Who has insights? The who, where, and when of the Eureka moment

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at Charles Sturt University in December, 2016
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Certificate of original authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma at Charles Sturt University or any other educational institution, except where due acknowledgment is made in the thesis.

Any contribution made to the research by colleagues with whom I have worked at Charles Sturt University or elsewhere during my candidature is fully acknowledged. I agree that this thesis be accessible for the purpose of study and research in accordance with the normal conditions established by the Executive Director, Library Services or nominee, for the care, loan and reproduction of theses.

Signature

Linda Alice Ovington

December, 2016
Acknowledgments

Thank you to Dr Jeremy Goldring for continuing to supervise me through my honours thesis and now my PhD, even after leaving Charles Sturt University to pursue clinical psychology. I appreciate your interest, enthusiasm with my project, and honesty with your feedback—it made me a better researcher and writer. The feedback and help was exactly what I needed. Professor Carmen Moran, although you only supervised me in the first year or so, I appreciate your ideas, listening to my ‘thinking out loud’ and encouragement. I hope retirement is keeping you busy. Dr Charini Gunaratne, thank you for coming in at the end and providing support while I went through the completion stage of my thesis, it actually helped a lot. Professor Anthony Saliba, thank you for allowing me to study something I am passionate about, to drive my own ideas, and giving me experiences and responsibilities outside my PhD candidature. All those experiences have made me a better academic in the long run. I appreciate the time, effort, and patience provided to me by all my supervisors. Dr Gene Hodgins, a big thank you for your support in the last few months of my candidature, as well as the mentoring you provided me while I was teaching a number of psychology subjects. Dr Ramudu Bhanugopan, thank you for suggesting and assisting in last minute changes to my thesis.

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I want to thank my family for supporting me through my education, from being a mature-aged undergraduate student, to honours, and now at the completion of my PhD thesis; I could not have done it without you. To my son Miles, most of your life I have
been a student, which meant that I was always working on either assignments, my thesis, and/or other paid work. You have always understood this, never complained, and showed that you have learnt to work hard at school. I am proud that you are such a lovely person and incredibly smart, for getting into the gifted school in primary (and high school), and for representing your high school in academic challenges. It is my greatest enjoyment to see you grow into a wonderful (future) adult. If you ever decide to do a PhD, I will be there to support you all the way. I would also like to acknowledge my best friend and partner Rodney Studdert for his unconditional support, kindness and patience.
Statement of contributions to jointly authored works contained in this thesis and published works by the author contained in this thesis

A component of the results derived from the research have been published in peer-review journals. Chapters 5 and 6 are based on the published articles. I was responsible for conceptualising, planning, and executing data collection for the studies in these manuscripts. I was also responsible for analysing the data and drafting the manuscript, along with communicating with the editors through the publication process.

My supervisors Professor Anthony Saliba, Doctor Jeremy Goldring, and Professor Carmen Moran provided peer review feedback on the research design and written expression. A student peer (PhD candidate), Jasmine MacDonald, also provided advice on the qualitative aspects of the manuscript based on Chapter 5. The accuracy of the published findings and the thesis are my responsibility.

Work published by the author and incorporated into the thesis


Professional editorial assistance

Professional editor, Michelle Hey, provided copyediting and proofreading services, according to the guidelines laid out in the university-endorsed national *Guidelines for editing research theses*.

Professional editor, Rosemary Purcell, provided copyediting according to the guidelines laid out in the university-endorsed national *Guidelines for editing research theses*. 
Preface

The year I completed my honours thesis was a tough year. Apart from dealing with personal issues, I also had difficulties getting through the thesis process. I had chosen a research topic I knew nothing about, and had trouble getting my head around the ideas. Then I had problems with the online data collection as the program did not work on many participants’ computers, so that delayed my results considerably. Then the data did not seem to support my hypotheses, and the writing-up became stifled by my confusion and anxiety. I would often go for walks to take time away from it. A few weeks before my thesis submission date, as I was predicting a fail or a bare pass, I decided to do some clothes washing. When it was done, I took it outside and began to peg it on the clothesline. At one point when I picked up some pegs and a piece of clothing and reached up to peg it in place, a flash went through my mind, my eyes widened, and a jolt of energy and excitement went through me—“that’s it—of course—how did I not see that!” (I had worked out what the problem was with my thesis and how to solve it).

Like all good cognitive scientists, I think the best metaphor to describe the experience is a computer one. It was like a .zip folder was sent to my head. I knew the information inside the .zip folder was the answer I was looking for. It came as a whole with all the information inside; all I had to do was extract the information from the folder. I ran inside and began to write. I was more productive that day than I had been in months. This insight significantly improved my thesis—I ended up with a first class. It was because of this insight that I ended up being accepted into a PhD with an Australian Postgraduate Award scholarship. I have had many insights before and since then. I wholeheartedly believe that insights have the ability to change not only people, but societies, communities, and even the world—if only others can understand our insights, which as Einstein discovered, is not always easy. Insights are so clear and (subjectively)
correct that sometimes when we try to put them into words, we fail. If we can truly understand insights and how to increase or deepen them, we can go a long way towards creating positive change.
Ms Linda Ovington
School of Psychology
Charles Sturt University

Dear Ms Ovington,

Thank you for the additional information forwarded in response to a request from the School of Psychology Ethics Committee.

The Committee has now approved your proposal entitled “Is insight a skill? Contrasting spontaneous and analytical problem solving as differential abilities” for a twelve month period beginning 13 December 2012. The protocol number issued with respect to the project is 113/2012/65. Please be sure to quote this number when responding to any request made by the Committee.

Please note the following conditions of approval:

- All Consent Forms and Information Sheets are to be printed on School letterhead.
- Students should liaise with their Supervisor to arrange to have these documents printed.
- You must notify the Committee immediately in writing should your research differ in any way from that proposed. Forms are available at www.csu.edu.au/research/forms/ehrc_annrep.doc
- You must notify the Committee immediately if any serious and or unexpected adverse events or outcomes occur associated with your research, that might affect the participants and therefore ethical acceptability of the project. An Adverse Incident form is available from the website: as above.
- Amendments to the research design must be reviewed and approved by the School Ethics Committee or if no longer minimal risk research referred to the University Human Research Ethics Committee before commencement. Forms are available at the website above.
- If an extension of the approval period is required, a request must be submitted to the School Ethics Committee or if no longer minimal risk research referred
to the University Human Research Ethics Committee. Forms are available at the website above.

