are compatible, top-down information is used in a complimentary fashion in support of bottom-up information (see Section 5.1.5, p. 62; Barsalou, 1999). In Study 3, visually triggered simulation may not have been strong enough on its own to influence facilitation of processing related to the heal concept in the face of strong bottom-up healing. However, the stronger top-down effect caused by additional motor priming of the up bodily state may have allowed for the facilitation of bottom-up healing.

Secondly, the relationship between the type of embodiment examined and the type of prime may offer an explanation for the findings. It is proposed that the up bodily state is a motor embodiment derived from enactment of the up bodily state during online experiences of being healed. Thus, in an online condition it may be that a trigger of the original modality which formed the embodiment (i.e., enactment of the up bodily state) is required in addition to the visual prime (i.e., visual perception of person looking up) to trigger the simulation. It is also possible that motor priming of the up bodily state may have been enough in isolation to trigger simulation of the heal concept, although the design of Study 3 did not allow for examination of this distinction (see Section 17.3,

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66 It is important to note that this information is generally processed nonconsciously by the participant (Barsalou, 1999).
p. 184 for this design limitation). The correspondence between simulation trigger type and modality of embodiment is not proposed by Perceptual Symbol Systems theory, but online cognitive tasks often utilise the original modality of the embodiment as the simulation trigger (Jostmann, et al., 2009; Schubert, 2004; Schubert & Koole, 2009; G. L. Wells & Petty, 1980).

The final possible explanation regarding Study 3 findings is that conceptual processing in an online condition may not require simulation. Since online cognition tasks are not representation-hungry problems, it may be that they do not require representation (A. Clark & Toribio, 1994). The effect of motor priming in facilitating simulation, as interpreted according to Perceptual Symbol Systems theory, could be attributed to dynamical systems. This will be the focus of the next section. However, before that, the difference in findings for healing sensation compared to healing affect will be discussed.

17.1.3 Post hoc finding for healing sensation but not affect. The finding that joint visual and motor priming of the up bodily state resulted in a more pronounced perception of physical healing but not affect related to healing compared to joint visual and motor priming of the down bodily state suggests that, according to Perceptual Symbol Systems theory, simulation of the heal concept triggered via joint visual and motor priming of the up bodily state influences physical perception of healing but not affect related to healing.

Although physiological measures were not collected, the healing sensation measure is theoretically underpinned by perceived physical pain (e.g., negative end of scale was no sensation which is akin to a description of physiological pain), while the pain affect measure is underpinned by feelings and emotions about the pain (e.g., negative end of scale was not bad at all which is a description of a feeling; Hirsch & Liebert, 1998; Melzack & Wall, 1965). Thus, the finding seems counter intuitive since Perceptual Symbol Systems theory implies that it is more likely that psychological aspects (e.g., emotional introspections) of the abstract concept heal would be behaviourally realised rather than physiological aspects (Barsalou, 1999; Barsalou, et al., 2003).

This finding may be due to participants being more “in-tune” with the intensity of the physical pain compared to their emotions about the pain. However, it may also indicate the putative nonconscious nature of how simulation of the heal concept influences perceived healing. According to a Perceptual Symbol Systems theory
interpretation, the finding may suggest that the influence of simulation is below the conscious awareness of perceived emotion and may be working at a subconsciously perceived, neural level. Since grounded cognition is proposed to operate at the modal level, activation of the heal concept may have had a neural effect in increasing healing, akin to some perspectives on the placebo effect (Benedetti, Carlino, & Pollo, 2011; Wager, 2005). Consequently, this neural effect may have presented as a perceived increase in physical healing but not an increase at the level of affect related to healing. This speculative interpretation will remain conjecture until further research can shed light on this aspect of the findings.

17.2 Alternative Interpretations

Since Study 3 findings were not consistent with a Perceptual Symbol Systems theory account of conceptual processing in an online condition it is especially important to consider alternate theories which may better explain the findings. However, the following interpretations are provisional, since Study 3 hypotheses were derived explicitly from Perceptual Symbol Systems theory.

17.2.1 Amodal account. The finding that priming the up bodily state did not result in a more pronounced perception of physical healing or affect related to healing compared to priming of the down bodily state may suggest that conceptual processing in an online condition is amodally, rather than modally governed. These negative findings may have been due to amodal symbols being manipulated in online conceptual processing rather than the simulation of modal representations. However, the post hoc finding that joint visual and motor priming of the up bodily state resulted in a more pronounced perception of physical healing compared to joint visual and motor priming of the down bodily state is not consistent with an amodal account.

As implied by amodal accounts derived from connectionism, the heal concept may have been activated via its link to the up symbol (see Section 5.3.2, p. 70). However, amodal accounts cannot explain the pronounced perception of physical healing since it is argued that their neural architectures imply that perceptual and motor features of the concept are stripped during the putative process of transduction (Prinz & Clark, 2004). Consequently, there is no explanation for the behavioural realisation of activated concepts underpinned by amodal symbols.

Overall, Study 3 findings were not consistent with either Perceptual Symbol Systems theory or an amodal account. However, the finding that joint visual and motor
priming of the up bodily state resulted in a more pronounced perception of physical healing compared to joint visual and motor priming of the down bodily state could be interpreted as being more consistent with one of the accounts than the other if the question of whether the outcome was caused by motor priming in isolation or by joint visual and motor priming was illuminated. If it was caused by motor priming in isolation, Perceptual Symbol Systems theory could claim that simulation was triggered by the motor prime (since simulation can be triggered by any modal state). Similarly, amodal accounts could claim that the up bodily state motor prime may have triggered the up node and activated the heal concept via connectionist links (A. M. Collins & Loftus, 1975; McClelland & Rumelhart, 1986). Thus, if the effect was caused by the motor prime in isolation, both interpretations are equally likely.

However, if the effect was caused by joint visual and motor priming of the up bodily state, a Perceptual Symbol Systems theory account would be more consistent with the findings than an amodal account. An amodal interpretation would not be consistent with augmentation of an activated concept via joint priming from two separate modalities since they posit that concepts are stripped of their perceptual and motor features. Thus, a visual or motor trigger of the up bodily state would result in the same transduced, amodal up component which triggers the up node whether they occur together or in isolation. In comparison, since grounded cognition accounts such as Perceptual Symbol Systems theory do not posit transduction of perceptual states, and visual and motor triggered activation of a concept are implied to use the same neural substrate, a congruent visual perception and motor movement should augment conceptual processing (see Section 5.3.2, p. 70; Barsalou, 1999; Gallese & Lakoff, 2005; Simmons & Barsalou, 2003).

Since the post hoc finding did not shed light on this distinction, it was interpreted as ambiguous in relation to both Perceptual Symbol Systems theory and amodal accounts, whereas the negative direction (H5a and H5b) and interaction (H6a and H6b) findings of Study 3 were considered inconsistent with both Perceptual Symbol Systems theory and amodal accounts of online conceptual processing.

**17.2.2 Dynamical systems account.** Interpretation of Study 3 findings from a dynamical systems perspective requires a radically different conceptualisation of the relationship between mind, body, and world and thus also between the up bodily state and the heal concept (L. B. Smith, 2005). Dynamical systems accounts conceptualise the mind, body, and world as a single, coherent, continuously functioning, coupled
system which can be defined mathematically and cognition as directly constitutive of the interaction between perception and action (Chemero, 2009; L. B. Smith & Gasser, 2005; Van Gelder, et al., 1998).

One of the major points of difference between dynamical systems and Perceptual Symbol Systems theory is the conceptualisation of cognition as directly constitutive of the interaction between perception and action. It is argued that the dynamical systems account’s definition of cognition as directly constitutive of the interaction between perception and action eliminates any need for representations, and consequently the neural notion of concepts as well (Chemero, 2009; L. B. Smith, 2005). For both amodal and modal accounts of conceptual knowledge, concepts provide stability in perception, cognition, and behaviour (Barsalou, 1999; L. B. Smith, 2005). Dynamical systems find stability in the self-organisation of the mind, body, world system in a particular context and time, and thus consider concepts only necessary for explanatory purposes rather than as neural structures (L. B. Smith, 2005). Since Study 3 was centred on the representation of the heal concept, it is now apparent why a reconceptualisation is required to interpret the findings from a dynamical systems perspective.

It is important to note there that the Study 3 post hoc finding can be tentatively reinterpreted according to a dynamical systems account due to difference in the relationship between the visual prime and the participant and the motor prime and the participant in Study 3. When presented with the visual prime the participant is passive, since they are only required to look at the photograph of the person looking up or down (bodily state); whereas the motor prime requires the participant to be active, in the sense that they are required to enact looking up or looking down (bodily state). Since dynamical systems do not posit representations, conceptual knowledge would not be triggered by passively viewing a photograph, as may be suggested by the Study 3 findings; however, in actively engaging in the world, dynamical systems suggest that the cognitive systems can be engaged, as may be suggested by the Study 3 post hoc finding (if it is the motor prime in isolation, rather than the combination of motor and visual primes which caused the Study 3 post hoc finding effect; Chemero, 2009; L. B. Smith, 2005; Van Gelder, et al., 1998).

Interpretation of the Study 3 post hoc finding via a dynamical system account can be paralleled with the dynamical systems reinterpretation of the object concept in the A-not-B error work (see p. 32 for details of Thelen, et al., 2001). Similar to Thelen
et al.’s (2001) interpretation of the object concept, a dynamical systems account would conceptualise the *heal* concept as a coupled and coherent process of online perceptions and actions (L. B. Smith, 2005). Akin to children in the A-not-B task habituating to their reaching locations from the (A) trials, the up bodily state can be considered a habituation to healing experiences. Thus, a basic, coherent, dynamic system for a healing experience can be considered the coupled process between the up bodily state and the environmental perception of healing (e.g., relief from the cold pressor task). Similar to changes in motor movement breaking down the coherent, coupled system and eliminating the A-not-B error in infants, changes in motor movements in a healing situation (e.g., enacting a down bodily state) may have broken down the coherency and coupling in the healing dynamic system, leading to a decreased experience of healing.

The Study 3 finding that joint visual *and* motor priming, rather than visual priming *in isolation* of the up bodily state facilitated the perception of physical healing compared to the down bodily state can be considered more consistent with a dynamical systems account than a modal or amodal account since as posited by a dynamical systems account, if representations do not exist, visually perceiving a person looking up or down would not trigger activation of conceptual knowledge, only changes in motor state would influence the *heal* system (Chemero, 2009; L. B. Smith, 2005; Van Gelder, et al., 1998). However, this speculative conclusion is expressed cautiously since it assumes that it was the motor prime in isolation, rather than the combination of motor and visual primes which caused the Study 3 post hoc finding effect and since the Study 3 hypotheses were derived explicitly from Perceptual Symbol Systems theory.

**17.2.3 Other accounts.** The finding that joint visual *and* motor priming of the up bodily state resulted in a more pronounced perception of physical healing compared to joint visual *and* motor priming of the down bodily state could also be explained by factors outside those stemming from the theories discussed above.

One of these alternative explanations is that physically tilting the head up directs *attention away* from the hand in acute pain which may have had a direct effect on reducing pain sensation; conversely physically tilting the head down, directs *attention to* the hand which may have had a direct effect on increasing pain sensation. Indeed, it has been found that averting attention from a hurting body part via physical manipulation away from the site of pain can be a successful strategy to reduce pain (Van Ryckeghem, Van Damme, Crombez, Eccleston, Verhoeven, & LeGrain, 2011).
The second of these alternative explanations is that physically tilting the head up may activate concepts such as pride or positive affect rather than heal which may have a direct effect on reducing pain sensation. Studies have found that head posture can manipulate feelings of pride and positive affect (Stepper & Strack, 1993) and it has also been found that pride and positive affect can influence the perception of pain (Burges, Seale, & Ostir, 2011). Thus, it follows that physically tilting the head up may have activated feelings of pride or positive affect, rather than healing, which may have consequently reduced the perception of pain in Study 3.

17.3 Limitations

Study 3 findings must be considered in the light of a number of limitations. Firstly, the Study 3 design did not allow for interpretation of whether the post hoc finding which suggested that joint visual and motor priming (as opposed to motor priming in isolation) of the up bodily state facilitated perception of physical healing compared to the down bodily state was attributable to motor movement priming the up bodily state in isolation or due to joint influence of visual and motor priming. The inclusion of a motor only group along with the visual and visual + motor groups present in Study 3 would shed light on this issue (see Section 14.3, p. 151).

A second limitation was the manner in which the visual analogue scale was completed by participants during the task. Participants were prompted by the investigator to complete a rating every 30s during the task and this movement involved a tilt of the head down (in order to look at the rating sheet). In a task which was underpinned by the theory that up and down bodily states influence pain/healing responses, these brief periods of looking down at the sheet during the crucial rating periods may have confounded the results, especially in light of the finding that motor movement may have had a decisive impact on the results.

A third limitation was the comparison of pain data between groups. Numerous studies and reviews of pain measurement have expressed difficulty in measuring pain not only for comparison between people, but within the same person at different times (Chapman, Casey, & Dubner, 1985; Kane, Bershadsky, Rockwood, Saleh, & Islam, 2005; Turk & Melzack, 2001). The visual analogue scale measure of pain has been found to be a reliable measure within subjects (Dixon & Bird, 1981; Sriwatanakul, Kelvie, & Lasagna, 1983; Yarnitsky, Sprecher, Zaslansky, & Hemli, 1996) but it has not been considered ideal for measuring differences across subjects or groups (Kane,
Bershadsky, Lin, Rockwood, & Wood, 2002; Kane, et al., 2005). Due to the subjective and multifaceted nature of pain, it is difficult for any measure to compare pain accurately between subjects (Kane, et al., 2005; Turk & Melzack, 2001). Thus, it would have been ideal if Study 3 measured both up and down conditions within subjects; however this was not plausible due to covert nature of the design.

A fourth limitation was the utilisation of the visual analogue scale as a measure of healing (or pain recovery). The common utilisation of the visual analogue scale is as a measure of pain threshold and pain severity and although a few studies have used the visual analogue scale in the assessment of recovery from pain, its reliability and validity in assessing this aspect of pain remains untested (Langley & Sheppeard, 1985; Morris, et al., 2007; Myles, Weitkamp, Jones, Melick, & Hensen, 2000). Thus, further studies are required to assess whether the Study 3 interpretation of the visual analogue scale data is valid.

The final limitation was that of water temperature control in the cold pressor task. Variations of more than 2°C have been found to cause significant changes in pain responses (Mitchell, et al., 2004). Study 3 controlled water temperature prior to task initiation; however, it is known that heat build up around the hand during the task can result in decreased perception of pain and Study 3 did not control for water temperature around the hand during the task (Von Baeyer, et al., 2005). Future studies should consider using a water circulation device to reduce differences in water temperature changes due to hand heat (Von Baeyer, et al., 2005).

### 17.4 Suggestions for Future Research

In addition to the testing of other embodiments of heal (e.g., “light”), the inclusion of a direction control group, the use of eye tracking equipment, inclusion of manipulation checks, and using incongruent priming paradigms outlined in Section 14.4 (p. 153), findings of Study 3 raised further questions and suggestions for future research.

Firstly, the post hoc finding that joint visual and motor priming of the up bodily state facilitated the perception of physical healing, but not affect related to healing, was unexpected but opens up possible methodological extensions for further exploration. The perception of physical healing, as measured by healing sensation on the visual analogue scale, is related to the more primal, physiological, and sensory dimensions of pain, as opposed to healing affect, which is related to the emotional dimension of pain.
(Hirsch & Liebert, 1998; Melzack & Wall, 1965). Thus, it would be interesting for future studies to assess if joint visual and motor priming of the up bodily state facilitates physiological healing in addition to perceived healing sensation. Measures of cold pain related physiological changes such as increased heart rate, respiratory rate, and blood pressure could be considered (Kalpakcioglu, Gokpinar, Khani, Gutenbrunner, & Fischer, 2008; Quartana, Bounds, Yoon, Goodin, & Burns, 2010; Tandon, Himani, & Singh, 1997).

Secondly, future studies can improve on the limitation related to the method of completing the visual analogue scale (see p. 184 for details of limitation) by programming the computer to display the visual analogue scale automatically at each rating time-point either at the top or bottom of the projector, thus allowing for rating whilst maintaining motor movement. This technique has two potential benefits: one being that the participant does not have to move their head for the entire task duration and the other being that there no longer needs to be an investigator present during the task. It is unlikely that the presence of the investigator caused a bias in the responses, since the aims of the study were not revealed. However, the presence of the investigator in the room during the task may have cased nervousness in some participants or may have at least been a minor distraction.

Thirdly, it would be interesting to examine whether joint visual and motor priming of the up bodily state also facilitates psychological healing. It was theorised that the up bodily state applies to both psychological and physical healing (see p. 84). Thus, on the basis of the Study 3 post hoc finding it may be that joint visual and motor priming of the up bodily state might also facilitate psychological healing. Furthermore, words utilised for Study 2 were derived from both physical and psychological healing, thus further suggesting that the up bodily state may also facilitate psychological healing.

Fourthly, since Study 3 findings were considered more consistent with a dynamical systems interpretation than modal or amodal interpretations, it would be interesting to apply a fully-fledged dynamical systems framework to healing. It is beyond the scope of this thesis to detail the technicalities of a dynamic system for healing. However, in conceptual terms, healing would be set in dynamic field, involving the coupled interaction between brain, body, and world forming a self-organised and coherent dynamic system which could be described in mathematical terms (L. B. Smith, 2005; Van Gelder, et al., 1998; Warren, 2006). Utilising the Study 3 variables, the dynamic field would involve the world, in the form of recovery from the cold pressor
task, the body, in the form of the habitually learnt up bodily state, and the brain, which provides the modality-based information to the body. These aspects would form the self-organising, coherent, dynamic system for healing and it would be hypothesised that the system could be broken down by altering either the brain, body (as in Study 3, via the down bodily state), or world. The mathematics underpinning dynamical systems has the potential to provide important and specific information about what conditions would be required to facilitate or interfere with healing.