- You are required to complete a Progress Report form, which can be downloaded as above, by 13 December 2013 if your research has not been completed by that date.
- You are required to submit a final report, the form is available from the website above.

You are reminded that an approval letter from the CSU HREC constitutes ethical approval only.

If your research involves the use of radiation, biological materials or chemicals separate approval is required from the appropriate University Committee.

Please don’t hesitate to contact Robyn Waddell telephone 6338 4580 or email psychethics@csu.edu.au if you have any enquiries about this matter.

Yours sincerely,
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Cc Associate Professor Anthony Saliba; Dr Jeremy Goldring; Professor Carmen Moran
List of abbreviations

ABS = Australian Bureau of Statistics
ACC = Anterior cingulate cortex
A-E = Assimilative and explorative
AGFI = Adjusted goodness of fit index
AMOS = Analysis of moment structures
ANOVA = Analysis of variance
APS = Arousal Predisposition Scale
BFI = Big-Five inventory
CAQ = Creative Achievement Questionnaire
CFI = Comparative fit index
CI = Confidence interval
CLARION = connectionist learning with adaptive rule induction online
CMIN = Minimum discrepancy function C
CMV = Common method variance
CRA = Compound remote association
CSI = Cognitive Style Index
CFA = Confirmatory factor analysis
df = degrees of freedom
DFS-2 = Dispositional Flow Scale-2
DIS = Dispositional Insight Scale
DMN = Default mode network
EFA = Exploratory factor analysis
EEG = Electroencephalography
EII = Explicit-Implicit Interaction
ESM = Experience sampling methods
FFP = Five-factor personality
FMA = Few moves available
FMI = Freiberg Mindfulness Inventory
fMRI = functional magnetic resonance imagery
FOW = Feelings of warmth
GFI = Goodness of fit index
HR = Heart rate
IQ = Intelligence quotient
ML = Maximum likelihood
MLE = Maximum likelihood estimation
MMA = Many moves available
MRA = Multiple regression analysis
NFC = Need for cognition
PANAS = Positive and Negative Affect Scale
PCLOSE = Close fit of the population
PCR = polymerase chain reaction
RAT = Remote Associates Test
REM = Rapid eye movement
RCT = Representational change theory
RMR = Root mean-square residual
RMSEA = Root mean-square error of approximation
SEC = Self-estimates of creativity
SEM = Structural equation modelling
SPSS = Statistical Package for the Social Sciences
SRMR = Standardised root mean-square residual
TIPI = Ten-item personality inventory
VIF = Variable inflation factor

WM = Working memory
Abstract

**Background:** Research investigating insight problem solving consists predominantly of experimental studies exploring the neurological and cognitive mechanisms. A limited number of studies have focused on individual differences. Of the few studies that have been conducted, most centre on neurological associates and cognitive ability/style. A tacit assumption is that all people experience insight, meaning some studies are afflicted with methodological issues; for example, that “insight problems” are solved only with an insight. Additionally, few studies have investigated insight using qualitative methods.

**Aims:** The overall goal of this thesis was to investigate individual differences in insight problem solving. Using a mixed-methods approach, the first study aimed to investigate the subjective meaning, and contexts in which insights occur. The second study aimed to construct a brief scale which measures insight as a disposition (Dispositional Insight Scale). The third study aimed to uncover traits that may predict insight, including positive affect, flow, and mindfulness. The fourth study aimed to compare the personality traits of insightful people and analytical people, and to confirm whether those who are highly insightful have a higher predisposition to arousability than those lower in insightfulness.

**Method:** A sample of 1,114 participants completed an online self-report questionnaire. The study included demographic questions, and open-ended questions regarding where and when insights occur, the personal meaning of their insights, and an additional opportunity to report other thoughts. The questionnaire also included closed-ended questions on insight, rated on a Likert scale, and scales assessing cognitive style, and the dispositions: affect, flow, mindfulness, the five-factor personality scale, and predisposition to arousability.
Results: Eighty per cent of participants reported having insights, with the highest percentage falling in the female, younger, highly educated demographic categories. Qualitative results showed most have insights at night, in the shower, and at work. Perceptions of insights centre on the belief that they come from the subconscious, and when not thinking about the problem. This perception converges on the research definition—insight is sudden (processing outside conscious awareness), and often arrives after an incubation period. It was also reported that insights improve with age, that the details (of the problem) are needed first, and that they are unexpected. The results from the second study revealed a five-item scale measuring dispositional insight with acceptable reliability. The third study found that dispositional flow and trait mindfulness (not positive affect) predicted insight, but only marginally. The fourth study found that openness was the strongest predictor of insight, and that conscientiousness was the strongest predictor of analysis. This study also found that highly insightful people reported a higher level of general arousability compared to those low on insightfulness; the effect size was moderate.

Implications for theory: The findings from this thesis suggest that insight is not only a continuous trait but also dichotomous, that is, while most people have insights, some people do not. From this research, a self-report scale was developed in order to measure propensity towards experiencing insights; this tool will be of use to other insight researchers. Researchers have raised anecdotal reports of insights occurring at/during the night, and in the shower. The findings from this thesis lend empirical support to these anecdotes. This is also the first study to report gender differences, with more females reportedly experiencing insights than males. Finally, there were a number of traits shown to positively predict insightful people that have not been studied previously: mindfulness, propensity to flow experiences, openness to new experiences, and a tendency towards high arousal.
Conclusions: As many as one-fifth of the population may not experience—or may not be aware of—their insights. For those who do experience insights, these occur at times when they are relaxed, or in situations where their mind may wander. Increasing flow and mindfulness could marginally improve insight experiences, and to a greater degree than positive affect. While openness is the strongest predictor of insightfulness, conscientiousness strongly predicts a more analytical strategist. Future studies should be aware that some participants may not be capable of experiencing insight, and thus should either control for these people, or study them directly.
Chapter 1
Introduction: Individual differences in insight and challenges with measurement
1.1 Chapter overview

This chapter begins with an overview of problem solving, the different types of problems, and the ways in which they can be solved. The claim that insight solutions are different from other types of solutions (e.g. analysis) will then be explored. One way in which insights are studied is by using “insight problems”. It will be asserted that this method is problematic due to evidence that not everybody solves these problems in the way that researchers expect them to, and why this is the case. Following this discussion, it will be argued that insight in problem solving needs to be studied as an individual difference, and that other dispositions that facilitate the cognitive process involved in insight solutions (positive affect, flow states, and mindfulness) should predict insightfulness. It will also be proposed that predictors of creative thinking (personality types: openness, extraversion, and a higher predisposition to arousability) will also predict insightfulness. The final sections of the chapter include the problem statement, aim and scope of the thesis, key terms, and significance of the research, before concluding with an overview of the thesis.
1.2 Introduction

Problem solving is fundamental to individual and social human processes; it is the basis for innovation, for the evolution of technology, and for scientific discovery. Solving problems is part of daily life: it includes the minor problems that individuals face every day; the more complicated, multi-faceted, and challenging problems that take longer to solve; and those that go beyond human understanding. Through a historical lens, some people have exhibited exceptional problem-solving abilities. Albert Einstein solved some of the most complicated physics problems of his time, while also raising new conundrums that have still not been solved today (see, Einstein, 1982). Einstein’s life’s work was to seek out new and challenging problems to solve, and he persisted until the solutions were found. Many of these solutions came to Einstein as insights:

I was sitting in the patent office in Bern when all of a sudden a thought occurred to me: if a person falls freely, he won’t feel his own weight. I was startled. This simple thought made a deep impression on me. It impelled me toward a theory of gravitation. (Einstein, Calaprice, & Dyson, 2010, p. 377)

Insight is one of a number of ways that problems can be solved. Most of the research focuses on the problem-solving process; what makes a person motivated to seek out and formulate novel problems, as Einstein did, has received little empirical research (Davidson & Sternberg, 2003).

1.3 What is problem solving?

A problem is defined as a goal that is temporarily unattainable (Davidson & Sternberg, 2003). Problem solving, therefore, is the implementation of a set of behaviours that allows the attainment of the goal. Problem solving encompasses four components: cognitive (happens in the brain), processual (moving through stages), directed (at a particular issue), and personal (dependent on factors relating to the person, including importance, knowledge, and skills) (Mayer, 1999). In sum, problem solving is a
cognitive process that is directed towards a particular goal, with success of meeting that goal based on personal knowledge, experience, and other skills related to solving the problem. Success is based on both state factors and traits, but solving problems is also a skill that can be improved (Mayer, 1999).

At the broadest level, problems are classed into two types (Davidson & Sternberg, 2003): well-defined and ill-defined, also known as routine and non-routine respectively (Mayer, 1999). Well-defined or routine problems allow for a clear representation of the problem (i.e. a clear understanding of the elements and operations of the problem; Gick & Lockhart, 1995) and have a clear goal, such that the path to the solution is often relatively straightforward (Davidson & Sternberg, 2003). Solutions for well-defined problems are based on previous learning from similar problems (Dominowski, 1995). An example of a well-defined problem is a mathematical equation. A new mathematical equation can easily be solved by employing learned techniques to solve it, through analogous thinking (Davidson & Sternberg, 2003). An inability to solve these types of problems is due to a lack of knowledge or skill (DeYoung, Flanders, & Peterson, 2008), suggesting that what is a well-defined or routine problem for one person may not be for another—this point will be returned to later. The routine nature of well-defined problems means that the solution is not novel, and is therefore considered non-creative thinking (Schraw, Dunkle, & Bendixen, 1995). Ill-defined or non-routine problems, by contrast, start with an incorrect representation of the problem (Gick & Lockhart, 1995), and have a relatively obscure path to the solution, in that it is not immediately obvious how the problem can be approached (Davidson & Sternberg, 2003). Many problems in life are ill-defined, calling for a more novel or creative thinking strategy (DeYoung et al., 2008).

A good example of an ill-defined problem is undertaking doctoral research, as it is not always immediately obvious how to begin formulating the research problem, or the
strategies to solve it. The process of solving a research problem can often start with an incorrect representation that needs to be restructured in some way to meet the goal. The difficulty with solving ill-defined problems is that there may be very little previous learning available to draw upon, or that experience is (continuously) drawn upon but does not solve the problem, rather the strategy becomes an impediment to finding the solution (Dominowski, 1981; Ellen, 1982). The latter point will be discussed in detail in the literature review (Chapter 2). Depending on the problem, it often requires an examination from different angles and learning new information, although what information needs to be gained is not always clear either. At other times, solving ill-defined problems requires thinking about the problem in a different way (e.g. ambiguous problems), which may include restructuring current schemas or the semantics of the problem (Ash, Cushen, & Wiley, 2009). The cognitive processes used to solve ill-defined problems are believed to be predominantly unconscious, so that when the solution appears in conscious awareness it is subjectively sudden and unexpected—the *Aha*! moment (Davidson, 1995; Metcalfe & Wiebe, 1987; R. Smith & Kounios, 1996; Stanley, Mathews, Buss, & Kotler-Cope, 1989). Well-defined problems by contrast, rely on conscious, analytical processes (Metcalf & Wiebe, 1987), so are not likely to produce an insight.

### 1.4 What is insight problem solving, and why is it different to other forms of problem solving?

The definition of insight is based on two aspects: its phenomenological experience, and the cognitive process that precedes it. The experience of insight is the *sudden* comprehension of the problem elements and its solution (Mayer, 1995). As the quote by Einstein earlier stated: “all of a sudden…I was startled”. The cognitive process that leads to insight has three phases (Ash & Wiley, 2006; Metcalfe, 1986; Ohlsson, 1984;
Sternberg & Davidson, 1995; Weisberg, 2013). The first involves an initial faulty representation of the problem, or there may be uncertainty about how to best cognitively represent the problem. During the second phase there is a search in the faulty problem space that can often lead to an impasse. The final phase is where a restructuring of the problem’s elements occurs, allowing for new connections to be made that lead to the correct solution (Ohlsson, 1984). The final phase occurs unconsciously, in that the solver cannot report how they came to the solution (Metcalfe & Wiebe, 1987). The insight solution often leaves an emotional impact on the solver (Bowden, Jung-Beeman, Fleck, & Kounios (2005); as Einstein stated, “it made a deep impression on me … It impelled me”. Conversely, as analytical problem solving starts with a clear goal; relying on a conscious, staged approach, and leading to a predictable solution (Metcalfe & Wiebe, 1987), it does not leave the same emotional impact as an insight.