Finally, the success of the cold pressor task in being able to elicit putatively embodied healing\(^67\) raises the possibility that similar “real world” online tasks could be utilised to assess other concepts. This relatively novel methodology which elicits embodied conceptual processes in the real world is not common in the literature (some examples are Friedman & Elliot, 2008; Riskind & Gotay, 1982). This type of methodology could be applied to other concepts such as anger, based on its relationship with heat (Wilkowski, et al., 2009). For example, investigators could control the physical temperature of the room and ask participants to assess their anger in relation to specific stimuli. It would be expected that anger rating would be higher in a hot room compared to a cold room. This type of study could be conducted for a number of different concepts and may extend the findings of previous research (Wilkowski, et al., 2009) by demonstrating that the embodied concept affects real world interaction as well as conceptual processing.

17.5 Implications

The novel data reduction technique utilised in Study 3 raises an important methodological implication for further research. The design of Study 3 required the production of numerous ratings of healing over time, originating from the same healing measure. Since these were within subject ratings, they were highly correlated and thus it was decided that an attempt would be made to reduce them to a single measure of healing\(^68\) for each participant. To the best of the author’s knowledge, this type of time-based data reduction has not been attempted before in psychological research. It was found that principal components analysis was commonly used in the signal processing literature to reduce signals which are recurrent in nature, such as the electrocardiogram signal (Castells, et al., 2007; Pinheiro, et al., 2012). Since the theoretical logic of

\(^{67}\) Albeit only in the visual + motor condition.

\(^{68}\) “Sensation” and “affect”.
reducing a set of correlated, time-sampled electrocardiogram traces into one electrocardiogram signal which describes the data accurately, parallels the logic of reducing multiple, correlated ratings of healing into one overall healing rating which describes the data accurately, principal components analysis was applied to the healing data. This type of efficient and accurate reduction of multiple correlated variables originating from the same measure would be an effective “noise-reduction” technique for any psychological study measuring an outcome variable across time.

The findings of Study 3 also culminate in a number of practical implications. Negative findings for direction (H5a and H5b) and the interaction between direction and strength (H6a and H6b) suggest that a Perceptual Symbol Systems theory account of healing may not be able to enhance understanding of the placebo effect by bridging the Cartesian divide. However, the post hoc finding that joint visual and motor priming of the up bodily state facilitated the perception of physical healing compared to joint visual and motor priming of the down bodily state imply a number of practical implications akin to the placebo effect.

Firstly, first-aid attendees who are commonly faced with people in physical pain may benefit from applying the post hoc findings of Study 3 to their profession ("St John Ambulance Australia," 2010). Performance criteria one and two of element two of the Australian government’s outcomes for first aid training involve calmly providing information to the casualty and using available resources to make the casualty feel as comfortable as possible (HLTFA301C Apply first aid, 2011). This is considered an important first step in treating the casualty and improving their perception of healing would be of benefit to both the attendee and the casualty. The post hoc finding of Study 3 implies that the up bodily state enactment may be an extra resource to make the casualty feel as comfortable as possible. Applying first-aid or comforting the casualty while they enact an up bodily state may facilitate their perceived healing. It is important to note that physical healing does not cease after contact with the first aid attendee. Thus, the casualty should be encouraged to maintain an up bodily state, especially when they are in high levels of physical pain or when they are feeling mentally “down” due to their pain.

Secondly, when extended to psychological healing, the post hoc finding of Study 3 suggests that therapy may be enhanced via enactment of the up bodily state. Psychological healing, via therapy, involves the interaction between a counsellor and the counselee in a therapeutic setting. Any possible enhancement to this therapeutic...
interaction would be beneficial to the well-being of the patient (Di Blasi, et al., 2001; Savage & Armstrong, 1990). A number of studies have examined the effect of physician posture on patient-physician interaction (Bruera, et al., 2007; Mitcham, 1989) but there have been no studies, to the best of the author’s knowledge, examining the effect of patient posture on health outcomes; however, motor manipulations have been proposed as treatments for depression (Teasdale, 1993). In line with this suggestion, the post hoc finding of Study 3 suggests that the patient or counselee enacting an up bodily state may facilitate perceived healing during the session. This postural manipulation can be applied by seating the counselee on a lower chair than the counsellor, thus covertly forcing the counselee to enact an up bodily state. This simple but important adjustment of posture may facilitate the therapeutic interaction and consequently the effectiveness of the therapy.

17.6 Chapter Summary

In summary, Study 3 findings suggested that priming the up bodily state did not facilitate the perception of healing compared to priming the down bodily state. Furthermore, Study 3 did not find the expected interaction between direction and strength. Thus, findings were not consistent with a Perceptual Symbol Systems theory account of online conceptual knowledge. However, a post hoc finding suggested that joint visual and motor priming of the up bodily state facilitated the perception of physical healing compared to joint visual and motor priming of the down bodily state. It was provisionally argued that this finding may be more consistent with a dynamical systems account than modal or amodal accounts of online conceptual processing.

Study 3 succeeded in its aims of empirically investigating the putative embodiment of the heal concept in the up bodily state in an online condition and examining the influence of adding a motor prime to the visual prime in manipulating the strength of the putative simulation. Finally, heal specific data drawn from Study 3 was used to discuss testable hypotheses and models about the types of systems used in conceptual knowledge for future research.

V. INDIVIDUAL DIFFERENCES INVESTIGATION

18. Individual Differences Aims and Hypotheses

The individual differences investigation of the present project aimed to offer a secondary, novel method of drawing inferences regarding the hypothesised simulation
process taking place in studies 2 and 3. The aim was to assess the extent to which three individual differences factors moderated the significant main effects identified in studies 2 and 3. However, of the various main effect predictions made for Study 2 and Study 3, only one (decreased response latencies in the up versus down conditions in the offline, Study 2 investigation; see Section 13.1, p. 142) was significant and consistent with Perceptual Symbol Systems theory.\(^{69}\) Therefore, the investigation of individual difference moderators of main effect manipulations across Study 2 and 3 focussed solely on this effect.

It was specifically hypothesised that:

- The difference in response latencies between the up and down conditions in the direction found in Study 2 would be augmented for those of a Western cultural background compared to those of an Eastern cultural background (H7a). Rationale: see Section 8.5 (p. 97).
- The difference in response latencies between the up and down conditions in the direction found in Study 2 would be augmented for those who have had more pain experiences compared to those who have had less pain experiences (H8a). Rationale: see Section 8.5 (p. 97).
- The difference in response latencies between the up and down conditions in the direction found in Study 2 would be augmented for those who have experienced a higher intensity of pain compared to those who have experienced a lower intensity of pain (H9a). Rationale: see Section 8.5 (p. 97).

19. Method for Individual Differences Investigation

19.1 Sample Demographics

The sample was the same one used for Study 2 (see Section 12.1, p. 130).

19.2 Operationalisation of Variables and Effects

19.2.1 Direction effect. Same as Study 2 (see Section 12.2.1, p. 130).

19.2.2 Cultural background/Frequency of pain experiences/Intensity of pain experiences effects. Cultural background/frequency of pain experiences/intensity of pain experiences were the between subjects variables in each of the analyses referring to

\(^{69}\) Since interpretation of the positive post hoc Study 3 finding was ambiguous in relation to Perceptual Symbol Systems theory it was not considered appropriate to draw inferences about it using individual differences factors.
the Western vs. Eastern, more vs. less, and high vs. low groups, respectively. The groups were operationalised according to scores on respective scales detailed in Section 19.3 (p. 191), and split according to method detailed in Section 19.5.1 (p. 192). The cultural background/frequency of pain experiences/intensity of pain experiences effects were operationalised as the difference in response latencies between the Western vs. Eastern, more vs. less, and high vs. low groups, respectively across direction conditions.

There was no hypothesised cultural background/frequency of pain experiences/intensity of pain experiences effects independent of the direction effect.

**19.2.3 Direction by Cultural background/Frequency of pain experiences/Intensity of pain experiences interaction effect.** The direction by cultural background/frequency of pain experiences/intensity of pain experiences interaction effects were operationalised as the differences in slopes between the Western and Eastern, more and less, and high and low groups, respectively for up and down conditions.

The predicted interaction effects would be observed if the difference in response latencies between the up and down conditions in the direction found in Study 2 are augmented for those of a Western cultural background/those who have had more pain experiences/those who have experienced a higher intensity of pain compared to those of an Eastern cultural background/those who have had less pain experiences/those who have experienced a lower intensity of pain, respectively.

**19.3 Materials**

Questionnaire was the same as was used for Study 2 (see Section 12.3.1, p. 131), with the addition of the Shortened Prior Pain Experience Questionnaire. The cultural background was assessed via a restricted choice question stated as “Cultural Background (note most influenced by): Western/Eastern/Both”.

**19.3.1 Shortened Prior Pain Experience Questionnaire.** The original 79-item Prior Pain Experience Questionnaire was developed by a group of pain researchers at the University of Florida as an assessment of an individual’s frequency of pain experiences and intensity of pain experiences (Stutts, McCulloch, Chung, & Robinson, 2009). Consistent with its theoretical development, it was found that the scale was best modelled as a single factor (Stutts, et al., 2009). There has been no reliability or validity information published for the Prior Pain Experience Questionnaire.

70 Only one selection can be made.
The Shortened Prior Pain Experience Questionnaire utilised for the present study consisted of 61-items. Eighteen items which were deemed by the investigator (and as aided by Stutts et al.’s (2009) analysis of most uncommon painful experiences) as extreme and uncommon (e.g., sexual abuse/assault, rape, gun shot, etc.) were removed from the Prior Pain Experience Questionnaire to form the Shortened Prior Pain Experience Questionnaire. These items were removed due to ethical concerns about the impact of asking such questions of participants.

All 61 items of the Shortened Prior Pain Experience Questionnaire were rated yes or no according to whether the participant had experienced the event or not, which provided a measure of frequency of pain experiences. Frequency of pain experiences scores for each participant ranged from 0-61. Participants then rated each event they had experienced on an 11-point scale ranging from 0 (No pain) to 10 (Worst pain possible) which provided a measure of intensity of pain experiences. Intensity of pain experiences rating scores for each participant ranged from 0-610. An example of an item from the Shortened Prior Pain Experience Questionnaire is: “Childbirth”.

19.4 Procedure and Apparatus

Procedure and apparatus was the same as for Study 2 (see Section 12.4, p. 134).

19.5 Data Analytic Approach

19.5.1 Generation of dichotomous individual differences variables. Those who responded “both” to the cultural background question\(^{71}\) were excluded from the cultural background analysis. Frequency of pain experiences and intensity of pain experiences variables were converted into dichotomous variables in order to explore extreme groups and to include them as between subjects factors in the analyses. Due to the absence of a well-defined cut-off score for the two variables, it was considered appropriate to use the 70\(^{th}\) percentile variable score as the cut-off point for the more/high groups and the 30\(^{th}\) percentile variable score as the cut-off for the less/low groups for each of the variables. The cut-off scores for each of the variables are displayed in Table 16.

\(^{71}\) Indicating that they were equally influenced by Western and Eastern cultures.
Table 16

Cut-off points for frequency of pain experiences and intensity of pain experiences

<table>
<thead>
<tr>
<th>Cut-off</th>
<th>Frequency of pain experiences</th>
<th>Intensity of pain experiences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less/low</td>
<td>34.00</td>
<td>2.71</td>
</tr>
<tr>
<td>More/high</td>
<td>42.70</td>
<td>4.01</td>
</tr>
</tbody>
</table>

19.5.2 Data screen method. Three 2 (Direction) by 2 (Cultural Background/Frequency of Pain Experiences/Intensity of Pain Experiences) mixed design ANOVAs were conducted. Prior to conducting the mixed ANOVAs examining the individual differences hypotheses, a data screen was performed on latency values to ensure reliability of grouped data and to ensure that all assumptions for a mixed ANOVA were met. The same grouped data used in Study 2 was used in the present analyses. The grouped data screen began with a screening for univariate outliers in the direction variables between the cultural background, frequency of pain experiences, and intensity of pain experiences groups, using the z-score range, as described in Section 9.6.3 (p. 104). A number of mixed ANOVA assumptions were then tested prior to the analyses for each of the three individual differences variables including: normality, linearity, sphericity, homogeneity of variance, and homogeneity of covariance matrices as described in Section 12.6.1 (p. 142).

20. Results of Individual Differences Investigation

This chapter details the analyses examining the cultural background (H7a), frequency of pain experiences (H8a), and intensity of pain experiences hypotheses (H9a), respectively (see Chapter 18, p. 189 for hypotheses).

20.1 Analysis of Cultural Background, Frequency of Pain Experiences, and Intensity of Pain Experiences Influence on Study 2 Main Effect (H7a, H8a and H9a)

Three 2 (Direction) by 2 (Cultural Background/Frequency of Pain Experiences/Intensity of Pain Experiences) mixed design ANOVAs were conducted.

20.1.1 Data screen. In accordance with Study 2, the participant who fell below the cut-off point of 70% correct answers was excluded from the analyses prior to the
data screen. Four participants who responded both to the cultural background question were excluded from the cultural background analysis.

According to the method described in Section 19.5.2 (p. 193) there was one univariate outlier. This participant was excluded from all of the analyses. Both of the direction variables for all individual differences groups were considered to be normal and linear. The sphericity assumption was automatically met for the current analysis since the within subject variable (direction) had only two levels (up and down). The homogeneity of variance assumption was met for all within subject conditions and the homogeneity of covariance matrices assumption was also met.

The final numbers of participants in each of the individual differences groups are displayed in Table 17.

<table>
<thead>
<tr>
<th>Table 17</th>
<th>Participants in the Western and Eastern groups for cultural background, the more and less groups for frequency of pain experiences, and the high and low groups for intensity of pain experiences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual differences group samples</td>
<td></td>
</tr>
<tr>
<td>Cultural background</td>
<td>Frequency of pain experiences</td>
</tr>
<tr>
<td>Western</td>
<td>Eastern</td>
</tr>
<tr>
<td>30</td>
<td>24</td>
</tr>
</tbody>
</table>

**20.1.2 Hypothesis Testing.**

**20.1.2.1 Cultural background.** Response latency means and standard deviations for up and down conditions for both cultural background groups are displayed in Table 18. The analysis revealed a trend towards an interaction between direction and cultural background \((F(1,52) = 0.57, p = .45, \text{partial } \eta^2 = 0.01)\) and a trend towards a main effect for cultural background \((F(1,52) = 0.68, p = .41)\). The significant main effect for direction from Study 2 remained \((F(1,52) = 8.40, p < .01, \text{partial } \eta^2 = 0.14)\).

Inspection of the interaction graph, displayed as Figure 28, demonstrates that as expected, the difference in response latencies between the up and down conditions in the direction found in Study 2 was augmented for Western cultural background \((\text{mean difference} = 61.60)\) compared to Eastern cultural background \((\text{mean difference} = 35.62)\), however these were only nonsignificant trends.
Furthermore, a nonsignificant trend towards shorter response latencies were found across direction for Western cultural background compared to Eastern cultural background.

Table 18
Response latency means and standard deviations for up and down conditions in Western and Eastern cultural background groups

<table>
<thead>
<tr>
<th>Cultural background</th>
<th>Up Mean (SD)</th>
<th>Down Mean (SD)</th>
<th>Total Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western</td>
<td>3122.15 (329.19)</td>
<td>3183.31 (394.34)</td>
<td>3152.29 (357.18)</td>
</tr>
<tr>
<td>Eastern</td>
<td>3210.59 (294.02)</td>
<td>3246.21 (322.04)</td>
<td>3228.71 (302.65)</td>
</tr>
<tr>
<td>Total</td>
<td>3161.46 (314.29)</td>
<td>3211.27 (362.06)</td>
<td></td>
</tr>
</tbody>
</table>

N = 55 (30 in Western group, 24 in Eastern group)

Figure 28. Mean response latency for up and down trials between cultural background groups. Error bars represent one standard error.

20.1.2.2 Frequency of pain experiences. Response latency means and standard deviations for up and down conditions in both pain experience groups are displayed in Table 19. The analysis revealed no interaction effect between direction and frequency of pain experience ($F(1,35) = 0.14$, $p = .72$). The significant main effect for direction from Study 2 remained ($F(1,35) = 7.17$, $p < .05$, partial $\eta^2 = 0.17$).
Contrary to expectations, there was no difference in response latencies in up and down conditions between more frequency of pain experiences and less frequency of pain experiences.

Table 19
Response latency means and standard deviations for up and down conditions in more and less frequency of pain experience groups

<table>
<thead>
<tr>
<th>Direction</th>
<th>Frequency of pain experiences</th>
<th>Up Mean (SD)</th>
<th>Down Mean (SD)</th>
<th>Total Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>More</td>
<td>3170.75 (339.72)</td>
<td>3232.32 (392.32)</td>
<td>3201.16 (361.23)</td>
</tr>
<tr>
<td></td>
<td>Less</td>
<td>3237.06 (302.35)</td>
<td>3283.78 (329.79)</td>
<td>3260.84 (310.20)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>3201.22 (320.41)</td>
<td>3255.97 (360.90)</td>
<td></td>
</tr>
</tbody>
</table>

N = 37 (20 in more group, 17 in less group)

20.1.2.3 Intensity of pain experiences. Response latency means and standard deviations for up and down conditions for both intensity of pain experiences groups are displayed in Table 20. The analysis revealed a trend towards an interaction between direction and intensity of pain experiences ($F(1,33) = 2.15, p = .15, \text{partial } \eta^2 = 0.06$). The significant main effect for direction from Study 2 remained ($F(1,31) = 5.08, p < .05, \text{partial } \eta^2 = 0.14$).

Inspection of the interaction graph, displayed as Figure 29, demonstrates that as expected, the difference in response latencies between the up and down conditions in the direction found in Study 2 was augmented for high intensity of pain experiences ($\text{mean difference} = 78.76$) compared to low intensity of pain experiences ($\text{mean difference} = 18.58$), however these were only nonsignificant trends.
Table 20
*Response latency means and standard deviations for up and down conditions in high and low intensity of pain experiences groups*

<table>
<thead>
<tr>
<th>Intensity of pain experiences</th>
<th>Up</th>
<th>Down</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>High</td>
<td>3199.52 (293.60)</td>
<td>3278.28 (380.03)</td>
<td>3238.44 (330.27)</td>
</tr>
<tr>
<td>Low</td>
<td>3187.15 (314.55)</td>
<td>3205.73 (352.64)</td>
<td>3197.32 (331.50)</td>
</tr>
<tr>
<td>Total</td>
<td>3193.51 (299.50)</td>
<td>3243.04 (363.43)</td>
<td></td>
</tr>
</tbody>
</table>

*N = 35 (18 in high group, 17 in low group)*

*Figure 29.* Mean response latencies for up and down trials between intensity of pain experiences groups. Error bars represent one standard error.

**20.2 Chapter Summary**

Results of the novel investigation of individual difference factors potentially moderating the effect of primes on simulation related to *heal* revealed nonsignificant trends towards augmentation of the difference in response latencies between the up and down conditions in the direction found in Study 2 for the cultural background (H7a) and intensity of pain experiences (H9a) factors. However, the expected augmentation of the Study 2 main effect was not found for the frequency of pain experiences (H8a) factor.
21. Discussion of Individual Differences Investigation

The individual differences investigation aimed to draw further inferences regarding the hypothesised simulation process taking place in studies 2 and 3 by investigating three factors which were proposed to influence the embodiment of *heal* in the up bodily state. Of the various main effect predictions made for Study 2 and Study 3, only one was significant and consistent with Perceptual Symbol Systems theory, thus only the influence of individual differences factors on the significant effect of up bodily state primes facilitating processing related to *heal* found in Study 2 were investigated.

Individual differences hypotheses were derived explicitly from factors which were expected to influence the embodiment and simulation of the *heal* concept in the up bodily state according to Perceptual Symbol Systems theory. Therefore, Perceptual Symbol Systems theory interpretations will be privileged in the current discussion, although other interpretations will also be explored.

21.1 Cultural Background

Investigation of the influence of cultural background on the significant effect of up bodily state primes facilitating processing related to *heal* found in Study 2 suggested a nonsignificant trend toward the expected augmentation. According to Perceptual Symbol Systems theory, this is consistent with the notion that those with a Western cultural background embody the *heal* concept in the up bodily state to a greater degree than those with an Eastern cultural background.

According to Perceptual Symbol Systems theory, simulators and simulations of concepts are culturally-derived and people should acquire similar simulators for concepts only if they share similar socio-cultural institutions (Barsalou, 1999). Similarly, D. Cohen and Leung (2009) argue that it is culture which determines the accessibility of certain concepts via embodiments and guides interpretation of the environment and the body. Furthermore, it has been argued that some embodiments of phenomena may be more prevalent in some cultures compared to others and that the same phenomena may be embodied in different ways according to culture (Bender & Beller, 2012; Leung, Qiu, Ong, & Tam, 2011).

It is important to consider that the metaphor and nonempirical literature which suggested a link between *up* and the *heal* concept as well as between *down* and *ill health, depression, and pain* was primarily of Western origin (Kirmayer, 2008; Lakoff & Johnson, 1980; Meier & Robinson, 2006; Schoeneman, et al., 2004; Toombs, 1988).
Numerous papers have investigated differing cultural perspectives on the perceptions and management of pain and health (Callister, 2003; Kirmayer, 2004; Kizilhan, 2011; Stella & Schofield, 2010). Literature examining the Eastern conception of pain describe a much more diverse concept involving not only components of physical sensation and negative feeling but also more complex domains of power and honour (L. M. Chen, et al., 2008; Ellis, Jacob, & Maycock, 2009; Sharts-Hopko, 2003). In turn, concepts such as power have been found to be related to the up bodily state (Schubert, 2005). Thus, although the Eastern conception of healing may include the up bodily state, it may not be as entrenched as it is in a Western conception of healing.

The current cultural background investigation finding is consistent with the abovementioned proposal as well as a small body of empirical literature suggesting that culture influences the putative embodiment and simulation of conceptual knowledge. Culturally influenced simulation was implied in a study which suggested that Mandarin speakers were faster to confirm that March comes earlier than April after seeing a vertical array of objects compared to seeing a horizontal array, and the reverse was true for English speakers (Boroditsky, 2001). This was interpreted as being due to reading of the Mandarin language in a vertical direction and English in a horizontal direction (see Leung & Cohen, 2007 for another study suggesting culture influenced simulation).

The primary study was well positioned to examine the influence of cultural background since there were approximately equal number of participants from Western ($N = 30$) and Eastern ($N = 24$) backgrounds. The influence of cultural background on the Study 2 main effect suggests that, as implied by Perceptual Symbol Systems theory, the putative relationship between the up bodily state embodiment and the heal concept may be culturally influenced. However, since the finding was only a trend and was extrapolated on the basis of Perceptual Symbol Systems theory assumptions of Study 2, it requires further research and should be interpreted with caution.

Finally, it is important to consider the nonsignificant trend towards facilitation of processing related to the heal concept for those of a Western cultural background compared to those of an Eastern cultural background. This trend may in fact be a confound, due to the high ratio of participants who reported English as their second language in the Eastern cultural background group (66.7%) compared to the Western cultural background group (3.3%). Those with English as their second language are likely to have taken longer to process the lexical stimuli compared to those with English as their primary language.
21.2 Frequency of Pain Experiences

Investigation of the influence of frequency of pain experiences on the significant effect of up bodily state primes facilitating processing related to heal found in Study 2 did not reveal the expected augmentation, thereby providing no support for the hypothesised difference in the embodiment of the heal concept in the up bodily state between those who have experienced more pain and those who have experienced less pain. This finding raises two theoretical issues in relation to the frequency of pain experiences and the putative embodied representation of the heal concept.

Firstly, the present finding was not consistent with the Perceptual Symbol Systems theory derived prediction that the entrenchment of a situated conceptualisation in memory is dependent on the frequency at which that situation is experienced with the same embodiment (Barsalou, 2005; Barsalou, et al., 2003), thus more frequent experiences of pain, and therefore more healing, should lead to a better entrenched situated conceptualisation of heal.

However, the present finding may suggest that once the up bodily state embodiment of heal is learnt and entrenched, further experiences with healing may not magnify the difference between the up and down bodily state embodiments, but may instead strengthen both. Thus, embodiments of a concept may have “experiential set points” which define how much they facilitate or interfere with access to the concept. If the concept is fully accessible after these set points, further experience with the concept may lead to strengthened facilitation from both positive (up bodily state) and negative (down bodily state) embodiments. Thus, the absence of an influence of frequency of pain experiences on the significant effect of up bodily state primes facilitating processing related to heal found in Study 2 could be explained by the majority of the sample having reached their experiential set points for heal as embodied in the up bodily state, resulting in both groups demonstrating equal facilitation via both up and down bodily state embodiments. This interpretation has not been theorised in the Perceptual Symbol Systems literature. However, since the operational mechanisms of embodiments, simulators, simulations, and situated conceptualisations are largely unknown, further work exploring this interpretation would benefit the Perceptual Symbol Systems theory literature (Barsalou, 2008b, 2009).

Secondly, the influence of frequency of pain experiences on the significant effect of up bodily state primes facilitating processing related to heal found in Study 2 may be more consistent with a Conceptual Metaphor Theory account rather than a
Perceptual Symbol Systems theory account. Conceptual Metaphor Theory posits that once the structure of an abstract concept is matched with the structure of a primary concept, it is then conceptualised according to the primary concept. Since the primary concept image schema is proposed to ground numerous abstract concepts, it must be stable and uninfluenced by experiences of specific abstract concepts. Thus, according to Conceptual Metaphor Theory, whilst still being conceptualised via the up metaphor, increased experience with the heal concept would not result in an augmented strength of its relationship to up, since this primary concept is stable. Due to this mapping onto stable primary concepts, abstract concepts in Conceptual Metaphor Theory are less dynamic than those proposed in Perceptual Symbol Systems theory and thus more consistent with the present finding. However, this interpretation is provisional, since the frequency of pain experiences hypothesis was derived explicitly according to a Perceptual Symbol Systems theory interpretation of the Study 2 main effect.

Finally, the possibility that a measure of pain experience may not be ideal for the examination of healing experience should also be considered. The assumption was that the frequency of pain experiences is equivalent to the frequency of healing experiences. This is likely to be the case in most situations, since people heal from most pain experiences. However, some cases may be more complicated and may be ongoing such as scars related to surgery causing psychological pain, trauma related to pain during childbirth, or chronic ailments such as back pain from which full healing may not have occurred or may never fully occur (Creedy, Shochet, & Horsfall, 2000; Lebovits, et al., 2009; Van Loey & Van Son, 2003). In cases such as these, a pain experience measure may not be an ideal indicator of healing experience. Due to this possibility, since the finding was only a nonsignificant trend, and since it was extrapolated on the basis of Perceptual Symbol Systems theory assumptions of Study 2, it requires further research and should be interpreted with caution.

21.3 Intensity of Pain Experiences

Investigation of the influence of intensity of pain experiences on the significant effect of up bodily state primes facilitating processing related to heal found in Study 2 suggested a nonsignificant trend toward the expected augmentation. According to Perceptual Symbol Systems theory, this is consistent with the hypothesised process whereby those who have experienced a higher intensity of pain embody the heal
concept in the up bodily state to a greater degree than those who have experienced a lower intensity of pain.\textsuperscript{72}

According to a Perceptual Symbol Systems theory interpretation, the augmentation trend found for intensity of pain experiences suggests that a higher quality of healing experiences strengthens embodiment of the \textit{heal} concept in the up bodily state via entrenchment of the putatively embodied \textit{heal} concept in memory (see p. 65 for details of situational entrenchment). It was theorised that those who have had more intense and higher quality experiences of pain, and thus healing, would be more likely to have more entrenched simulations and thus situated conceptualisations of the \textit{heal} concept, since more perceptual attention would be allocated to healing from higher intensity healing experiences compared to lower intensity healing experiences. A higher quality \textit{heal} simulator and greater entrenchment of situated conceptualisations for the \textit{heal} concept were predicted to result in more efficient and thus augmented processing related to the concept.

Although the influence of frequency of pain experiences and intensity of pain experiences on the significant effect of up bodily state primes facilitating processing related to \textit{heal} found in Study 2 suggest that it is the \textit{quality} of experiences of the embodied concept rather than their \textit{frequency} which entrenches them in memory, Perceptual Symbol Systems theory does not make this distinction. Since these findings were only trends and were extrapolated on the basis of Perceptual Symbol Systems theory assumptions of Study 2, they should be interpreted with caution. However, these findings suggest that further research needs to be conducted in order to empirically illuminate the Perceptual Symbol Systems theorised mechanisms of embodiments, simulators, simulations, and situated conceptualisations.

\textbf{21.4 Limitations}

A number of theoretical and design limitations to the individual differences investigation should be noted. Firstly, in relation to cultural background, only the broad domains of Eastern and Western cultures were examined. This provides a strong foundation for further research and was appropriate for the present investigation, due to its lack of statistical power. However, it is limited in drawing conclusions about specific cultural groups, especially in the light of literature suggesting differences \textit{within} Eastern
cultural groups and *within* Western cultural groups in their conceptualisation of and reactions to healing and pain (Kizilhan, 2011).

A second limitation is the possible influence of Westernised participants who considered themselves of an Eastern background. In order to overcome this limitation the present investigation asked for the culture participants were *most influenced by*. However, some participants who have spent the majority of their lives in Australia may have still reported themselves as from an Eastern cultural background, due to the influence of their parents and family friends on their lives. It has been found that “bicultural” individuals, who are influenced by two cultures have reference to embodiments of both cultures and refer to the relevant one according to the situation at hand (Leung & Cohen, in press in D. Cohen & Leung, 2009). Thus, bicultural individuals in the present investigation may have referred to their Western embodiments of *heal* in the clinical experimental situation, since it is likely to be considered a more Western than Eastern setting (Christakis, 1992).

A third limitation is that “within-culture atypicals” were not accounted for. The present investigation assumed that participants followed the culture they were most influenced by; however, not all members of a culture are prototypical, and some may have rejected their cultural heritage, these members have been referred to as “within-culture atypicals” (Leung & Cohen, 2011). A recent analysis of trends in the use of complementary and alternative medicines in America suggested that between 2002 and 2007 acupuncture use rose 35.85%, Yoga-Taichi-Qigong rose 14.41%, and the use of Ayurvedic medicine rose 25% (Su & Li, 2011). In contrast, statistics have suggested that between 1999 and 2004 revenue from Western medicine in China increased from 44.3% to 47.4% while revenue from traditional Chinese medicine dropped from 26.4% to 18.8% (Shen, et al., 2011). These findings suggest that members of the Western culture are increasingly leaning towards an Eastern conceptualisation of healing, and vice versa. Consequently, cultural background may not be an ideal measure of the influence of an individual’s experience on their embodied conceptualisation of *heal*.

A fourth individual differences investigation limitation was the arbitrary cut-off scores used to differentiate groups for both frequency of pain experiences and intensity of pain experiences. The Prior Pain Experience Questionnaire had no published cut-off scores since it had previously only been utilised as a continuous measure (Stutts, et al., 2009). There are a number of methods to dichotomise continuous variables, the most common being the median split method (MacCallum, Zhang, Preacher, & Rucker,
2002). However, since the present investigation aimed to examine extreme groups, this method was considered too conservative and the 30\textsuperscript{th} percentile and 70\textsuperscript{th} percentile scores were selected as cut-offs for the less/low and more/high groups, respectively. Different cut-off scores for the less/more frequency of pain experiences groups and the low/high intensity of pain experiences groups may have influenced the present findings.

A fifth limitation is the absence of validation and reliability data for the Prior Pain Experience Questionnaire. The Prior Pain Experience Questionnaire (shortened version) was utilised for the present investigation because it was the only measure of pain experience found in the literature. Since it was not a primary measure, it was beyond the scope of the present investigation to perform reliability and validation tests on the questionnaire prior to its use. Thus, it remains unknown whether the questions are internally consistent and exactly which aspects of pain experience it measures. One qualitative aspect of the Prior Pain Experience Questionnaire which may have affected conclusions from the present investigation was the omission of any items related to psychological pain. Thus, it would be premature to conclude that frequency of pain experiences does not influence the putatively embodied heal concept without first examining the influence of psychological pain experience.

A sixth limitation relates to whether intensity of pain experiences is equivalent to intensity of healing experiences. This issue also exists for frequency of pain experiences (see p. 201 for details); however, it is potentially augmented for intensity of pain experiences. Unlike frequency of pain experiences, intensity of pain experiences may be unrelated to intensity of healing experiences since a high intensity of pain may result in a low intensity of healing due to the elevated probability of increased recovery time (C. Chen, Hogg-Johnson, & Smith, 2007; Côté, Hogg-Johnson, Cassidy, Carroll, & Frank, 2001; Menezes Costa, et al., 2009). Whether this applies to a participant would dependent on whether they conceptualise healing as more intense according to recovery from high intensity pain or when it occurs more rapidly (i.e., from low intensity pain).

Finally, it is possible that intensity of an experience is not an adequate measure of experience quality. A number of studies and reviews have found strong positive correlations between measures of pain intensity and experience quality in both chronic and acute pain (Burckhardt & Bjelle, 1994; Chanda, Alvin, Schnitzer, & Apkarian, 2011; Dudgeon, Raubertas, & Rosenthal, 1993). Thus, it was assumed that intensity of pain experiences was an adequate measure of pain experience quality and thus also healing experience quality. However, intensity of pain experiences was a measure
derived from the Prior Pain Experience Questionnaire, which had not been validated. Thus, it is not clear whether intensity of pain experiences is a measure of the quality of the pain experience. Future studies should validate the pain intensity component of the Prior Pain Experience Questionnaire against the McGill Pain Questionnaire (Melzack, 1975) or the Pain Sensation Scale (Geissner, 1996), which are validated measures of pain quality (Michalski, Liebig, Thomae, Hinz, & Then Berg, 2011; Ngamkham, Holden, & Wilkie, 2011).

21.5 Suggestions for Future Research

The findings and limitations of the individual differences investigation suggest a number of areas for future research: three which concern cultural background and three which concern frequency of pain experiences and intensity of pain experiences. Firstly, in order to make specific cultural predictions, research considering the effects of culture on healing, or any putatively embodied concept, should examine specific cultural groups as opposed to the broad Western vs. Eastern dichotomy. Secondly, it would be beneficial for future research to consider not only specific cultural groups but also bicultural individuals in order to illuminate which putative embodiments they utilise and whether this changes according to cultural context. Thirdly, in order to control for within-culture atypicals, as well as situational variables, Leung and Cohen (2011) suggest the use of a “Culture x Person x Situation” approach in which people are considered agents within a cultural system who follow or reject their culture, as well as considering the influence of context.

The fourth suggestion for future research is to extend the Prior Pain Experience Questionnaire, develop a new measure, or conduct interviews to evaluate nonclinical psychological ill-being. This would allow for illumination of the question of whether psychological healing experiences influence the putatively embodied heal concept. The fifth suggestion is for future studies to employ a measure of healing experience/intensity rather than pain experience/intensity when examining the affect of healing experience/intensity on the heal concept. The final suggestion for future research relates to the trend that frequency of healing experiences did not influence the putative embodiment of the heal concept in the up bodily state. Before this conclusion can be drawn, more evidence must be gathered in relation to the influence of past conceptual experience on putatively embodied conceptual knowledge. If future studies corroborate the hypothesised “experiential set point” relationship (see pg. 200 for details) between
congruent and incongruent embodiments of a concept, it has important theoretical implications for Perceptual Symbol Systems theory.