There are two opposing perspectives on insight—those who have argued that insight is nothing-special, or business-as-usual (Fleck & Weisberg, 2004), and those who have proposed that insight is a unique, or a special form of problem solving (Schooler, Ohlsson, & Brooks, 1993). Weisberg, DiCamillo, and Phillips (1978) contended that all problems are solved through association from past experiences, and that new problems always begin with what is known. From here, they maintained, the solver’s knowledge is modified so that it meets the specific problem at hand. Insight is said to only differ in that it is a sudden remembering of problem-relevant information (Davidson, 1995). The special process view of insight posits that sudden restructuring leads to flashes of inspiration, is a short-circuiting of normal reasoning processes, and that special abilities are needed to solve insight problems that differ from other problem-solving processes (Davidson, 1995). Cognitive studies have shown that insight problems are solved without awareness of the restructuring process, and analytical problems are solved through reportable processes (Metcalfe & Wiebe, 1987). Likewise,
neurological differences between insight and analysis have also been reported (see Kounios & Beeman, 2014, for a review). As further research is published, it becomes more clear that insight and analysis differ in terms of their underlying neurological and cognitive process, supporting the special-process view of insight. Further supporting evidence for this view will be reviewed throughout this and the literature review chapters.

At present, the current research predominantly focuses on the cognitive mechanisms and the neural correlates of insight versus analysis. A line of inquiry has begun to examine individual differences, as outlined in the literature review (Chapter 2). Similar to other insight studies, the individual differences research has focused on the neural correlates that predict subsequent solution type (insight or analysis; Kounios et al., 2006), cognitive style (Ansburg, 2000; Ansburg & Hill, 2003), and working memory (WM) abilities (e.g. Ash & Wiley, 2006).

One qualitative study investigated naturalistic stories of insights, revealing that insights can be gained through multiple pathways (Klein & Jarosz, 2011). At present, no other research appears to have examined insight qualitatively. As insight is a subjective experience, qualitative research methods are well-suited to examining the insight experience, and what these experiences mean to people in the general population. This is one of the goals of this thesis.

1.5 The challenges with insight problems

In order to investigate insight experimentally, researchers have formulated insight problems that are deliberately ambiguous, or lead the solver in the wrong direction, in terms of the solution. There are currently three types of insight problems: verbal, spatial, and visual (Weisberg, 1995). An example of a verbal problem is the following: A man in a small town married 20 different women of the same town. All are still living
and he never divorced. Polygamy is unlawful but he has broken no law. How can this be? (He is a priest; Dominowski, 1994). Spatial problems include the nine-dot problem (Burnham & Davis, 1969). This problem shows nine dots in the formation of a square, and to solve requires four straight lines to be drawn through all nine dots without lifting the pencil. The only way this problem can be solved is to draw the lines outside the square. Visual problems include Duncker’s (1945) candle problem. Participants are given a box containing a candle, matches, and thumbtacks. The task is to attach the candle to a screen so that the wax will not drip on the table below. The solution is to melt the candle, apply wax to the box to stick the candle on, and use the thumbtacks to attach it to the screen. The assumption is that restructuring the elements of the problem is required to solve these problems, and when correctly achieved, this will lead to an insight. Thus, merely solving the problem is enough for the researcher to conclude that insight has occurred.

There are several possible problems with using these tests to assess insight. First, participants in the research may have had experience with similar types of problems to those used in the experiment. Based on the theory that learning experience in the domain of interest leads to an analytical solution (through conscious recall of past strategies), they may not have an insight (Bowden, 1997). Second, as noted by Bowden, et al. (2005), impasse and restructuring may not always precede an insight. A third issue is that some people may be adept at breaking down an insight problem into cognitively manageable parts, and solving it through discrete conscious, analytical stages. It will be discussed in the literature review (Chapter 2), that when researchers design strategies to facilitate insight, they are inadvertently designing analytical strategies to help solve the problems they label insight problems, which some participants may also do naturally. To avoid these confounders, a small number of studies have obtained self-report data on whether the solutions were an insight or not (e.g. Bowden & Jung-Beeman, 2007).
Another research strategy could also identify whether everyone has insights, or only a certain proportion of the population. Insight may be a dichotomous trait (insightful or not insightful), and for those who do experience insights, it could be a skill that falls on a continuum from the occasional insight to regular insights, as well as from superficial insights into daily issues to the more profound “epiphany” type that solves, for example, a long-standing complicated physics problem. As this question has not been tested, no research tool has been constructed to measure it. One way to identify a disposition towards insight solutions is through the development of a self-report psychometric scale.
1.5.1 Why insight should be seen through the lens of individual differences

Taking into account the argument so far, a thought experiment may help to illustrate the issue in a real-world situation. Using the PhD as an ill-defined problem from the example given earlier, the following is a scenario about how four new PhD students might approach the problem of identifying and clarifying their research question. Student A initially thinks about how to go about her topic. She reads the literature but still cannot formulate a cognitive representation of what the research problem is, and the goal is not clear, so she puts it aside and takes a break. One day, during the break, she suddenly has an *Aha!* moment in the shower. The topic of her research and how it can be approached comes to her all in a single flash (i.e. a one-step solution). Further insights may also arise throughout her candidature, with analytical strategies also used where possible. Student B on the other hand, approaches his research question by breaking the problem down into manageable steps, and drawing on what knowledge he has from similar experiences in his undergraduate studies. Each step is clearly and consciously represented, and so he is able to solve each of the issues through analytical strategies, before arriving at a clear goal for his research question. Both of these students are attempting to solve a problem that is subjectively ambiguous and difficult; however, each is attempting it in different ways. For Student A, this is an insight problem, but for Student B, it is an analytical problem. To further illustrate that problems cannot be defined objectively, Student C has completed a PhD, and is now attempting to do another one. She is likely to draw on her previous experience of completing a PhD, and is now able to solve the problem with less effort (analytically). For her, a PhD is not an insight problem. Finally, Student D attempts to start his PhD; eventually, after having difficulty he decides to quit university and take on another job.
Many people may simply not enjoy challenging problems, and therefore not stick with them.

The point here is that individuals differ in the way they approach complicated problems. If they have previous experience with the problem it is less ambiguous, and thus they are likely to employ previously used strategies (i.e. analysis). Where there is no experience with the problem, some may find solutions through an insight, while others have developed the ability to use analytical strategies. Others may believe the problem is impossible to solve and give up on it entirely. Any of these strategies may be used on insight problems in the experimental setting. This is why it is important to be certain an insight has occurred (or not), and to understand these differences and what may predict them.