21.6 Implications

Investigation of the influence of individual difference factors on the significant effect of up bodily state primes facilitating processing related to heal found in Study 2 suggest a number of implications. Firstly, it presents a novel methodology for drawing inferences about the processes underlying the relationship between bodily states and concepts. Broadly, the use of individual differences factors proposed to influence specific theorised processes presents a novel method of drawing further inferences for any investigation adopting a traditional experimental approach.

Secondly, one of the major implications of the cultural individual differences investigation is that it suggests that studies examining the putative embodiment of concepts need to consider the cultural background of their sample and whether the theorised embodiment of the concept applies across the sample. Similarly, before applying the embodied educational techniques outlined in Section 14.5 (p. 155), educational professionals must take into account the cultural background of the students and whether the techniques would be beneficial according to their background.

Finally, since Perceptual Symbol Systems theory implicates experience as a major influence on embodied conceptual knowledge, trends found in the present investigation potentially shed light on the mechanism of this influence (Barsalou, 1999). Firstly, the absence of an influence of frequency of pain experiences suggests that there may be experiential set points to embodiments of concepts. Secondly, the trend towards an influence of intensity of pain experiences suggests that the mechanism of entrenchment of simulators and situated conceptualisations may be via quality of experiences rather than their frequency. However, all the aforementioned implications are derived from nonsignificant trends which were specific to the heal concept. Thus, further research needs to be conducted in order to ground these implications on a firm theoretical foundation.

21.7 Chapter Summary

In summary, investigation of individual difference factors on the significant effect of up bodily state primes facilitating processing related to heal found in Study 2 suggested trends toward the influence of cultural background and intensity of pain
experiences on the embodiment of the *heal* concept in the up bodily state. These trends were consistent with a Perceptual Symbol Systems theory account of the effect of up bodily state primes on processing related to *heal*. However, there was no trend suggesting that frequency of pain experiences influenced the embodiment of the *heal* concept in the up bodily state.

The individual differences investigation succeeded in its aims of offering a secondary, novel method of drawing further inferences regarding the Perceptual Symbol Systems theory interpretation of the significant effect of up bodily state primes facilitating processing related to *heal* found in Study 2.

**VI. GENERAL DISCUSSION**

22. **Overview of Project Findings**

Prior to integrating findings from the present project, it is considered important to outline the findings from each of the studies conducted as an overview of all of the project’s findings and in order to avoid oversimplification in their integration.

Study 1 findings suggested that lexical associates were produced significantly earlier, on average, than simulated responses suggesting that, as predicted by Language and Situated Simulation theory, the linguistic system activation peaks before perceptual symbol system activation. It was also found that introspective properties were identified significantly more commonly for abstract compared to concrete concepts while entity properties were identified significantly more commonly for concrete compared to abstract concepts, as predicted by Perceptual Symbol Systems theory.

Study 2 findings revealed significantly shorter response latencies for up trials compared to down trials, suggesting that, according to Perceptual Symbol Systems theory, simulation of the up bodily state allowed for facilitation of access to the *heal* concept compared to simulation of the down bodily state. However, the nonsignificant interaction effect between direction and strength suggested that the strength of the simulation, and thus access to the *heal* concept, could not be manipulated by the addition of a motor prime to the visual prime.

Study 3 findings suggested that priming of the *up* bodily state did *not* result in a more pronounced perception of physical healing or affect related to healing compared to priming of the *down* bodily state. However, post hoc findings revealed that joint visual *and* motor priming of the up bodily state resulted in a more pronounced increase...
in perceived healing sensation compared to joint visual and motor priming of the down bodily state. These findings were tentatively considered as consistent with a dynamical systems account.

Findings of the individual difference investigation of factors potentially moderating the effect of primes on simulation of the heal concept revealed nonsignificant trends towards augmentation of the difference in response latencies between up and down conditions in the direction found in Study 2 according to cultural background (H7a) and intensity of pain experiences (H9a). However, the expected augmentation of the Study 2 main effect was not found for frequency of pain experiences (H8a).

23. A Pluralistic Cognitive System

In the service of an integration of the entire project, this chapter will argue that findings of studies 1 and 2 were broadly consistent with Language and Situated Simulation theory and Perceptual Symbol Systems theory, whereas findings of Study 3 were more consistent with a dynamical systems account. Consequently, it will be proposed that offline cognition may primarily employ a linguistic system as well as a perceptual symbol system and online cognition may primarily employ a dynamical system. It is plausible that conceptual processing is pluralistic in terms of representation and may employ different mechanisms according to cognitive context (offline or online) and depth of processing (shallow or deep). The arguments forwarded in this chapter are provisional and speculative since the assumptions and hypotheses of the three studies and the individual differences investigation were derived explicitly from Perceptual Symbol Systems theory and/or Language and Situated Simulation theory. Further research is required to tease apart these complex questions.

23.1 The Tri-Partite Cognitive System

Findings of studies 1 and 2 of the present project suggest that offline cognition is consistent with Language and Situated Simulation theory, in which rapid, superficial cognitions which require no access to conceptual meaning are primarily handled by a linguistic system, while deeper offline cognitions which require access to conceptual meaning are primarily handled by a perceptual symbol system (Barsalou, 1999; Barsalou, et al., 2008). Alternatively, a tentative post hoc argument for Study 3 findings was framed suggesting that online cognitions may be primarily handled by a
situationally-oriented dynamic system which requires online interaction with the environment (L. B. Smith, 2005). Thus a “tri-partite cognitive system” consisting of linguistic, modal, and dynamical aspects is proposed.

Dynamical systems accounts differ from modal theories, such as Perceptual Symbol Systems theory, primarily in their elimination of the neural notion of representation (Chemero, 2009; Van Gelder, et al., 1998). A perceptual symbol system stores conceptual representations in simulators, whereas a dynamical system does not store representations. If representations occur repeatedly over time, they become tied into a dynamical system which is appropriated on later online interactions with the concept (L. B. Smith, 2005). An important point here is that it can only be appropriated on later online interactions with the concept, thus a dynamical system struggles to account for offline cognition (Shapiro, 2011). Considering this, there is no reason why a dynamical system cannot work in tandem with a system underpinned by modal representations, such as a perceptual symbol system. It is plausible that dynamical systems may be the primary source of online cognitions, while modal representations are stored and utilised for offline cognitions.\(^73\)

This type of system is consistent with an evolutionary account which views the modal simulation system of the brain as having developed in response to online interactions with the environment (Barsalou, et al., 2007). Consequently, before the development of the proposed perceptual symbol system employed for offline cognition, online cognition may have utilised a more primal, dynamic, direct perception/action system for interactions with the environment (Barsalou, et al., 2007). Furthermore, the instantiation of a linguistic system which is void of conceptual meaning also fits in with an evolutionary account of cognition. Language is proposed to have developed to support simulations and according to neuroimaging studies is likely to be prefrontally located, thus situated even later down the evolutionary track (Barsalou, et al., 2007; Schmaus, 2005).\(^74\)

One of the major arguments against pluralistic theories, such as the tri-partite system suggested here, is their lack of parsimony (Dove, 2009). Accounts that posit only one mechanism for cognition, whether they be representationally modal or amodal, or nonrepresentational, are considered to be preferred over those that are pluralistic, due

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\(^73\) A representationally plural system also provides a possible solution for Shapiro’s (2011) apple argument (see p. 35) since modal representations could also assist in online cognitive activity.

\(^74\) Although Language and Situated Simulation theory does not comment on the neural basis of the system.
to their more efficient description of phenomena. Dove (2009) offers three arguments against this point of view; two which apply to the tri-partite cognitive system. The first is that parsimony does not suggest accuracy; not all currently supported theories in psychology are the most parsimonious account, as Dove exemplifies with the example of the reflex arc theory of memory, which was shown to be incompatible with numerous empirical findings.

The second argument is that parsimony only comes into consideration if all available evidence fits both the parsimonious and nonparsimonious theories. In relation to the tri-partite cognitive system, it would be more parsimonious to explain all the findings of the present project using Language and Situated Simulation and Perceptual Symbol Systems theories. However, the finding that priming the up bodily state did not facilitate the perception of healing compared to priming the down bodily state whereas joint visual and motor priming of the up bodily state facilitated the perception of physical healing compared to joint visual and motor priming of the down bodily state is tentatively considered more consistent with a dynamical systems account.

Theories of cognition are often pitted against each other on the basis of their philosophical or theoretical underpinnings leading to the underlying assumption that all cognitive processes are governed by one particular type of mechanism. However, the possibility that some aspects of cognition are governed by specific mechanisms while other aspects are governed by other mechanisms should be considered. If a “representational continuum” were to be developed, it would have the computational theory of mind approach with its arbitrary, amodal symbols at one end and the dynamical systems account with its complete abolishment of representations at the other, with the grounded cognition account sitting somewhere in the middle with its modal representations (Chemero, 2009; Pezzulo, 2011). Each of the mechanisms proposed by these approaches/accounts have limitations related to different aspects of cognition which often correspond to the strengths of mechanisms posited by other accounts (e.g., grounded cognition can account for offline cognition where dynamical systems accounts struggle). Thus, it is plausible that the cognitive system contains multiple mechanisms which are utilised in different cognitive contexts.

23.2 Chapter Summary

In integrating linguistic, offline, and online findings of the present project a tri-partite cognitive system was proposed. The system consists of a linguistic system and
perceptual symbol system containing modal representations primarily for offline cognition, and a dynamical system, which may be void of representation, primarily for online cognition. The idea of a pluralistic cognitive system is consistent with an evolutionary account and is supported by numerous arguments against parsimony.

24. Project Strengths, Limitations, Suggestions for Future Research, and Implications

The three experimental studies and the individual differences investigation conducted as part of this project generated a number of limitations, suggestions for future research, and implications, as discussed in the respective Discussion chapters above. However, viewing the project as a whole throws light on novel, integrated strengths, limitations, suggestions for future research, and implications.

24.1 Strengths

One aspect of the studies which has not been discussed is their strengths, which are illuminated when they are viewed in the context of the project. Firstly, Brown, Cromby, Harper, Johnson, and Reavey (2011) discussed the difficulty in engaging in a qualitative analysis of embodied experience, let alone a quantitative analysis. The present project achieved its meta-aim of examining the embodied concept across multiple conditions (i.e., linguistic, offline, and online) demonstrating that it is possible to analyse a phenomenologically derived conceptual process (i.e., simulation) quantitatively and draw inferences about the process from behavioural data. This quantifiable source of phenomenological information is one example of original information provided by the present project.

Secondly, the present project’s design, which was underpinned by a specific theory rather than a comparison of models, was a source of strength. Using a theory as the foundation of a project instead of the comparison of models has its limitations (see p. 213 for Anderson’s problem), but the advantages of such a structure are often overlooked. Findings from a project underpinned by a particular theory may not be as specific and conclusive as its model comparison counterparts, but it allows for quite unambiguous conclusions to be drawn about whether the theory specific predictions are supported or not and it provides a foundation to guide model comparisons in future studies as well as raising interesting new questions which could not have arose from a model comparison project (e.g., is there a cultural basis for embodiment?).
Thirdly, studies 2 and 3 provided new information and raised new questions regarding the proposed augmentation of simulation via joint visual and motor priming. Studies 2 and 3 were the first, to the best of the author’s knowledge, to examine the proposed influence of joint visual and motor priming on simulation, and raise the question of whether simulation augmented by joint visual and motor priming has a distinct influence from motor priming in isolation.

Fourthly, a number of methodological aspects highlight a major strength of the present project. Firstly, the novel individual differences method of investigating experimental findings regarding a putatively embodied concept allowed for further inferences to be drawn about the processes underlying the relationship between the proposed embodiment and the concept. Secondly, the “real world” online cognitive task utilised in Study 3, which physically stimulated healing, was a novel method of investigating online cognition, differing from online cognitive tasks in the grounded cognition literature which present online, computerised depictions of concepts (Reed & Farah, 1995; Tucker & Ellis, 1998). Finally, the feasibility of the Study 3 data reduction technique which reduced multiple ratings of healing across time from the same measure into one variable suggests that this technique can be extended from the signal processing domain to the psychological domain.

A fifth strength was that the present project was the first, to the best of the author’s knowledge, to examine the heal concept. Although the project was unable to illuminate the placebo phenomenon by bridging the Cartesian divide via modal grounding, it provided important information regarding the embodied conceptualisation of the heal concept and how this could be utilised to enhance healing in real world situations (see Section 17.5, p. 188 for details).

Finally, the present project was able to comprehensively examine Perceptual Symbol Systems theory and in particular the putative processes of simulation and embodiment of a specific concept in a variety of conditions (i.e., linguistic, offline, and online) and generate testable hypotheses and questions about the types of systems used in conceptual knowledge for future research. In examining the heal concept across conditions the present project was able to propose the tri-partite cognitive system which remains to be further explored by future research.
24.2 Limitations

In addition to the numerous study-specific limitations discussed throughout the thesis, a number of broad limitations which applied across the studies should be noted. Firstly, although the broad nature of the present project raised interesting new questions, it also left the project open to the criticism of being unable to provide a conclusive explanation for findings. Studies 2 and 3 were “demonstration studies” (see Barsalou, 2008a) of an embodied concept which aimed to examine whether a theorised embodiment of a concept could facilitate its processing, rather than examining mechanisms underpinning the embodiment. Demonstration studies are underpinned by a theory and can only draw conclusions regarding whether the embodiment influenced processing according to the assumptions of the specified theory.

This underpinning by Perceptual Symbol Systems theory left the present project with what Machery (2007) terms “Anderson’s problem”. Anderson’s problem is that neither modal nor amodal cognitive theories make specific, testable predictions about experimental task performance. Thus, studies which aim to test theories of cognition against each other should choose specific models derived from theories and test them against each other. This would solve Anderson’s problem since models derived from theories make specific, testable predictions about experimental task performance (Machery, 2007).

A second limitation of the present project relates to the difficulty in generalising a concept to experience. Embodied cognition theories are underpinned by phenomenological philosophy in which experience is considered primary in cognition (Gallagher & Zahavi, 2007). However, phenomenology focuses on giving a proper description of experience in life rather than focusing on mechanisms behind the experience (Gallagher & Zahavi, 2007). The limitation is that in attempting to ground cognitive mechanisms and processes in experience, embodied cognition loses some phenomenological focus. For example, a phenomenological study of experience and embodiment highlights how an experience of the same concept or setting differs vastly between individuals with a common biological cognitive system and common experience with the concept/setting (Brown, et al., 2011). Thus, although empirical studies underpinned by embodied cognition (specifically grounded cognition) capture how concepts are derived from common experiences, they are limited in their ability to explain how modal systems account for phenomenological differences in experiences of the same concept.
A third set of limitations of the present project relate to the generalisability of the findings. Although Study 1 was not focussed on a specific concept, generalisability of the finding that abstract concepts are underpinned primarily by introspective properties may be questioned due to the nature of the abstract concepts utilised. This is particularly important since the democracy concept, which could be considered a “pure” abstract concept, was found to behave differently to the two “emotion-related” abstract concepts (anger and heal). Abstract concepts such as democracy are nonphysical and nonspatially constrained, while emotion-related abstract concepts such as anger and heal, although nonspatial, can be perceived (at least internally), leading some authors to suggest that they form a different conceptual type all together (Altarriba, et al., 1999). The use of two emotion-related abstract concepts may have influenced the results and thus may also limit the generalisability to all abstract concepts.

Findings of studies 2 and 3 are limited in their generalisability across concepts due to their focus on the heal concept. Firstly, interpretations of the findings assumed generalisability according to prior research which has suggested that other concepts can also be theoretically embodied (prominent examples include Hung & Labroo, 2011; Jostmann, et al., 2009; Meier, et al., 2007; Schubert, 2005; Wilkowski, et al., 2009). Despite this, study 2 and 3 findings must be confirmed for other abstract concepts before generalisability can confidently be assumed. Secondly, the cultural background individual difference finding suggests that the Study 2 main effect may be stronger for those of a Western cultural background compared to those of an Eastern cultural background and thus less generalisable to those of an Eastern cultural background.

A fourth set of project limitations relate to the design of studies 2 and 3. The conclusions drawn from findings of studies 2 and 3 were underpinned by numerous assumptions which separate the mind, body, and brain (e.g., simulation in the modal system). One of the major challenges of research which aims to explore amodal and modal theories of cognition is the question of how to methodologically separate mind and brain (Machery, 2007). Prior research has attempted to address this problem by utilising neuroimaging and considering activation in sensorimotor areas as modal activation signifying brain as opposed to the mind posited by amodal accounts (Kan, et al., 2003; Simmons, et al., 2008). However, amodal accounts can explain these findings post hoc, thus they do not provide evidence against amodal accounts nor against the concept of mind.
The final project limitation is a pragmatic one which hampered all three studies. Although a number of findings of the present project were statistically significant, they had low statistical power due to their relatively small sample sizes. The small sample sizes were primarily due to financial constraints on the project; thus, it is important that findings of the present project are interpreted with caution. As the first investigation of its type, the present project’s power limitations are arguably acceptable. However, future research should aim to replicate these findings using larger samples especially in the light of the moderate to large effect sizes found across the major analyses of the project (interpretation of effect sizes according to J. Cohen, 1988).

24.3 Suggestions for Future Research

A number of suggestions for future research arise from the present studies when viewed as a project. Firstly, the present project adds to the growing literature suggesting that abstract concepts can be embodied (prominent examples include Chandler & Schwarz, 2009; Jostmann, et al., 2009; Schubert, 2005; Wilkowski, et al., 2009). The aim for future research should be to move on from demonstration studies and answer the questions raised by them regarding the mechanisms behind the phenomena. Although empirically difficult, it is important for future studies to explore whether the findings of the demonstration studies are underpinned by modal or amodal systems. Future studies should adhere to Machery’s (2007) suggestion of comparing specific assumptions of an amodal model to those of a modal model and to extend the findings of studies 2 and 3 by clarifying whether the putative simulation process can be augmented by the joint priming of two (or more) simulation triggers. These studies may be able to determine whether the modal system plays a central or peripheral role in abstract conceptual knowledge.

The second suggestion for future research is to examine how a perceptual symbol system is neurally instantiated. Simmons and Barsalou (2003) provide a firm theoretical foundation from which future research can extend or examine empirically using neuroimaging. Such studies may be able to illuminate whether or not it is neurally plausible that a perceptual symbol system can implement all the functions required of higher order cognition, including the representation and simulation of abstract concepts.

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75 In terms of assessing the heal concept and comprehensively examining Perceptual Symbol Systems theory in linguistic, offline and online conditions as well as via individual differences.
Finally, the importance of neuroimaging in grounded cognition research should not be overlooked. Numerous behavioural studies examining components of Perceptual Symbol Systems theory (Santos, et al., 2011; Solomon & Barsalou, 2004) have been replicated using neuroimaging (Kan, et al., 2003; Simmons, et al., 2008) in order to neurally clarify their assumptions. Although neuroimaging cannot conclusively rule out a role for amodal symbols in cognitive processing, the method can be used to test assumptions made according to modal theories about the nature of neural processes.

Neuroimaging would be a vital tool in exploring whether the use of two simulation triggers (e.g., visual and motor) can augment simulation, since it is the only method capable of measuring the separate influences of visual perception and motor movement on the modal system, and thus simulation. Neuroimaging could also play an important role in clarifying the simulatability of abstract concepts by assessing whether introspections can be simulated. Akin to a study which suggested that simply viewing pictures of foods activated gustatory areas (Simmons, Martin, & Barsalou, 2005), future studies could examine whether pictures of situations involving emotion-related abstract concepts activate emotion-related neural areas. Future grounded cognition research can benefit from utilising advances in technology, such as neuroimaging.

24.4 Implications

Findings of the present project have a number of important theoretical and methodological implications. Firstly, the major implications of the present project are the new and interesting questions it raises in regard to the design of studies examining embodied cognition (see Section 11.4, p. 126; Section 14.4, p. 153; Section 17.4, p. 185), the types of systems which may be involved in conceptual knowledge (see Section 23.1, p. 208), properties of different concept types (see Section 11.2, p. 119), and more specifically in relation to assumptions of Perceptual Symbol Systems and Language and Situated Simulation theories and the heal concept (see Discussion sections).

Secondly, one of the major theoretical implications arising from the findings of the present project is that abstract concepts are conceptualised primarily by introspections, as predicted by Perceptual Symbol Systems theory. One of the major criticisms of modal theories of cognition, such as Perceptual Symbol Systems theory, is their alleged inability to account for abstract concepts (Mahon & Caramazza, 2008). However, Barsalou (1999) posits that abstract concepts are introspectively perceptual and considers the introspective system a major component of the sensorimotor system.
Study 1 findings add to a growing literature consistent with Barsalou’s contention that abstract concepts are conceptualised via introspective properties (Barsalou & Wiemer-Hastings, 2005; Kousta, et al., 2011; Wiemer-Hastings, et al., 2001; Wiemer-Hastings & Xu, 2005).

Thirdly, the Perceptual Symbol Systems theory of embodied abstract concept representation posits that abstract concepts can be simulated via their introspective nature. Although abstract concepts are primarily conceptualised via introspections, some emotion-related abstract concepts, such as heal and power also have a nonintrospective, perceptual nature (e.g., up bodily state). Findings of Study 2 suggested that using its introspective and nonintrospective, perceptual nature, the heal concept was embodied and simulated, consistent with numerous studies which have presented empirical evidence for the proposed embodiment and simulation of abstract concepts, both offline and online (prominent examples include Chandler & Schwarz, 2009; Crawford, et al., 2006; Jostmann, et al., 2009; Meier, et al., 2007; Schubert, 2005). Thus, an important theoretical implication from the present project is that abstract concepts are conceptualised primarily via introspection and can therefore be simulated according to Perceptual Symbol Systems theory.

Finally, the post hoc Study 3 finding that joint visual and motor priming of the up bodily state facilitated the perception of physical healing compared to joint visual and motor priming of the down bodily state was a source for a major practical implication. Implications of this finding align with Teasdale’s (1993) suggestion that motor manipulation may be effective as a psychological treatment by implying that enacting an up bodily state may facilitate physical, and possibly psychological healing.

24.5 Chapter Summary

This chapter covered the integrated project strengths, limitations, suggestions for future research and implications. Overall the project had a number of strengths related to its novel theoretical nature and design, which was also the major source for a number of its limitations. The project also had a small number of implications but the most important area was the suggestions for future research arising from the findings, design, and limitations of the project.
25. Conclusion

The present project was successful in its meta-aim to examine the embodied *heal* concept across multiple conditions (i.e., linguistic, offline, and online) in order to provide a comprehensive examination of Perceptual Symbol Systems theory; however it was unable to illuminate the poorly understood placebo phenomenon in medicine. The present project was successful in its specific aims to examine Language and Situated Simulation theory assumptions regarding systems for the putative domains of shallow, linguistic and deep, conceptual processing as well as Perceptual Symbol Systems theory assumptions regarding the nature of abstract and concrete concepts. Furthermore, the project was able to empirically investigate the putative embodiment of the *heal* concept in the up bodily state in offline and online conditions; to examine the influence of adding a motor prime to the visual prime in manipulating the strength of the putative simulation; and finally to use *heal* specific data drawn from the study to generate testable hypotheses and models about the types of systems used in conceptual knowledge for future research.

Study 1 findings were consistent with the cognitive system proposed by Language and Situated Simulation theory, in which a shallow processing, linguistic system is activated before a deep processing, perceptual symbol system and with the Perceptual Symbol Systems theory assumption that abstract concepts are primarily conceptualised via their introspective properties. Study 2 findings were partially consistent with a Perceptual Symbol Systems theory account of conceptual knowledge which implies that simulation of the up bodily state embodiment facilitates processing related to the *heal* concept compared to simulation of the down bodily state embodiment. Study 3 findings were tentatively considered to be more consistent with a dynamical systems account of online conceptual knowledge than with Perceptual Symbol Systems theory. Findings of the cultural background and intensity of pain experiences investigations allowed for further inferences to be drawn in favour of a Perceptual Symbol Systems theory interpretation of the Study 2 main effect. However, the frequency of pain experiences finding did not allow for such inferences to be drawn.

Overall, it was concluded that the cognitive system may be pluralistic. A tri-partite cognitive system consisting of a linguistic system and perceptual symbol system containing modal representations primarily for offline cognition, and a dynamical system, which may be void of representation, primarily for online cognition was provisionally proposed on the basis of integrated findings from the present project.
Furthermore, although the examination of embodiment in the *heal* concept was unable to illuminate the placebo phenomenon, the present project was able to provide important information regarding the embodied conceptualisation of the *heal* concept and how this could be utilised to enhance healing in real world situations.
VII. REFERENCES


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Appendix A.
The relationship between naturalism and phenomenology

The problem

Before discussing how Dewey’s and Merleau-Ponty’s theories are related to each other, it is crucial to understand that naturalistic and phenomenological theories approach philosophy from different angles. Husserl viewed the job of philosophy as to understand meaning, rather than explore what exists in the world, which is a job he assigned to science (G. J. Marshall, 2008). Thus, phenomenology is committed to describing experience, which is where meaning arises for humans (G. J. Marshall, 2008). Under his definition of philosophy, Husserl would view naturalism as more of a theoretical science rather than a philosophy because it explains how mind and meaning come to be, independent of the experience of the subject. Thus, phenomenology describes subjective experience through the “lived-body-in-the-world” and naturalism objectively describes how these experiences naturally form the mind through the body (Gallagher & Zahavi, 2007).

The problem occurs when meaning is introduced: Merleau-Ponty’s phenomenology finds meaning directly in the body’s relationship with the world. While Dewey’s naturalism also finds meaning in the body’s relationship with the world, it must be finally reduced to a psychophysical (naturalistic) account (Aikin, 2006). As Aikin (2006, p. 326) puts it “Lovers may love, and pains may pain, but the naturalistic perspective can attend only to the lovers, not their love; to the pains, but not their feelings of pain.” Similarly, the phenomenological perspective can attend only to the love, not the lovers and to the feelings of pain rather than the pains. Thus, phenomenology and naturalism are often seen as incompatible (Aikin, 2006). However, this is not a fair view since the two traditions approach the problem of meaning from different perspectives.

The resolution

Phenomenology maybe “anti-naturalistic” in the sense that it is not an analysis of the psychophysical constitution of a human being, but this does not mean that it cannot be an important aid in an analysis of the psychophysical constitution of a human being (Aikin, 2006; Gallagher & Zahavi, 2007). In relation to reductionism, Nagel (1974) pointed out that in order to successfully reduce a cognitive phenomenon, it is a necessary requirement to first understand that phenomenon. This statement is also true of naturalism, in that in order to successfully build a naturalistic account of a cognitive phenomenon, it is a necessary requirement to first understand that phenomenon as it is experienced by the subject (Gallagher & Zahavi, 2007).

Phenomenology explores the intentional, spatial, temporal, and phenomenal aspects of experience which naturalists, psychologists, and neuroscientists try to explain in terms of neural structures, cognitive models, and the brain (Gallagher & Zahavi, 2007). Thus, phenomenologists provide to naturalists, psychologists, and neuroscientists a more precise model of the phenomenon which they attempt to explain than they would have if they were to use the “commonsense” approach of starting with a scientific theory of the phenomenon (Gallagher & Zahavi, 2007). This sentiment was acknowledged by Wilshire (1977, p. 54) when he stated that “Pragmatism (a derivative of naturalism) and phenomenology should be seen as mutually assisting philosophical efforts...”, and echoed by a chorus of philosophers (Bourgeois, 1996; Rosenthal, 1990). Sullivan (2002, p. 203) specifically stated that “... Merleau-Ponty’s phenomenology is...
so close to…Dewey’s pragmatism…” The different directions in which phenomenology and naturalism approach the question of meaning and mind do not make them mutually exclusive but rather compatible in a way which produces a more accurate final analysis of a phenomenon.

In response to Aikin’s (2006) abovementioned problem, the phenomenologist can examine the experience of love and pain for the naturalist to examine how lovers and pains feel that love and pain naturalistically. The problems as outlined by Aikin arise mainly due to definitional inconsistencies in phenomenology and naturalism. These problems are overcome when the general aims of the two traditions are explored rather than their specific definitions.
Appendix B.
Study 1 consent information statement and form

Consent Information Statement

Why we are conducting this study...
The primary aim of this study is to examine people’s understanding of concepts. A number of previous studies have found that the content of people’s concepts depends on the type of concept in question and their past experiences with the concept. The findings of this study will help build more accurate theories of cognition which may flow onto widespread benefits for learning and technology.

What you will have to do...
If you choose to participate in this study, the student investigator will arrange with you a convenient time for you to come into Swinburne University, Hawthorn to do the study. At the testing session, you will first be asked to sign a consent form if you are still happy to go through with the study. Following this you will be asked to complete a questionnaire after which experimental testing will begin. During the testing session the investigator will name a concept and you will be asked to verbally list any thoughts that come to mind in relation to that concept for thirty seconds. It is important to know that this study is about what people associate with concepts, not about knowledge or intelligence – hence, there are no right or wrong answers to the questions we will ask, only your personal understanding of the concept. This procedure will be repeated for 6 different concepts.

Your verbal responses will be recorded using an audio recording device. Your questionnaire data and verbally recorded response data will be linked using a code number, which has no link to any identifying information. It is estimated that the entire study will take no longer than 30 minutes.

Participant rights and interests...
Your participation in this study is completely voluntary. Your initial agreement of participation in this study does not stop you from discontinuing participation and you are free to withdraw at any time. Please consider the purposes and time commitment of this study before you decide whether or not to participate. Please feel free to print out and retain this information sheet for your records. You will also be given a hard copy of it before you sign consent if you choose to participate in the study.

Due to the nature of the study, no potential problems are expected. However, if an issue of concern comes to light during the experiment (of psychological or physical nature), you can obtain counselling from the Swinburne Hawthorn service or medical assistance from the Swinburne Hawthorn doctor (on campus medical service), whose contact details are provided below. Furthermore, the investigator will always be with you should an unexpected situation arise.

<table>
<thead>
<tr>
<th>Hawthorn Counselling Service</th>
<th>Hawthorn Medical Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 Wakefield Street (corner Wakefield &amp; John Streets)</td>
<td>McLeod Lane (Between John and William Streets Hawthorn)</td>
</tr>
<tr>
<td>Service hours are usually 9am - 5pm weekdays</td>
<td>Health Service Building</td>
</tr>
<tr>
<td>Phone: 9214 8025</td>
<td>Room: SH102</td>
</tr>
<tr>
<td>Fax: 9214 5993</td>
<td>Ph: 9214 8483</td>
</tr>
<tr>
<td></td>
<td>Fax: 9818 7548</td>
</tr>
</tbody>
</table>
Privacy, confidentiality and research output...
Your participation in this study is not anonymous, because the student investigator will see you during the testing session. You will be allocated a unique code number which will be put on your questionnaires and recorded response data. **There will be no information linking identifying information (i.e. informed consent forms) with your allocated code number after data collection is completed.** Your signed consent forms will be stored separately to your questionnaires and recorded response data and only the student investigator will have access to them. The results of this investigation will be presented as a part of a PhD thesis. Only group data will be presented and no individuals will be identified if the results of this study are published in a scientific journal.

Storage and destruction of data...
During the study, consent forms and questionnaires will be stored in separate locked filing cabinets at Swinburne University accessible ONLY to the main student investigator. Recorded response data will be stored on a password-protected data file on the main student investigator’s private computer and on a USB accessible ONLY to the main student investigator and principal investigator. When questionnaire and response data is moved to an electronic format for analysis, it will be stored on a password-protected data file on the main student investigator’s private computer and on a USB accessible ONLY to the main student investigator and principal investigator. Questionnaire data and recorded response data will be linked using a random code which will not be traceable to any identifying information, thus maintaining confidentiality. Data will be held for a minimum of 5 years post publication, after which it will be destroyed.

Concerns & complaints...
If there are any questions, concerns or complaints involving this study please contact: Associate Professor Greg Murray, Swinburne University of Technology, PO Box 218, Hawthorn, Victoria 3122, Tel (03) 9214 8300 or email gwm@swin.edu.au.

This study conforms to the principles set out in the Swinburne University of Technology Policy on Research Ethics and the NHMRC guidelines as specified in the National Statement on Ethical Conduct on Research Involving Humans. This project has been approved by or on behalf of Swinburne’s Human Research Ethics Committee (SUHREC) in line with the National Statement on Ethical Conduct in Research Involving Humans. If you have any concerns or complaints about the conduct of this project you can contact: Research Ethics Officer, Office of Research & Graduate Studies (H68), Swinburne University of Technology, PO Box 218, HAWTHORN VIC 3122. Tel (03) 9214 5218 or resethics@swin.edu.au
**Consent Form**

1) I have been provided with a copy of the project consent information statement and verbal explanation and any questions I have asked have been answered to my satisfaction.

2) In relation to this project (please circle your response):

- I agree to complete questionnaires asking me about cognition and pain experience  
  YES  NO

- I agree to undergo the testing session as described above  
  YES  NO

- I agree to have my responses recorded using an audio recording device  
  YES  NO

3) I acknowledge that:
   a. my participation is voluntary and that I am free to withdraw from the project at any time without explanation;
   b. the project is for the purpose of research and not for profit;
   c. my personal information will be collected and retained for the purpose of carrying out this project, but will not be linked to my questionnaire or testing data;
   d. my anonymity is preserved and I will not be identified in publications or otherwise without my express written consent.

NAME OF PARTICIPANT………………………………………………………………

SIGNATURE………………………………………………………………………DATE…………………
Appendix C.
Language and Situated Simulation Coding Scheme


The response categories below are ordered from most to least linguistic (and, conversely, from least to most conceptual). When two or more categories were possible for coding a response, the most linguistic one was used. The general category of linguist responses included the specific categories of CF, BF, SS, RS, SN, and AN below. The general category of taxonomic responses included the specific categories of DH, DL, and DS. The general category of object-situation responses was identical to the specific category of OS. See the text for further description.