Although research has already begun to explore individual differences in insight, only a few studies have relied on self-reports to determine solution type. In a seminal study, Kounios et al. (2006) investigated the neurological differences between insight and non-insight solvers prior to the presentation of hybrid problems (i.e. how they prepare themselves to solve problems). For each problem solved, the participant self-reported whether the solution was an insight or not an insight. Those who solved the problems through insight showed increased activity in the medial frontal lobe and temporal regions, which are associated with cognitive control and semantic processing, respectively. Conversely, those who solved the problem through analysis showed increased activity in the occipital region, an area associated with visual attention to the environment. They were able to demonstrate that neurological activity can predict who will have an insight and who will not, even before seeing the problem. This finding further suggests that there is a degree to which individuals differ in the way they approach problem solving. However, the question that remains is—beyond neurological associations—what are these differences?
1.5.2 Predictors of insight and the people who have them

As Perkins (1995, p. 523) stated, “human thinking has a homing characteristic” in that it automatically gravitates to what it knows. When encountering a problem that has no clear path to the goal, people are not prepared to deal with the demands that are required, because it requires a “style of thinking rather different from the usual homing mode of operation” (Perkins, 1995, p. 523). This statement implicitly suggests that it is possible that some people may not experience insights if they do not possess the capacity to think in ways that produce them. Put another way, insight is likely to be a skill that individuals either have or do not have (i.e. a dichotomous trait). As stated earlier, there may be within-individual differences for those who do have insights (frequency and quality of the insight).

The question is, what distinguishes non-insightful from (highly) insightful people? Research has established the neurological differences (see Kounios & Beeman, 2014), but why these differences occur is still unknown. It is possible that some individuals may not have the motivation or the ability to solve highly complex problems, and simply do not attempt to solve them. Others may be adept at breaking cognitively demanding problems down into smaller, manageable problems that can be solved analytically—where possible. However, many ambiguous and complex problems do exist that the human conscious mind does not have the capacity to solve; for example, complex social problems. These problems require a thinking that is totally new, as Einstein stated (Einstein et al., 2010, p. 476): “The significant problems we face cannot be solved at the same level of thinking that was used when we created them”. If analytical solutions come from what we know, then insight is needed to produce solutions that surpass the known.

Insight researchers agree that the phase between encountering the problem and the insight involves a degree of unconscious cognitive processing (e.g. Bowden et al., 2005;
Gilhooly & Fioratou, 2009; Metcalfe & Wiebe, 1987). Unconscious cognitive processing has a greater capacity for a more “global” search for solutions to more obscure problems (Ansburg, 2000), and has been shown to produce solutions more superior in quality than conscious processes (Dijksterhuis & Meurs, 2006). One particular factor that has been observed to facilitate global processing is positive affect (Gasper & Clore, 2002; Rowe, Hirsh, & Anderson, 2007). The beneficial role that positive affect has on global processing has formed the basis of a hypothesis that it in turn should also facilitate insight, which has been supported (Subramaniam, Kounios, Parrish, & Jung-Beeman, 2008). Negative affect has been demonstrated to have no effect on insight solutions, although it possibly has greater support for analytical solutions (Subramaniam et al., 2008). Affect has only been investigated as a state; whether trait positive affect predicts insightful people is yet to be determined.

This thesis aims to uncover whether insight is a dichotomous trait by asking people if they have ever experienced insight (do/do not experience insights). It also aims to uncover what state factors encourage insights to occur. For those who have insights, there could be many factors important in their facilitation. One way of uncovering what these factors are, would simply be to ask people when insights tend to occur. Theoretically, environmental and other state factors need to facilitate the global/flexible cognitive processes for searching beyond current knowledge. As will be discussed in Chapter 2, anecdotal stories of insights have suggested that the person was in a state of relaxation, or even sleeping at the time of the *Aha!* moment. Understanding what specifically triggers these moments for insightful people will help to devise strategies for encouraging more of them.

In terms of trait factors that are associated with insightful people, skills related to creative thinking may also be applicable (Epstein, 1999). Epstein identified four competencies for generating creativity: capturing and preserving new ideas as they
happen; broadening knowledge and education; frequent changes to physical surroundings; and seeking out challenges with an ability to handle failure. Seeking challenges and resilience to failure are particularly important elements of being insightful, as will be discussed in detail in Chapter 6. To be able to tolerate the uncertainty and difficulty of coming to terms with a complex, ambiguous, seemingly unanswerable problem, it is vital that a person is able to enjoy the challenge and overcome the many failures they may face throughout the problem-solving process. One personality trait that is specifically known for seeking challenging situations for the sake of the challenge (intrinsically rewarding) and not for any external reward, is autotelic personality, also known as dispositional flow (Csikszentmihalyi, 1991).

Another important adjunct to insightfulness is being able to pay attention more diffusely. When attention is focused, there is a greater likelihood of accessing closer associations (Finke, Ward, & Smith, 1992; Martindale, 1995). Diffuse attention, however, leads to greater access to more remote (distant) associations. Individuals with a broader attentional capacity have a greater chance of noticing unexpected cues—and a better ability to generate distant associations—than their more narrowly focused counterparts (Ansburg & Hill, 2003). Kounios and Beeman (2014) hypothesised that individual differences are a result of what is occurring during activation of the default mode network in the brain—a collection of brain regions that are active during resting state (Raichle, 2015). Activation of the default network in those who have insights reflects a broader attention focus to the environment, followed by an inward-directed focus during preparation and problem solving. Analytical solvers are thought to have the opposite cognitive pattern—during resting-state they are less outwardly focused, while during the preparation and solving phase, they become more outwardly focused. The inward focus of insightful people reduces distractions from the environment (Kounios & Beeman, 2014).
Those higher on trait mindfulness have been shown to use less effort during activities that require greater attention (Jensen, Vangkilde, Frokjaer, & Hasselbalch, 2012), a broader attentional capacity (Langer & Moldoveanu, 2000), and a greater perceptual (MacLean et al., 2010) and visual sensitivity than those low on mindfulness (Brown, Forte, & Dysart, 1984a, 1984b). Greater perceptual and visual sensitivity increase the ability to detect subtle changes to stimuli in the environment. For gaining insights, this ability allows the solver to notice new information relevant to the problem. Meditation (i.e. state mindfulness) and trait mindfulness have been demonstrated to assist in solving insight problems (Ostafin & Kassman, 2012); however, the researchers did not collect information on whether the participants had insights, only whether the solution was found. Their hypothesis for the connection between mindfulness and insight centres on another important facet of mindfulness—cognitive flexibility (see Chiesa, Calati, & Serretti, 2011, for a review)—which is needed for generating novel solutions. The literature on positive emotions, mindfulness, and flow are discussed in greater depth in Chapter 6, where this hypothesis will be tested.