**CF Compound continuation forward**
These word associates produce larger compound phrases that are common in English and that may be lexicalized. A forward continuation is one where the association follows after the cue in the continuation. Each of these must be a common phrase to be included as a continuation, not just something that it is possible to say in English. The participant may just say part of the continuation (e.g., BEE → sting), or say the whole compound (e.g., BEE → bee sting).
Examples: BEE → sting, hive; GOLF → club, course

**CB Compound continuation backward**
These word associates produce larger compound phrases that are common in English and that may be lexicalized. A backward continuation is one where the association precedes the cue in the continuation. Each of these must be a common phrase to be included as a continuation, not just something that it is possible to say in English. The participant may just say part of the continuation (e.g., BEE → honey), or say the whole compound (e.g., BEE → honey bee).
Examples: BEE → honey; GOLF → miniature

**SS Sound similarity**
These word associates are “clang” sound-based associations. They could be rhymes or also words that sound very similar.
Examples: BUMPY → lumpy; ACCEPT → except

**RS Root similarity**
These word associates have the same root morpheme as the cue, either adding or deleting morphemes. Typically, the grammatical class of the cue and the association differ (e.g., a verb will produce a noun).
Examples: ACCEPT → acceptance

**SN Synonym**
These word associates have essentially the same meaning as the cue. They are not close taxonomically related concepts, which were usually coded instead as DS (i.e., different concepts at the same level of a taxonomy). There may be more than one synonym for a cue, especially for actions and abstract concepts.
Examples: CAR → automobile
AN Antonym
These word associates are have the opposite meaning of the cue. There may be more than one antonym for a cue.
Examples: ACCEPT → give, reject, deny, decline

DH Domain higher level category
These word associates are higher level categories in taxonomies that include the cue as a subcategory. Higher level categories could come from a variety of levels, and there could be more than one.
Examples: BEE → insect, bug, living thing

DL Domain lower level category
These word associates are lower level categories in taxonomies that are sub-categories of the cue. Lower level categories could come from a variety of levels, including specific individuals, and there could be more than one. Partonomic associations, such as BEE→ wing, are not included by are instead coded as OS (e.g., code BEE → honey bee, bumble bee as CB, not as TL).
Examples: CAR → sedan; DOLL → Raggedy Ann; EUROPE → France

DS Domain same level category
These word associates are contrasting categories at the same level of a taxonomy or semantic field, having common superordinate or domain, although this may be difficult to discern for actions and abstract concepts. There could be many contrasting concepts at the same taxonomic level for a cue, which may be fairly diverse and vaguely related for actions and events.
Examples: BEE → wasp, ant, grasshopper; ACCEPT → take, acknowledge, forgive

OS Object or Situation Descriptor
These word associates are a property of the cue concept or are some other associated aspect of the same situation, including settings, thematic objects, actions, events, goals, mental states, etc.
Examples: BEE → wings, summer, candles, flowers; GOLF → sunshine, boring, Jack Nicklaus

N None
The responses did not fit into any of the other ten coding categories.
Appendix D. Perceptual Symbol Systems Concept Properties Coding Scheme


Entity Properties. Properties of a concrete entity, either animate or inanimate. Besides being a single self-contained object, an entity can be a coherent collection of objects, or an institution, if it consists of at least some concrete entities (e.g., forest, government, and society).

Larger whole. A whole to which an entity belongs (e.g., window–HOUSE; apple–TREE).

Spatial relation. A spatial relation between two or more properties within an entity, or between an entity and one of its properties (e.g., car–window ABOVE door; watermelon–green OUTSIDE).

External surface property. An external property of an entity that is not a component, and that is perceived on or beyond the entity’s surface, including shape, color, pattern, texture, size, touch, smell, and taste (e.g., watermelon–OVAL; apple–RED; car–STINKS).

Internal surface property. An internal property of an entity that is not a component, that is not normally perceived on the entity’s exterior surface, and that is only perceived when the entity’s interior surface is exposed, including color, pattern, texture, size, touch, smell, and taste (e.g., apple–WHITE, watermelon–JUICY).

External component. A three-dimensional component of an entity that, at least to some extent, normally resides on its surface (e.g., car–HEADLIGHT; tree–LEAVES).

Internal component. A three-dimensional component of an entity that normally resides completely inside the closed surface of the entity (e.g., apple–SEEDS; jacket–LINING).

Systemic property. A global systemic property of an entity or its parts, including states, conditions, abilities, and traits (e.g., cat–ALIVE; dolphin–INTELLIGENT; car–FAST).

Entity behavior. An intrinsic action that is characteristic of an entity’s behavior, and that is not an entity’s normal function for an external agent, which is coded as SF (e.g., dog–BARKS; children–PLAY).

Associated abstract entity. An abstract entity associated with the target entity and external to it (e.g., computer–SOCIETY; transplanted Californian–RELIGIOUS AFFILIATION).

Quantity. A numerosity, frequency, or intensity of an entity or its properties (e.g., jacket–an ARTICLE of clothing; cat–FOUR legs; tree–LOTS of leaves; apple–COMMON fruit; watermelon–USUALLY green; apple–VERY red).
Situation Properties. A property of a situation, where a situation typically includes one or more participants, at some place and time, engaging in an event, with one or more entities (e.g., picnic, conversation, vacation, and meal).

Participant. A person in a situation who typically uses an entity or performs an action on it and/or interacts with other participants (e.g., toy–CHILDREN; car–PASSENGER; furniture–PERSON).

Location. A place where an entity can be found, or where people engage in an event or activity (e.g., car–IN THE GARAGE; buy–IN A STORE).

Spatial relation. A spatial relation between two or more things in a situation (e.g., watermelon–the ants crawled ACROSS the picnic table; car–drives ON the highway; vacation–we slept BY the fire).

Time. A time period associated with a situation or with one of its properties (e.g., picnic–FOURTH OF JULY; sled–DURING THE WINTER).

Action. An action that a participant performs in a situation (e.g., shirt–WORN; apple–EATEN).

Associated entity. An entity in a situation that contains the focal concept (e.g., watermelon–TABLE; cat–LITTER).

Function. A typical goal or role that an entity serves for an agent (e.g., car–TRANSPORTION; clothing–PROTECTION).

Quantity. A numerosity, frequency, or intensity of a situation or any of its properties except of an entity, whose quantitative aspects are coded with EQ (e.g., vacation–lasted for EIGHT days; car–a LONG drive).

Manner. The manner in which an action or behavior is performed (e.g., watermelon–SLOPPY eating; car–FASTER than walking).

Event. An event or activity in a situation (e.g., watermelon–PICNIC, car–TRIP).

State of the world. A state of a situation or any of its components except entities, whose states are coded with ESYS (e.g., mountains–DAMP; highway–CONGESTED).

Origin. How or where an entity originated (e.g., car–FACTORY; watermelon–GROUND).

Introspective properties. A property of a participant’s mental state as he or she views a situation, or a property of a participant’s mental state in a situation.

Affect/emotion. An affective or emotional state toward the situation or one of its components by either the participant or a participant (e.g., magic–a sense of EXCITEMENT; vacation–I was HAPPY; smashed car–ANGER).
Evaluation. A positive or negative evaluation of a situation or one of its components by either the participant or a participant (e.g., apples–I LIKE them; vacation–I wrote a STUPID

Representational state. A representational state in the mind of a situational participant, including beliefs, goals, and ideas (e.g., smashed car–believed it was not working; cut tree–wanted to cut it down).

Cognitive operation. An operation on a cognitive state, including retrieval, comparison, and learning (e.g., watermelon–I REMEMBER a picnic; rolled up lawn–LOOKS LIKE a burrito; car–I LEARNED how to drive).

Contingency. Contingency between two or more aspects of a situation, including if, enable, cause, because; depends, requires, correlated, uncorrelated, and negatively correlated (e.g., car–REQUIRES gas; tree–has leaves DEPENDING ON the type of tree; vacation–FREE FROM work; magic–I was excited BECAUSE I got to see the magician perform).

Quantity. Numerosity, frequency, or intensity of an introspection or one of its properties (e.g., truth–a SET of beliefs; buy–I was VERY angry at the saleswoman; magic–I was QUITE baffled by the magician).

Negation. An explicit mention of the absence of something, with the absence requiring a mental state that represents the opposite (e.g., car–NO air conditioning, apple–NOT an orange).
Appendix E.
Affect and pain coping style measures

Positive and Negative Affect Schedule
A brief version of the Positive and Negative Affect Schedule (PANAS, D. Watson, Clark, & Tellegen, 1988) was used to collect state mood information. According to the factor loadings of Zevon and Tellegen (1982); positive affect (PA) was measured on four items (Excited, Interested, Determined and Active) and negative affect (NA) was measured on five items (Upset, Guilty, Scared, Hostile and Jittery) of the original PANAS. Adequate reliability for the brief PA (ranging from $\alpha = .69$ to $\alpha = .88$) and NA (ranging from $\alpha = .55$ to $\alpha = .75$) scales have been reported (Murray, Goldstone, & Cunningham, 2007).

Participants were asked to rate each statement according to what extent they felt that way at the present moment on a 5-point scale ranging from 1 (Very slightly/not at all) to 5 (Extremely). PA scores ranged from 4-20 and NA scores ranged from 5-25, with higher scores indicating higher levels of PA and NA, respectively.

Pain Coping Questionnaire
The Pain Coping Questionnaire (PCQ, Reid, Gilbert, & McGrath, 1998) was used in the present study to measure pain coping styles. The original 39-item scale consisted of eight subscales (information seeking, problem solving, seeking social support, positive self-statements, behavioural distraction, cognitive distraction, externalising, internalising/catastrophising) and three second-order scales (approach, problem-focused avoidance, emotion-focused avoidance) and was originally designed for use with children (Huguet, Miro, & Nieto, 2009; Reid, et al., 1998). However, a number of studies have used the PCQ in adult populations (Inman, Faut-Callahan, Swanson, & Fillingim, 2004; Unruh, Judith Ritchie, & Merskey, 1999).

Analyses of the PCQ in adults have suggested that the seven subscale PCQ model provided the best fit for adult sample data (Huguet, et al., 2009; Thastum, Zachariae, Scholer, & Herlin, 1999). The suggested subscales were information seeking/problem solving, seeking social support, positive self-statements, behavioural distraction, cognitive distraction, externalising, internalising/catastrophising (Thastum, et al., 1999). The three second order factors did not fit the adult sample data and high internal consistency ($\alpha$ ranging between .70-.91) and good construct validity were found for the seven subscales of the PCQ (Huguet, et al., 2009). Thus, only the seven subscales were employed for the primary study of the present project.

The PCQ used in Study 3 consisted of the original 39-items which were scored on a 5-point scale ranging from 1 (Never) to 5 (Very often). Participants were asked to rate each item based on how often they respond in the way described in each statement when they are in pain for a few hours or days. An example of an item from the PCQ is: “Talk to a friend about how I feel”. The score for each PCQ subscale was calculated by summing the ratings given for each item within each scale, and dividing by the number of items in that scale.
Appendix F.
Online questionnaire

1. Participant code:_____________

2. Age:___________

3. Gender:

Male
Female

4. Dominant (preferred) hand:

Right
Left

5. Cultural background (most influenced by):

Western
Eastern
Both

6. Mood

This scale consists of a number of words that describe different feelings and emotions. Read each word and indicate to what extent you feel this way at the present moment using the provided scale.

<table>
<thead>
<tr>
<th></th>
<th>Very slightly or not at all</th>
<th>A little</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interested</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excited</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upset</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guilty</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scared</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hostile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determined</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jittery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7. Pain Experience

Place a check mark (x) next to those events you have experienced. If you have experienced the event please rate how painful the experience was by placing the number from the scale in the second column.

<table>
<thead>
<tr>
<th>Experienced?</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Broken limb (arm or leg).</td>
<td>____</td>
</tr>
<tr>
<td>2. Childbirth</td>
<td>____</td>
</tr>
<tr>
<td>3. Broken nose</td>
<td>____</td>
</tr>
<tr>
<td>4. Minor surgery (no general anesthetic)</td>
<td>____</td>
</tr>
<tr>
<td>5. Major surgery</td>
<td>____</td>
</tr>
<tr>
<td>6. Sprained ankle</td>
<td>____</td>
</tr>
<tr>
<td>7. Headaches</td>
<td>____</td>
</tr>
<tr>
<td>8. Concussion or head injury</td>
<td>____</td>
</tr>
<tr>
<td>9. Injections</td>
<td>____</td>
</tr>
<tr>
<td>10. Backache</td>
<td>____</td>
</tr>
<tr>
<td>11. Spinal tap</td>
<td>____</td>
</tr>
<tr>
<td>12. Cut hand or foot</td>
<td>____</td>
</tr>
<tr>
<td>13. Minor burns</td>
<td>____</td>
</tr>
<tr>
<td>14. Major burns</td>
<td>____</td>
</tr>
<tr>
<td>15. Toothache</td>
<td>____</td>
</tr>
<tr>
<td>16. &quot;jammed finger&quot;</td>
<td>____</td>
</tr>
<tr>
<td>17. Slam hand or finger in door</td>
<td>____</td>
</tr>
<tr>
<td>18. Bee or wasp stings</td>
<td>____</td>
</tr>
<tr>
<td>19. Pulled muscle</td>
<td>____</td>
</tr>
<tr>
<td>20. Dog bite or small mammal bite</td>
<td>____</td>
</tr>
<tr>
<td>21. Chest pain</td>
<td>____</td>
</tr>
<tr>
<td>22. Sunburn</td>
<td>____</td>
</tr>
<tr>
<td>23. Broken fingernail</td>
<td>____</td>
</tr>
<tr>
<td>24. Stomach cramps</td>
<td>____</td>
</tr>
<tr>
<td>25. Blister</td>
<td>____</td>
</tr>
<tr>
<td>26. Frostbite</td>
<td>____</td>
</tr>
<tr>
<td>27. Acid burn</td>
<td>____</td>
</tr>
<tr>
<td>28. Indigestion</td>
<td>____</td>
</tr>
<tr>
<td>29. Mosquito bite</td>
<td>____</td>
</tr>
<tr>
<td>30. Dust in eye</td>
<td>____</td>
</tr>
<tr>
<td>31. Slap in the face</td>
<td>____</td>
</tr>
<tr>
<td>32. Falling down on pavement</td>
<td>____</td>
</tr>
<tr>
<td>33. Stomach ulcer</td>
<td>____</td>
</tr>
<tr>
<td>34. Skin ulcer</td>
<td>____</td>
</tr>
<tr>
<td>35. Having hair pulled</td>
<td>____</td>
</tr>
<tr>
<td>36. Hitting finger with a hammer</td>
<td>____</td>
</tr>
<tr>
<td>37. Stepping on a nail or glass in bare feet</td>
<td>____</td>
</tr>
<tr>
<td>38. Muscle soreness</td>
<td>____</td>
</tr>
<tr>
<td>39. Menstrual cramps</td>
<td>____</td>
</tr>
</tbody>
</table>
8. Pain Coping Styles

Everyone has had a time when they have been hurt or in pain for a few hours or longer. For example, you might have had headache, a stomach ache, a bad muscle pull, pain in your joints (elbow, knee), back pain, an earache, or, for women, menstrual pain, etc. Below are some things that people might say, do, or think when they are hurt or in pain. We are interested in the things you do, say and think when you are in pain for a few hours or days’.

Please respond to the following statements on the scale from **never** to **very often** according to how often you respond in this way when you are hurt or in pain for a few hours or days.

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Hardly ever</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very Often</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ask questions about the problem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus on the problem and see how I can solve it. Focus on the problem and see how I can solve it</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Talk to a friend about how I feel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tell myself, don’t worry everything will be OK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Go and play</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>---------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forget the whole thing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Say mean things to people</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worry that I will always be in pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ask a nurse or doctor questions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Think about what needs to be done to make things better</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Talk to someone about how I am feeling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Say to myself, be strong</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do something fun</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ignore the situation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argue or fight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keep thinking about how much it hurts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Find out more information</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Think of different ways to deal with the problem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tell someone how I feel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tell myself it’s not so bad</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do something I enjoy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Try to forget it</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yell to let off steam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Think that nothing helps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learn more about how my body works</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Figure out what I can do about it</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Talk to a family member about how I feel</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Say to myself, things will be OK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do something active</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Put it out of my mind</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get mad and throw or hit something</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Think that the pain will never stop</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Try different ways to solve the problem until I find one that works</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Let my feelings out to a friend</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tell myself I can handle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anything that happens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do something to take my mind off it</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don’t think about it</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curse out loud</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worry too much about it</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. **Musical Preference**

Please rate the following styles of music based on how much you enjoy each style, using a 1-5 scale, where:

1 = totally dislike, 2 = dislike, 3 = neutral, 4 = like, 5 = like a lot.

Thank you for completing the questionnaire stage of this study. You will now move onto the experimental stage.
Appendix G.  
Heal and Non-Heal concept word groups and LSA analysis results

<table>
<thead>
<tr>
<th>Heal 1 LSA value (healed)</th>
<th>Heal 2 LSA value (healed)</th>
<th>Non-Heal 1 LSA value (healed)</th>
<th>Non-Heal 2 LSA value (healed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>well 0.21</td>
<td>rejuvenated -0.01</td>
<td>isky 0.07</td>
<td>considerate 0.04</td>
</tr>
<tr>
<td>revived 0.07</td>
<td>remedied 0</td>
<td>clever 0.16</td>
<td>provocative 0.04</td>
</tr>
<tr>
<td>alright -0.04</td>
<td>renewed 0.06</td>
<td>loved 0.21</td>
<td>captivating 0.22</td>
</tr>
<tr>
<td>better 0.15</td>
<td>restored 0.08</td>
<td>appreciated 0.23</td>
<td>privileged 0.03</td>
</tr>
<tr>
<td>healthy 0.06</td>
<td>good 0.13</td>
<td>honoured 0.07</td>
<td>attractive 0.05</td>
</tr>
<tr>
<td>cured 0.23</td>
<td>uplifted 0.04</td>
<td>adored 0.07</td>
<td>intelligent 0.09</td>
</tr>
<tr>
<td>refreshed 0.08</td>
<td>elated 0.17</td>
<td>idolised -0.04</td>
<td>sophisticated 0.06</td>
</tr>
<tr>
<td>lifted 0.18</td>
<td>improved 0.11</td>
<td>engaged 0.09</td>
<td>charming 0.07</td>
</tr>
<tr>
<td>thankful 0.11</td>
<td>joyful 0.1</td>
<td>prosperous 0.08</td>
<td>respected 0.18</td>
</tr>
<tr>
<td>regenerated 0.03</td>
<td>delighted 0.13</td>
<td>passionate 0.16</td>
<td>sexy 0.12</td>
</tr>
<tr>
<td>rehabilitated 0.19</td>
<td>happy 0.1</td>
<td>surprised 0.17</td>
<td>trusted 0.08</td>
</tr>
<tr>
<td>optimistic 0.05</td>
<td>fit 0.17</td>
<td>beautiful 0.15</td>
<td>honest 0.17</td>
</tr>
<tr>
<td>revitalised 0.02</td>
<td>energised 0</td>
<td>seductive 0.03</td>
<td>proud 0.22</td>
</tr>
<tr>
<td>relieved 0.19</td>
<td>lively 0.15</td>
<td>affectionate 0.1</td>
<td>unsselfish 0.07</td>
</tr>
<tr>
<td>strengthened 0.1</td>
<td>aroused 0.06</td>
<td>fascinated 0.19</td>
<td>cool 0.07</td>
</tr>
<tr>
<td>stimulated 0.05</td>
<td>enthusiastic 0.08</td>
<td>intrigued 0.04</td>
<td>friendly 0.12</td>
</tr>
<tr>
<td>empowered -0.01</td>
<td>pleased 0.19</td>
<td>impulsive 0.04</td>
<td>generous 0.19</td>
</tr>
</tbody>
</table>
Appendix H.
Debrief statement

As you may remember, you participated in a study examining the effect of music on cognition and pain perception sometime in the last two years. During the study you were asked to make a number of word evaluations about the concept ‘heal’ and place your hand in icy water then record your pain ratings, whilst listening to music. I thank you again for participating in my study.

Now that the study has been completed I can inform you that we were not actually testing the effects of music on cognition and pain perception but the effect of bodily posture on cognition and pain perception. The effect of bodily posture on cognition is known as embodied cognition. The classical theory of cognition says that we learn about concrete concepts (which are physical concepts that we can see, touch etc) during development through our interactions with them in the environment. Then at a particular age it is said that we develop the ability to think abstractly in a symbolic form. This is said to happen within our own heads, separate from our body’s interaction with the environment. Embodied cognition says that this separation from the environment in our thinking never occurs. Instead we continually learn about concepts including abstract ones such as anger, healing and truth through our interactions and experiences of them in our environments. This study concentrated on the concept of healing and its relationship to the bodily posture of ‘up’. That is the theory that the concept of healing is partially learnt through our experience of it in the ‘up’ bodily posture. This come from observations that when we experience healing, either psychological or physical, we are usually in an ‘upward’ body posture. Thus, accessing knowledge about healing can be aided by being in the bodily posture that the concept of healing was learnt through or by simulation of that bodily posture. Simulation is very similar to imagination. In turn, it is theorised that our experience of healing can be influenced by thinking about healing. Thus healing may be enhanced by being in (or simulating) the bodily posture of ‘up’ in a situation where healing is required, i.e when in pain.

We told you that we were testing the effect of music on cognition and pain perception because we did not want to draw your attention to the bodily posture aspect of the study as it may have influenced the results. For example, there is a greater chance that you may have subconsciously evaluated the words in the ‘up’ position faster than the ‘down’ position if you had known the true aims of the study. Likewise you may have subconsciously rated greater healing in the ‘up’ condition than the ‘down’ condition in the cold pressor study. These are the results we expected to obtain but we did not want them to be influenced by your knowledge of the aims.

We hope you understand the need for deception in this particular study. If you have any concerns or complaints about the conduct of this project you can contact:
Research Ethics Officer, Office of Research & Graduate Studies (H68), Swinburne University of Technology, PO Box 218, HAWTHORN VIC 3122. Tel (03) 9214 5218 or resethics@swin.edu.au. (will be referred to the information sheet, which will be given to all participants).

If you have any questions or queries regarding the study please email me at nleitan@swin.edu.au.
Appendix I.
Studies 2 and 3 information and consent documents

Consent Information Statement

Why we are conducting this study…
The primary aim of this study is to examine the effect of background music on cognitive (thinking) processing and pain perception. A number of previous studies have found that music can aid or hinder cognitive processing and can affect people’s perception of pain. The findings of this study will add to the knowledge of how music can enhance cognition, which has important implications for learning, teaching and study techniques and it will also add to the knowledge of how to better deal with pain using music.

What you will have to do…
If you choose to participate in this study you will be asked to come to Swinburne University, Hawthorn for a testing session which will last no longer than 1 hour and consists of 2 distinct tasks. When you come in, you will first be asked to sign a consent form if you are still happy to go through with the study. Following this you will be asked to complete a questionnaire after which experimental testing will begin. During the testing session you will be asked to do 2 tasks, a Cognitive Task and a Pain Perception Task.

Cognitive Task
The cognitive task consists of making a number of word evaluations whilst listening to background music and sometimes making movements with parts of your body (head and hands). You will be seated in front of a projector screen, on which words will appear to which you are to respond to by pressing buttons on a keyboard.

Pain Perception Task
The pain perception task consists of placing your non preferred hand in cold water (6-8 degrees celcius) for 1 minute or until the pain feels uncomfortable enough that you voluntarily remove your hand (this is called the cold pressor task and is a commonly used in pain experiments). The cold pressor task will cause short term pain which dissipates quickly after removal of your arm from the water and will NOT cause any permanent tissue damage or long term pain. The experiment will also involve reporting the level of pain you experience on placing your hand in the water, after you take it out and after 30, 60, 90 and 120 seconds whilst listening to background music. You will be given a chance to ask questions after the testing session.

Reimbursement and prizes…
If you participate in and complete the study you will receive a $20 gift voucher for your time and effort.

Exclusion criteria and side effects…
If you have cardiovascular or pain-related medical conditions or a history of frostbite, fainting, seizures or Reynaud’s syndrome (discolouration of fingers, toes etc.), you should not participate in this study. The short term side effects of the study may be cold pain in the arm, but no tissue damage can occur with the cold pressor task used in this study. If an issue of concern comes to light during the experiment, you may obtain counselling from the on campus service or medical assistance from the on campus doctor. Below are the contact details for the Swinburne University Counselling and Medical Clinics (note that these services are free for all Swinburne students). You can also contact these services if you have any psychological or physiological concerns during the course of this study which for any reason you do not want to reveal to the primary investigator or SUHREC.
Privacy, confidentiality and research output...
Your participation in this study is not anonymous, because we will see you during the testing session. However, your results will be unidentifiable. You will be allocated a unique code number which will link your questionnaire and computer data. **There will be no information linking identifying information (i.e. informed consent forms) with your allocated code number after data collection is completed.** The results of this investigation will be presented as a part of a PhD thesis. Only group data will be presented and no individuals will be identified if the results of this study are published in a scientific journal.

Your rights...
Your participation in this study is completely voluntary. Your initial agreement of participation in this study does not stop you from discontinuing participation and you are free to withdraw at any time. Please consider the purposes and time commitment of this study before you decide whether or not to participate. Please feel free to print out and retain this information sheet for your records. You will also be given a hard copy of it before you sign consent if you choose to participate in the study.

Concerns & complaints...
If there are any questions, concerns or complaints involving this study please contact: Dr. Greg Murray, Swinburne University of Technology, PO Box 218, Hawthorn, Victoria 3122, Tel (03) 9214 8300 or email gwm@swin.edu.au.

This study conforms to the principles set out in the Swinburne University of Technology Policy on Research Ethics and the NHMRC guidelines as specified in the National Statement on Ethical Conduct on Research Involving Humans. This project has been approved by or on behalf of Swinburne’s Human Research Ethics Committee (SUHREC) in line with the National Statement on Ethical Conduct in Research Involving Humans. If you have any concerns or complaints about the conduct of this project you can contact: Research Ethics Officer, Office of Research & Graduate Studies (H68), Swinburne University of Technology, PO Box 218, HAWTHORN VIC 3122. Tel (03) 9214 5218 or resethics@swin.edu.au
Consent Form

1) I have been provided with a copy of the project consent information statement and verbal explanation and any questions I have asked have been answered to my satisfaction.

2) The effects of the cold pressor task have been explained to me to my satisfaction and I consent to undergo the task.

3) To the best of my knowledge I do not have a pain related or cardiovascular condition or a history of frostbite, fainting, seizures or Reynaud’s syndrome.

4) I acknowledge that:
   
   e. my participation is voluntary and that I am free to withdraw from the project at any time without explanation;
   
   f. the project is for the purpose of research and not for profit;
   
   g. my personal and/or health information will be collected and retained for the purpose of carrying out this project;
   
   h. my personal and/or health information will be accessed and analysed by the researcher(s) for the purpose of conducting this project;
   
   i. my anonymity is preserved and I will not be identified in publications or otherwise without my express written consent.

NAME OF PARTICIPANT

SIGNATURE.................................................. DATE....................

Email (preferably your permanent email, not student): ........................................
Appendix J.
Study 2 group differences analyses

Pearson’s Chi Square statistics were conducted to compare any potentially confounding differences in sex, primary language and background and a series of independent samples t-tests were conducted to compare any potentially confounding differences in age and affect. As displayed in Table A1, Pearson’s Chi Square indicated no significant differences in sex or primary language between the two groups and as displayed in Table A2, independent samples t-tests indicated no significant differences in age or affect between the two groups.

Table A1.
Pearson’s Chi Square statistics for sex and primary language for visual and visual+ motor groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Values</th>
<th>N</th>
<th>Visual Frequency</th>
<th>%</th>
<th>Visual + motor Frequency</th>
<th>%</th>
<th>X²</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>30</td>
<td>14</td>
<td>15</td>
<td>24.14</td>
<td>16 (15)</td>
<td>27.59</td>
<td>.276</td>
<td>1</td>
<td>.599</td>
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<tr>
<td>Female</td>
<td>28</td>
<td>15</td>
<td>14</td>
<td>25.86</td>
<td>13 (14)</td>
<td>22.41</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary Language</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>33</td>
<td>18</td>
<td>16.5</td>
<td>31.03</td>
<td>15 (16.5)</td>
<td>25.86</td>
<td>2.99</td>
<td>2</td>
<td>.224</td>
</tr>
<tr>
<td>ESL</td>
<td>19</td>
<td>10</td>
<td>9.5</td>
<td>17.24</td>
<td>9 (9.5)</td>
<td>15.52</td>
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<td>Bilingual</td>
<td>6</td>
<td>1</td>
<td>3</td>
<td>1.72</td>
<td>5 (3)</td>
<td>8.62</td>
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<td>Background</td>
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<tr>
<td>Western</td>
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<td>25.86</td>
<td>15 (15)</td>
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<td>Eastern</td>
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<td>12</td>
<td>12</td>
<td>20.69</td>
<td>12 (12)</td>
<td>20.69</td>
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<tr>
<td>Both</td>
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<td>2</td>
<td>3.45</td>
<td>2 (2)</td>
<td>3.45</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N = 58 (29 per strength group)
ESL = English second language

The Chi Square assumption of “expected cell frequency” is violated where 16.67% of cells have expected frequencies <5.

NB. Expected cell frequencies are shown in parentheses
Table A2. *Group means and t-test statistics for age and affect for visual and visual + motor groups*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Visual Mean (SD)</th>
<th>Visual + motor Mean (SD)</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>30.21 (12.56)</td>
<td>28.75 (10.71)</td>
<td>0.469</td>
<td>54</td>
<td>.641</td>
</tr>
<tr>
<td>Affect</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>3.34 (.66)</td>
<td>3.03 (.71)</td>
<td>1.732</td>
<td>56</td>
<td>.089</td>
</tr>
<tr>
<td>NA</td>
<td>1.34 (.26)</td>
<td>1.25 (.24)</td>
<td>0.701</td>
<td>56</td>
<td>.486</td>
</tr>
</tbody>
</table>

PA = Positive Affect  
NA = Negative Affect  
Nage = 56 (28 per strength group - 2 missing values, 2 excluded in initial data screen)  
NPA = 58 (29 per strength group, 2 excluded in initial data screen)  
NNA = 58 (29 per strength group, 2 excluded in initial data screen)
Appendix K.
Study 2 further analysis

The interaction between direction and strength was further examined despite its nonsignificance. A visual depiction of the interaction between direction type and simulation trigger is shown in Figure A1. The graph suggests that response latencies were shorter for the visual group compared to the visual + motor group across direction conditions. Further inspection revealed an unpredicted, nonsignificant trend ($F(1,56) = 0.961, p = 0.331$) towards shorter response latencies for the visual group compared to the visual + motor group across direction conditions.

*Figure A1.* Mean response latencies for up and down trials between strength groups. Error bars represent one standard error.
Appendix L.
Study 2 qualifications

Firstly, unlike primes in traditional priming paradigms (see Section 12.5.1, p. 139) which are implicit, the prime utilised in Study 2 was presented explicitly. Although the prime was presented explicitly, it was implicit in that it was presented “without awareness on the part of the participant as to the purposes of the experimental procedures/testing” (Ober, 2002, p. 883). Thus, the Study 2 priming paradigm can be argued to be a legitimate priming paradigm.

A second set of qualification pertains to the type of priming elicited in Study 2. Firstly, although the relationship between the up bodily state and the heal concept is learnt through their association, Perceptual Symbol Systems theory implies that the up bodily state is a constituent of the heal concept. Thus, in the Study 2 design the up bodily state prime can be considered more semantic than associative priming of the heal concept.

Secondly, due to the Perceptual Symbol Systems theory assumption that conceptual knowledge is underpinned by the sensorimotor system, semantic priming in Study 2 also involved spatial priming. The standard theory of spatial priming is that “when attention is directed toward a specific region of visual space, stimuli presented to that location are detected and discriminated with greater speed and accuracy than are comparable stimuli presented to unattended locations” (Mangun & Hillyard, 1991, p. 1057). However, under the Study 2 priming paradigm, the spatial aspect (e.g., visual or motor priming of the up bodily state embodiment) has less to do with spatial attention and more to do with the semantic nature of the up bodily state embodiment, which is argued to constitute part of the heal concept. Thus, perceptual aspects of the prime (e.g., spatial component in the case of Study 2) formed the semantic relationship between the prime and target. Therefore, semantic/conceptual priming, operationalised as a type of spatial priming was used in the Study 2 priming paradigm.
Appendix M.
Visual analogue scales

**Pain Sensation**
(Sensation intensity)

Pain upon immersion of hand in water:
Please indicate on the line below with a vertical stroke to show how painful your hand feels.

No Sensation          Most intense sensation imaginable

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<table>
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<tbody>
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<td></td>
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</table>
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**Pain Affect:**
(Unpleasantness)

Affect upon immersion of hand in water:
Please indicate on the line below with a vertical stroke to show how painful your hand feels.

Not bad at all          Most intense bad feeling possible for me

```
<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>
```

Appendix N.

Visual analogue scale instructions

There are 2 aspects of pain that we are interested in measuring: The intensity, which is how strong the pain feels, and the unpleasantness, which is how disturbing the pain is for you. The distinction between these 2 aspects of pain might be made clearer if you think of listening to a sound, such as a radio. As the volume of the sound increases, I can ask you how loud it sounds, or how unpleasant it is to you. The intensity of the pain is like loudness; the unpleasantness of the pain depends not only on intensity, but also on other factors that may affect you. Although some pain sensations may be equally intense and unpleasant, we would like you to judge these 2 aspects of your pain independently. (This passage was stated verbally to the participant, not in writing).
Appendix O.  
Factor retention methods for healing sensation

**Velicer’s MAP**
Run MATRIX procedure:

Velicer's Minimum Average Partial (MAP) Test:

Eigenvalues  
3.3624  
.4682  
.0988  
.0705

Average Partial Correlations

<table>
<thead>
<tr>
<th></th>
<th>squared</th>
<th>power4</th>
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</thead>
<tbody>
<tr>
<td>.0000</td>
<td>.6283</td>
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</tr>
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<td>1.0000</td>
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<td>2.0000</td>
<td>.3616</td>
<td>.2625</td>
</tr>
<tr>
<td>3.0000</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

The smallest average squared partial correlation is .3155

The smallest average 4th power partial correlation is .1368

The Number of Components According to the Original (1976) MAP Test is 1

The Number of Components According to the Revised (2000) MAP Test is 1

----- END MATRIX ----- 

“The number of components that produces the minimum mean squared partial correlation is the number of components to retain” (Tabachnick & Fidell, 2007, p. 645)

For healing sensation data = 1 component

**Horn’s Parallel Analysis**
Run MATRIX procedure:

PARALLEL ANALYSIS:

Principal Components
Specifications for this Run:
Ncases 56
Nvars 4
Ndatsets 100
Percent 95

Random Data Eigenvalues

<table>
<thead>
<tr>
<th>Root</th>
<th>Means</th>
<th>Percentyle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000000</td>
<td>-5898.867394</td>
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</tr>
<tr>
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<td>1.142376</td>
</tr>
<tr>
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</tr>
<tr>
<td>4.000000</td>
<td>-5899.117329</td>
<td>.822946</td>
</tr>
</tbody>
</table>

----- END MATRIX -----

Total Variance Explained

<table>
<thead>
<tr>
<th>Factor</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>% of Variance</td>
</tr>
<tr>
<td>1</td>
<td>3.363</td>
<td>84.067</td>
</tr>
<tr>
<td>2</td>
<td>.468</td>
<td>11.699</td>
</tr>
<tr>
<td>3</td>
<td>.099</td>
<td>2.472</td>
</tr>
<tr>
<td>4</td>
<td>.071</td>
<td>1.763</td>
</tr>
</tbody>
</table>

Extraction Method: Maximum Likelihood.