Other previously unexplored traits that may be associated with insightful people pertain to personality. In this instance, reference is made to the five-factor model of personality: openness, conscientiousness, extraversion, neuroticism and agreeableness (Costa & McCrae, 1992). Personality is an enduring disposition of particular patterns of behaviours. These behaviours are stable over time and consistent across observers (of the behaviour). Evidence of heritability suggests that personality has a biological basis (Costa & McCrae, 1992). Openness refers to the enjoyment of intellectual activities, with individuals being open to new ideas and experiences, having a wide variety of interests, and a tendency to be non-conformist. Agreeableness refers to a person who is sympathetic and compassionate, with a “giving” nature. Conscientious people are productive, ethical, have aspirations to succeed, and are dependable and responsible.
Neuroticism refers to (a low) level of emotional stability and impulse control, and a tendency to experience anxiety. Extraverts are social, assertive, and talkative.

Personality is often investigated for predicting a wide range of skills and dispositions. A few studies have researched the connection between personality and creative thinking (not insight *per se*). Of these studies, openness shows the strongest prediction of creativity (e.g. Feist, 1998; King, Walker, & Broyles, 1996). Studies have also shown a positive relationship between extraversion and creative problem solving (Feist, 1998; Fink & Neubauer, 2008; King et al., 1996). Fink and Neubauer (2008) hypothesised that extraverts would produce more creative ideas than introverts. The argument for their hypothesis was based on the theory that extraverts exhibit lower cortical arousal, which is argued to be associated with higher creativity (Martindale, 1999). Several issues with this theory are raised in the literature review (Chapter 2), and in Chapter 7, where personality and predisposition to arousal are examined in relation to a disposition to insight.

### 1.6 Problem statement

While it is acknowledged that individuals differ in the way they solve complex or ambiguous problems, it is not fully understood what states or traits are conducive to making people in the general population insightful, nor is there a tool to identify the degree to which people are insightful. Experimental studies have begun to investigate individual differences in insight, with a particular focus on neurological differences (Fleck, 2008; Fleck et al., 2008; Kounios et al., 2008; Kounios et al., 2006), cognition, including WM (Ansburg, 2000; Ansburg & Hill, 2003; Ash & Wiley, 2006; Cushen & Wiley, 2011; DeYoung, Flanders, & Peterson, 2008; Fields, 2010; Gilhooly & Fioratou, 2009; Novick & Sherman, 2003), and cognitive style (Martinsen, 1993, 1994, 1995, 1997; Martinsen & Kaufmann, 1991). These studies have assisted in increasing
knowledge about how insight differs from other types of problem solving. However, many of these studies suffer from the methodological concerns raised earlier; that is, researchers assume that an insight has occurred when the problem was solved.

Experimental studies also focus almost entirely on the process and solutions to insight problems; however, insight problem solving depends largely on the formulation of a problem (Pretz, Naples, & Sternberg, 2003). Those who enjoy creative problem solving are better at formulating problems. Pretz et al. (2003) argued that formulating a problem relies on disposition and social context, which has not been a focus of empirical research. Few studies outside experimental work have investigated insight in general, and fewer have investigated individual differences.

Although experimental studies have the rigour of controlling for extraneous variables, their weakness is that they often lack ecological validity. Chaytor and Schmitter-Edgecombe (2003) discussed five ways that neuropsychological experiments lack ecological validity:

1. Test environment—what participants do in the test environment is not necessarily what they do in their everyday environment. The test environment is designed to reduce distraction; is quiet; and the start and completion of the test is controlled. Certain environments may be more conducive to the insight experience; however laboratories do not replicate these.

2. What the tests measure—this issue has already been raised in that insight tests may not actually elicit an insight. Furthermore, the tests may go beyond a participant’s abilities.

3. Sample of behaviour—a small sample of behaviour is measured in one environment, when the behaviour may be variable across time and situations. Insights may occur at a particular time of the day for some people, which does not match the time at which the testing is conducted.
4. Compensatory strategies—strategies that people use in their everyday life are constrained by the test situation. For example, when reaching a natural impasse, individuals may go for a walk or engage in another activity that is naturally helpful to their thinking/incubating process.

5. Non-cognitive factors—for example, emotional factors occurring during the experiment, that are not normal, may affect performance. This appears especially applicable for insight problems, as negative affect can reduce the likelihood of having an insight (Subramaniam et al., 2008).

Klein and Jarosz (2011) stated that: “However informative such case studies might be [famous cases of insight such as Archimedes], most of what we have learned about insight has come from the controlled laboratory examination of how college students react when they reach the impasse created by puzzles” (p. 337). They went on to claim that insight problems in experiments may fail to capture the processes occurring in natural environments; these tests may “provide a useful framework for understanding everyday insights, but we will not know unless we conduct naturalistic investigations” (p. 337). Their qualitative research findings uncovered different ways that insights occur—beyond the current assumptions. They also argued that historical case studies—such as Darwin—may not reflect the environments that people operate in today. Overall, research outside the laboratory is needed in order to provide new information about insights.

The possible outcomes are fourfold. First, is to comprehend the factors that facilitate the insight experience, from the subjective experience of people in the general population. Second, as no self-report scale exists that is able to measure dispositional insight, this thesis will aim to develop one. Third, to understand the degree to which dispositions that enhance flexible cognitive processing (positive emotions and mindfulness), and seeking out challenges (autotelic personality), have an effect on
dispositional insight. Finally, an identification of the personality factors that predict insightful people in comparison to analytical people, and an understanding of the general arousal levels that insightful people exhibit. Once the facilitators of insight are recognised, strategies can be developed so that individuals may experience insight more often, and possibly learn to enjoy complex problem solving. A scale that can measure dispositional insight will be invaluable to the research community, so that further work in identifying and understanding those who are insightful (or low on insightfulness) can continue.