“Only components from the real dataset whose eigenvalues exceed the averaged eigenvalue from the randomly generated dataset are retained” (Tabachnick & Fidell, 2007, p. 645)

For healing sensation data = 1 component

Scree Plot
“You look for the point where a line drawn through the point changes slope”  
(Tabachnick & Fidell, 2007, p. 644)

For healing sensation data = 1 component

**Kaiser-Guttman criterion**

Because the variance that each standardised variable contributes to a principal components extraction is 1, a component with an eigenvalue less than 1 is not important from a variance perspective, as an observed variable…if this is a reasonable number of factors for the data, if the number of variables is 40 or fewer, and if the sample size is large, the number of factors indicated by this criterion is probably right. (Tabachnick & Fidell, 2007, p. 644)

For healing sensation data = 1 component
Appendix P.
Factor retention methods for healing affect

Velicer’s MAP
Run MATRIX procedure:

Velicer's Minimum Average Partial (MAP) Test:

Eigenvalues
  3.4627
  .4274
  .0711
  .0388

Average Partial Correlations squared power4
  .0000 .6816 .5004
  1.0000 .2780 .1388
  2.0000 .3950 .2603
  3.0000 1.0000 1.0000

The smallest average squared partial correlation is .2780
The smallest average 4th power partial correlation is .1388

The Number of Components According to the Original (1976) MAP Test is 1
The Number of Components According to the Revised (2000) MAP Test is 1

----- END MATRIX ----- 

“The number of components that produces the minimum mean squared partial correlation is the number of components to retain” (Tabachnick & Fidell, 2007, p. 645)

For healing affect data = 1 component

Horn’s Parallel Analysis
Run MATRIX procedure:

PARALLEL ANALYSIS:

Principal Components
Specifications for this Run:
Ncases 60
Nvars 4
Ndatasets 100
Percent 95

Random Data Eigenvalues

<table>
<thead>
<tr>
<th>Root</th>
<th>Means</th>
<th>Prcentyle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000000</td>
<td>-5898.892203</td>
<td>1.351480</td>
</tr>
<tr>
<td>2.000000</td>
<td>-5898.966075</td>
<td>1.168878</td>
</tr>
<tr>
<td>3.000000</td>
<td>-5899.034794</td>
<td>.976755</td>
</tr>
<tr>
<td>4.000000</td>
<td>-5899.106927</td>
<td>.825156</td>
</tr>
</tbody>
</table>

----- END MATRIX -----
“You look for the point where a line drawn through the point changes slope”
(Tabachnick & Fidell, 2007, p. 644)

For healing affect data = 1 component

**Kaiser-Guttman criterion**
Because the variance that each standardised variable contributes to a principal components extraction is 1, a component with an eigenvalue less than 1 is not important from a variance perspective, as an observed variable…if this is a reasonable number of factors for the data, if the number of variables is 40 or fewer, and if the sample size is large, the number of factors indicated by this criterion is probably right. (Tabachnick & Fidell, 2007, p. 644)

For healing affect data = 1 component
Appendix Q.
Study 3 group differences analyses

Two sets of Pearson’s Chi Square statistics were conducted to compare any potentially confounding differences in sex and background and two one-way ANOVAs were conducted to compare any potentially confounding differences in age, affect and pain coping styles for healing sensation and healing affect. As displayed in Table A3 and A4, Pearson’s Chi Square indicated no significant differences in sex or primary language between the four groups for healing sensation and healing affect, respectively. As displayed in Table A5 and A6, the one-way ANOVAs indicated no significant differences in age, affect or pain coping style between the four groups for healing sensation and healing affect, respectively.
Table A3.
*Pearson’s Chi Square statistics for sex and background for healing sensation up/visual, up/visual + motor, down/visual, and down/visual + motor groups*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Values</th>
<th>Frequency</th>
<th>%</th>
<th>Frequency</th>
<th>%</th>
<th>Frequency</th>
<th>%</th>
<th>Frequency</th>
<th>%</th>
<th>$X^2$</th>
<th>df</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
<td>7 (7)</td>
<td>12.50</td>
<td>9 (7.5)</td>
<td>16.07</td>
<td>5 (6.5)</td>
<td>8.93</td>
<td>7 (7)</td>
<td>12.50</td>
<td>1.29</td>
<td>3</td>
<td>.731</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>7 (7)</td>
<td>12.50</td>
<td>6 (7.5)</td>
<td>10.71</td>
<td>8 (6.5)</td>
<td>14.29</td>
<td>8 (7)</td>
<td>14.29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Background</td>
<td>Western</td>
<td>9 (7)</td>
<td>16.07</td>
<td>8 (7.5)</td>
<td>14.29</td>
<td>5 (6.5)</td>
<td>8.93</td>
<td>6 (7)</td>
<td>10.71</td>
<td>4.86 $^a$</td>
<td>6</td>
<td>.567</td>
</tr>
<tr>
<td></td>
<td>Eastern</td>
<td>5 (6)</td>
<td>8.93</td>
<td>7 (6.4)</td>
<td>12.50</td>
<td>6 (5.6)</td>
<td>10.71</td>
<td>6 (6)</td>
<td>10.71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Both</td>
<td>0 (1)</td>
<td>0</td>
<td>0 (1.1)</td>
<td>0</td>
<td>2 (.9)</td>
<td>3.57</td>
<td>2 (1)</td>
<td>3.57</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$N = 56$ (14 in up/visual group, 15 in up/visual + motor group, 13 in down/visual group and 14 in down/visual + motor group)

$^a$ The Chi Square assumption of “expected cell frequency” is violated where 33.3% of cells have expected frequencies <5.

*Note.* - Expected cell frequencies are shown in parentheses
Table A4. 
Pearson’s Chi Square statistics for sex and background for healing affect up/visual, up/visual + motor, down/visual, and down/visual + motor groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Values</th>
<th>Frequency</th>
<th>%</th>
<th>Frequency</th>
<th>%</th>
<th>Frequency</th>
<th>%</th>
<th>Frequency</th>
<th>%</th>
<th>X²</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>up/visual</td>
<td></td>
<td>up/visual + motor</td>
<td></td>
<td>down/visual</td>
<td></td>
<td>down/visual + motor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>8 (7.5)</td>
<td>13.33</td>
<td>9 (7.5)</td>
<td>15</td>
<td>6 (7.5)</td>
<td>10</td>
<td>7 (7.5)</td>
<td>11.67</td>
<td>1.33</td>
<td>3</td>
<td>.721</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>7 (7.5)</td>
<td>11.67</td>
<td>6 (7.5)</td>
<td>10</td>
<td>9 (7.5)</td>
<td>15</td>
<td>8 (7.5)</td>
<td>13.33</td>
<td></td>
<td></td>
<td></td>
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<td>Background</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western</td>
<td>9 (7.5)</td>
<td>15</td>
<td>8 (7.5)</td>
<td>13.33</td>
<td>7 (7.5)</td>
<td>11.67</td>
<td>6 (7.5)</td>
<td>10</td>
<td>4.82</td>
<td>6</td>
<td>.567</td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
<td>6 (6.5)</td>
<td>10</td>
<td>7 (6.5)</td>
<td>11.67</td>
<td>7 (6.5)</td>
<td>11.67</td>
<td>6 (7.5)</td>
<td>10</td>
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</tr>
<tr>
<td>Both</td>
<td>0 (1)</td>
<td>0</td>
<td>0 (1)</td>
<td>0</td>
<td>2 (1)</td>
<td>3.33</td>
<td>2 (1)</td>
<td>3.33</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(N = 60\) (15 in each direction/strength group)

\(^{a}\) The Chi Square assumption of “expected cell frequency” is violated where 33.3% of cells have expected frequencies <5.

Note. -Expected cell frequencies are shown in parentheses
Table A5.
Group means and ANOVA statistics for age, affect and pain coping style for healing sensation up/visual, up/visual + motor, down/visual, and down/visual + motor groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>up/visual Mean (SD)</th>
<th>up/visual + motor Mean (SD)</th>
<th>down/visual Mean (SD)</th>
<th>down/visual + motor Mean (SD)</th>
<th>F df1, df2</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>35.38 (15.30)</td>
<td>26.13 (5.37)</td>
<td>25.85 (8.00)</td>
<td>30.08 (13.82)</td>
<td>1.648</td>
<td>3, 24.747</td>
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<tr>
<td>Affect</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>3.45 (.75)</td>
<td>3.05 (.65)</td>
<td>3.21 (.45)</td>
<td>3.11 (.74)</td>
<td>.998</td>
<td>3, 52</td>
</tr>
<tr>
<td>NA</td>
<td>1.39 (.47)</td>
<td>1.11 (.13)</td>
<td>1.35 (.75)</td>
<td>1.43 (.59)</td>
<td>1.113</td>
<td>3, 52</td>
</tr>
<tr>
<td>Pain coping style</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PS</td>
<td>3.41 (.98)</td>
<td>3.66 (.39)</td>
<td>3.38 (.48)</td>
<td>3.80 (.77)</td>
<td>1.456</td>
<td>3, 27.133</td>
</tr>
<tr>
<td>CD</td>
<td>2.85 (.60)</td>
<td>3.03 (.60)</td>
<td>3.17 (.96)</td>
<td>2.86 (.84)</td>
<td>.551</td>
<td>3, 52</td>
</tr>
<tr>
<td>SSS</td>
<td>3.27 (.89)</td>
<td>3.32 (.75)</td>
<td>2.90 (.83)</td>
<td>3.40 (.82)</td>
<td>.995</td>
<td>3, 52</td>
</tr>
<tr>
<td>EXT</td>
<td>2.03 (.74)</td>
<td>2.12 (.66)</td>
<td>1.92 (.65)</td>
<td>2.24 (.84)</td>
<td>.475</td>
<td>3, 52</td>
</tr>
<tr>
<td>INT</td>
<td>2.26 (.75)</td>
<td>2.12 (.52)</td>
<td>1.74 (.63)</td>
<td>2.15 (.80)</td>
<td>1.458</td>
<td>3, 52</td>
</tr>
<tr>
<td>PSS</td>
<td>3.27 (.79)</td>
<td>3.69 (.57)</td>
<td>3.17 (.66)</td>
<td>3.29 (.93)</td>
<td>1.384</td>
<td>3, 52</td>
</tr>
<tr>
<td>BD</td>
<td>2.77 (.74)</td>
<td>3.13 (.66)</td>
<td>3.27 (.99)</td>
<td>3.00 (.76)</td>
<td>1.004</td>
<td>3, 52</td>
</tr>
</tbody>
</table>

PA = Positive Affect
NA = Negative Affect
PS = Problem Solving
CD = Cognitive Distraction
SSS = Seeking Social Support
EXT = Externalising
INT = Internalising/Catastrophising
PSS = Positive Self-Statement
BD = Behavioral Distraction

Nage = 54 (13 in up/visual group, 15 in up/visual + motor group, 13 in down/visual group, 13 in down/visual + motor group – 2 missing, 4 excluded from initial data screen)

NPA = 56 (14 in up/visual group, 15 in up/visual + motor group, 13 in down/visual group, 14 in down/visual + motor group – 4 excluded from initial data screen)

NWA = 56 (14 in up/visual group, 15 in up/visual + motor group, 13 in down/visual group, 14 in down/visual + motor group – 4 excluded from initial data screen)

Npain coping style = 56 for each variable (14 in up/visual group, 15 in up/visual + motor group, 13 in down/visual group, 14 in down/visual + motor group – 4 excluded from initial data screen)

Note: Equal variances assumed (according to Levene’s test) for all variables except for Age and Pain coping style PS. Non-parametric Welch statistics used for these 2 variables
Table A6.

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Affect</th>
<th>Pain coping style</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>up/ visual</td>
<td>up/ visual + motor</td>
<td>down/ visual</td>
</tr>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Age</td>
<td>34.93 (14.80)</td>
<td>26.13 (5.37)</td>
<td>25.73 (7.57)</td>
</tr>
<tr>
<td>Affect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>3.52 (.77)</td>
<td>3.05 (.65)</td>
<td>3.17 (.46)</td>
</tr>
<tr>
<td>NA</td>
<td>1.36 (.47)</td>
<td>1.11 (.13)</td>
<td>1.31 (.70)</td>
</tr>
<tr>
<td>Pain coping style</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PS</td>
<td>3.49 (.99)</td>
<td>3.66 (.38)</td>
<td>3.38 (.46)</td>
</tr>
<tr>
<td>CD</td>
<td>2.88 (.59)</td>
<td>3.03 (.60)</td>
<td>3.27 (.93)</td>
</tr>
<tr>
<td>SSS</td>
<td>3.16 (.97)</td>
<td>3.32 (.75)</td>
<td>2.96 (.79)</td>
</tr>
<tr>
<td>EXT</td>
<td>1.99 (.73)</td>
<td>2.12 (.66)</td>
<td>1.93 (.60)</td>
</tr>
<tr>
<td>INT</td>
<td>2.19 (.78)</td>
<td>2.12 (.52)</td>
<td>1.72 (.61)</td>
</tr>
<tr>
<td>PSS</td>
<td>3.36 (.84)</td>
<td>3.69 (.57)</td>
<td>3.35 (.79)</td>
</tr>
<tr>
<td>BD</td>
<td>2.70 (.76)</td>
<td>3.13 (.66)</td>
<td>3.30 (.96)</td>
</tr>
</tbody>
</table>

PA = Positive Affect  
NA = Negative Affect
PS = Problem Solving
CD = Cognitive Distraction
SSS = Seeking Social Support
EXT = Externalising
INT = Internalising/Catastrophising
PSS = Positive Self-Statement
BD = Behavioral Distraction

Nage = 58 (14 in up/visual group and down/visual + motor group and 15 in up/physically augmented group and down/visual group – 2 missing)
NPA = 60 (15 in each direction/strength group)
NNA = 60 (15 in each direction/strength group)
Pain coping style = 60 (15 in each direction/strength group)

NB. Equal variances assumed (according to Levene’s test) for all variables except for Age and Pain coping style PS. Non-parametric Welch statistics used for these 2 variables.
Appendix R.
Ethics clearance letter and compliance statement

Study 1
To: A/Prof Greg Murray, FLSS/Mr Nuwan Leitan

Dear Prof Murray,

SUHREC Project 2010/217 The Representation of Concepts: A Property Generation Study
A/Prof Greg Murray, FLSS/Mr Nuwan Leitan
Approved Duration: 19/10/2010 To 19/09/2012 [Adjusted]

I refer to the ethical review of the above project protocol undertaken on behalf of Swinburne's Human Research Ethics Committee (SUHREC) by SUHREC Subcommittee (SHESC2) at a meeting held on 24 Sept 2010. Your responses to the review as e-mailed on 6 and 17 October have been reviewed by a SHESC2 delegate.

I am pleased to advise that, as submitted to date, the project has approval to proceed in line with standard on-going ethics clearance conditions here outlined.

- All human research activity undertaken under Swinburne auspices must conform to Swinburne and external regulatory standards, including the National Statement on Ethical Conduct in Human Research and with respect to secure data use, retention and disposal.

- The named Swinburne Chief Investigator/Supervisor remains responsible for any personnel appointed to or associated with the project being made aware of ethics clearance conditions, including research and consent procedures or instruments approved. Any change in chief investigator-supervisor requires timely notification and SUHREC endorsement.

- The above project has been approved as submitted for ethical review by or on behalf of SUHREC. Amendments to approved procedures or instruments ordinarily require prior ethical appraisal/clearance. SUHREC must be notified immediately or as soon as possible thereafter of (a) any serious or unexpected adverse effects on participants and any redress measures; (b) proposed changes in protocols; and (c) unforeseen events which might affect continued ethical acceptability of the project.

- At a minimum, an annual report on the progress of the project is required as well as at the conclusion (or abandonment) of the project.

- A duly authorised external or internal audit of the project may be undertaken at any time.
Please contact me if you have any queries about on-going ethics clearance. The SUHREC project number should be quoted in communication. Chief Investigators/Supervisors and Student Researchers should retain a copy of this e-mail as part of project record-keeping.

Best wishes for the project.

Yours sincerely

Kaye Goldenberg

Secretary, SHESC2

Studies 2 and 3
To: Mr Nuwan Leitan for A/Prof Gregory Murray FLSS

Dear Nuwan,

SUHREC Project 2010/026 Embodied Meaning in Cognition and Experience: Healing
A/Prof Gregory Murray FLSS; Mr Nuwan Leitan
Approved duration: 09/07/2010 To 09/04/2013 [Adjusted]

I refer to the ethical reviews of the above project protocol undertaken by Swinburne's Human Research Ethics Committee (SUHREC). Your responses to the reviews, as e-mailed/submitted on 9 April, 9/28 June, 6/9 July 2010, were put to and approved by SUHREC delegates.

I am pleased to advise that, as submitted to date, the project has approval to proceed in line with standard on-going ethics clearance conditions here outlined.

- All human research activity undertaken under Swinburne auspices must conform to Swinburne and external regulatory standards, including the National Statement on Ethical Conduct in Human Research and with respect to secure data use, retention and disposal.

- The named Swinburne Chief Investigator/Supervisor remains responsible for any personnel appointed to or associated with the project being made aware of ethics clearance conditions, including research and consent procedures or instruments approved. Any change in chief investigator/supervisor requires timely notification and SUHREC endorsement.

- The above project has been approved as submitted for ethical review by or on behalf of SUHREC. Amendments to approved procedures or instruments ordinarily require prior ethical appraisal/clearance. SUHREC must be notified immediately or as soon as possible thereafter of (a) any serious or unexpected adverse effects on participants and any redress measures; (b) proposed changes in protocols; and (c) unforeseen events which might affect continued ethical acceptability of the project.
At a minimum, an annual report on the progress of the project is required as well as at the conclusion (or abandonment) of the project.

- A duly authorised external or internal audit of the project may be undertaken at any time.

Please contact me if you have any queries about the ethical review process, citing the SUHREC project number. Copies of clearance emails should be retained as part of project record-keeping.

Best wishes for the project.

Yours sincerely

Ann Gaeth
for Keith Wilkins
Secretary, SUHREC

Statement of compliance
I, Nuwan Leitan, certify that all conditions pertaining to the clearance were properly met, and that annual/final reports have been submitted.

Nuwan Leitan