1.7 Aim and scope

This thesis has four primary aims. The first is to qualitatively investigate the general contexts (time and place) in which people tend to experience their insights, as well the general perceptions people have about their insight experiences. Although the data collected will be qualitative, the sample size aims to be large (approximately $N = 1,000$). This will be achieved by placing open-ended questions into a quantitative questionnaire, along with questions regarding demographics. Participants will also answer a question about whether they have ever experienced an insight on a dichotomous scale (yes/no). This question aims to investigate whether all people, or just a proportion of the population, have insight experiences. As the sample size will be large, this will allow for an approximation of what proportion do/do not experience insights generally. In sum, the first aim is to begin to understand the places, times, and meanings that the general population have about their insights, whether some people do not experience insights, and what demographics are associated with insightfulness.

The second aim of the thesis is to construct a self-report scale, called the Dispositional Insight Scale (DIS), which can identify to what degree an individual is insightful. As no scale like this exists, it will not only be an important contribution to
the current study for confirming identified traits that should predict insightfulness, but also to the broader research field. The aim is to make the scale as brief as possible so that it can be included with other psychometric scales—or used within experiments—without adding too much extra time to a study.

The third aim is to confirm whether other traits (positive affect, flow, and mindfulness) effect dispositional insight by increasing the degree to which an individual is insightful. This aim will be achieved through structural equation modelling (SEM), with the DIS used as the predictor variable.

The final aim is to investigate which of the five-factor personality (FFP) variables predict insight in comparison to predictors of analysis, and whether a higher degree of dispositional arousal is associated with greater insightfulness. This aim will be tested using two multiple regression analyses. In both analyses, the five personality variables will be the independent variables. The first model will use the DIS as the dependent variable, and the second model will be a disposition-to-analysis measure as the dependent variable. Overall, this aim will endeavour to identify the state and trait factors that contribute to insight that have not previously been identified in the literature.

Parameters were applied to the study, for the purpose of containing it to a manageable size. The goal is to identify factors that are related to people who are insightful, not to people who are at the analytical end of the continuum. Identifying predictors of analytical people (low on insight) is also important, but it must first be established that there is in fact a type of person who is ‘insightful’ and what it is about them that makes them capable of experiencing insights. If this is confirmed, then later studies can be conducted to identify the factors that relate to analytical-only people.

The data will be collected through a self-report questionnaire, with participants recruited from a research database. The sample will be as close as possible to a
representation of the Australian population. The participant sample will include a range of ages, occupations, levels of education, and with an as-close-as-possible equal ratio of men to women. In order to achieve a representative sample, a market research company will be approached to undertake recruitment. As market research-based companies are expensive, the study will be confined to a single recruitment process.

To keep the questionnaire to a size that could be completed within an acceptable time-frame, questions and scales were kept to three open-ended questions (to gain an understanding of the context and meaning that participants hold about their insights). The included scales will be kept to those that measure traits/dispositions, as well as purpose-designed questions that will be used to develop the DIS.

1.8 Key terms

Within this thesis, the term “insight problem” has a different interpretation to that in the broader insight research. In the literature, an insight problem is a problem that is specifically designed to elicit an insight solution. As argued earlier, this is a potential confounder if the solver has experience with the problem, or has an ability to break it down into smaller analytical tasks. In this thesis the term insight problem refers to a specific problem that an individual solves with an insight (Bowden & Jung-Beeman, 2007), not the description of the type of problem. Analytical problems will therefore refer to a problem that the solver has had experience with; or that the solver simply has the capacity to elicit strategies to solve a novel problem through a conscious, staged approach. Although the term “insight problem solving” is used, this is intended to encompass any situation in which an insight may occur, whether it is a creative, personal, or scientific problem, and so on. The term “dispositional insight” is intended to be a description of the degree to which a person experiences insight solutions. Although disposition refers to an enduring behaviour, it will also be hypothesised that
while this is a tendency for some, insight is also a skill that can be facilitated, as other researchers have theorised (e.g. Mayer, 1995). Therefore, insight in this thesis is viewed as a tendency, as well as a skill that can be increased through training of other skills (e.g. mindfulness), and positioning oneself in particular environments that may be conducive to the required processes.

### 1.9 Significance of the study

Based on the expected findings of the four studies, it is anticipated that at least four key contributions to the insight research will be made. The first will be that the proportion of the population that experiences insights will be identified and reported on, along with the most common times and places for insights to occur. These findings may hold further clues as to what facilitates Eureka moments for people. Currently, researchers have not formally investigated what insight means to people in general. By using open-ended questions to understand these experiences, researcher bias will be reduced, ecological validity of the results will be increased, and the participants’ true opinions will be understood and conveyed to the researchers (Hayes, 2000). Creative and thoughtful aspects to insight that researchers have not considered may also emerge. Gaining an understanding of the general population’s perceptions of insight will also help with the dissemination of results, and will allow the introduction of techniques to facilitate insights in a way that people can comprehend.

A second contribution will be the development of a self-report scale that aims to assist future research by enabling the identification of individual differences related to dispositional insight in the population. The scale can be used to measure the degree to which someone is insightful—useful either for individuals, or organisational psychologists responsible for corporate recruiting.
The third important contribution is recognising the key traits (positive emotions, autotelic personality, and mindfulness) that have an effect on improving insightfulness. If these factors are found to have an effect on insight in the current cross-sectional study, then further longitudinal research may confirm whether the practise of these traits will improve insight over time.

The final contribution will be the identification of stable traits (personality and arousability) that predict insightful people, and the recognition of personality differences in analytical people. In addition to these four significant contributions, the literature review adds to the theory of insight problem solving. Reviews of the literature have been published elsewhere (Chu & MacGregor, 2011; Kounios & Beeman, 2014; Sio & Ormerod, 2009; Weisberg, 2013) but have focused on a single issue, with few studies included. The literature review for this thesis brought together and analysed a wide variety of studies focusing on current research on cognitive and individual differences that has been published in peer-reviewed journals to date.

1.10 Research question

The research question for this thesis is: are insights experienced by everyone; and if not, do specific dispositions predict and/or increase them; and are particular times and places conducive to their occurrence? Specific aims and hypotheses will be discussed within the relevant chapters.

1.11 Overview of the thesis

Following this chapter, the thesis contains a further seven chapters. The second chapter reviews the current research literature on insight, with a particular focus on critiquing the methodological issues of the research. Along with the methodological issues, the literature review also raises the importance of understanding the individual differences
in problem solving (insight or analysis). Chapter 3 reports the research method. This chapter outlines how the data were collected, the demographic profile of the participant sample, the procedure of the study, and the psychometric scales included in the questionnaire.

Chapters 4 to 7 report the results of the four studies, identifying the state and trait predictors of the insight experience. Chapter 4 reports the qualitative results that were taken from the three open-ended questions included in the survey (when/where insights occur and their meaning, and other experiences). This chapter also reports the percentage of people who have had an insight, with these results being cross-tabulated with the demographics—gender, age categories, education, and occupation—in order to identify those who are more likely to have insights.

Chapter 5 reports the construction and validation of a brief scale that measures insight as a disposition: the DIS. In this chapter, the exploratory (EFA) and confirmatory factor analysis (CFA) performed on the purpose-made questions are reported, along with the reliability and validity of the scale. Other scales related to individual differences in insight (low need for cognition, intuition, and analysis [negative relationship]) were used for the purpose of convergent and divergent validity. Normative data for the DIS are also described in this study.

Chapter 6 utilises the DIS, representing insight as the dependent variable in a path analysis using SEM. SEM was used to confirm the theory that the three traits—positive affect, flow (i.e. autotelic personality), and mindfulness—facilitate insight. Demographics identified in Chapter 5 that were associated with insight are controlled for in the SEM analysis.

Chapter 7 also utilises the DIS as the dependent variable in order to investigate the five personality factors—openness, extraversion, conscientiousness, emotional stability (as opposed to neuroticism), and agreeableness—as a predictor of insight in a multiple
regression model. This result is compared with personality as a predictor of analysis. This chapter also reports the results of a connection between predisposition to arousability, and high versus low disposition to insightfulness.

Finally, Chapter 8 draws the findings of each study together, creating a picture of state and environmental factors when insights occur, as well as a trait profile of the insightful person. The chapter begins with a reminder of the thesis aims, followed by a summary of the research findings. The state and trait findings are then discussed within the context of previous insight research, particularly those concerning individual differences. This chapter establishes that insight is unlikely to be an experience that everyone is capable of having. For those who do have insights it was found that particular places, times of day, states of mind, and dispositions facilitate the process. This chapter demonstrates how the results of the thesis fit with previous research, and outlines its unique contribution to the literature. The final sections discuss the strengths and limitations of the study, and how these can be addressed in future research that should be undertaken in light of the current findings. This chapter then ends with implications for theory, research, industry, and individuals in the general population, and an overall conclusion.
Chapter 2
Individual differences in insight problem solving: A review
2.1 Chapter overview

Insight is the moment at which a sudden shift occurs in understanding a problem and its solution, a process that often occurs outside conscious awareness. Analysis, on the other hand, is a gradual, conscious movement through the stages of the problem before arriving at a predictable conclusion. Experimental researchers often examine the processes of insight using insight problems. This chapter argues that this is problematic given that insight often occurs with problems that are ambiguous or highly novel. That is, some participants may have experience with these problems, but not experience an insight as expected. Furthermore, this thesis has found that up to 20% of the population does not experience insight, suggesting the importance of understanding individual differences in the way people solve problems. This chapter reports particular dispositions that are likely to predict insight, as well as state factors that may further facilitate this process. Most importantly, it is argued that individual differences exist, and that the field needs to accept, categorise, and in particular control for these differences in order to progress.
2.2 Introduction

Insight, *Aha!* or light-bulb moments often appear when least expected, and as a consequence, are sometimes regarded as quite mysterious. An insight represents the pivotal moment at which a deep understanding of a problem occurs, and is responsible for many world-changing discoveries. Flashes of insight have revealed missing pieces of theoretical puzzles including Albert Einstein’s theory of gravity and relativity (Einstein, 1916; cited in Einstein, 1982), Charles Darwin’s theory of evolution through natural selection (Gruber, 1981), and Alexander Fleming’s discovery of penicillin (Sternberg & Lubart, 1995). All of these discoveries were reportedly preceded by a long period of working on the problems with no solution apparent, before suddenly—often at a time when the problem was not the object of attention—the solution arose all at once, as a whole. These well-known and documented insights often centre on scientists and inventors—who frequently possess a higher-than-average IQ and many years of formal education, along with the determination to solve a problem. This may suggest that intelligence and education play a part in the acquisition of such profound insights.

Years of education is not necessarily evident in all cases, however, with seven-year-old Helen Keller being a case in point. An illness at the age of 19 months had left her blind and deaf; her only way of learning was through touch (Keller, 1990). It was at the age of seven years that her teacher Anne Sullivan began to teach her language through associating an object (e.g. a doll)—held or touched in one hand—with its name, traced on the other hand. Despite this, Helen continued to confuse the different objects and names. In her autobiography *The Story of My Life*, Helen documented her experience, when at a well-house, Sullivan wrote “water” on her hand. Helen froze suddenly, fixed on the motions of Sullivan’s fingers—in an instant, the mystery of language was revealed to her for the first time in her life—everything had a name. While scientists and inventors have access to years of prior knowledge and analytical problem-solving
strategies, this was not so for Helen Keller. One common factor in the experiences of Helen Keller and other famous problem solvers, however, is the element of repetition of—or constant exposure to—the elements of the problem in the period leading up to the insight.

Initial developments in learning theory hypothesised that automatic associations were formed during trial-and-error learning, and that these associations resulted in reproductive thinking. In other words, individuals would simply reproduce previous successful solutions to future problems (Thorndike, 1898). These earlier theorists proposed that when a new problem arose, associations were either extended or modified, with nothing completely original ever created (Davidson, 2003). At the other end of the spectrum, Gestalt psychologists Max Wertheimer, Kurt Koffka, and Wolfgang Köhler argued that insight problem solving was a productive form of thinking that went beyond old associations into a completely novel way of viewing the problem (Koffka, 1922). When the novel solution was found, a subjective feeling of Aha! often followed. This was reflected in a sudden shift from confusion to a deep understanding of the problem and its solution (Maier, 1940).

Longstanding interest in the role of insight in problem solving has come from several fields including philosophy (e.g. Bohm, 1968, 1994; Bohm & Peat, 2010; Koestler, 1976; Lonergan, 1957; Wallas, 1926), experimental psychology (e.g. Duncker, 1945; Duncker & Krechevsky, 1939; Köhler, 1969; Maier, 1930, 1931, 1938, 1940; Maier & Casselman, 1970), and more recently, cognitive psychology and neuroscience (see Kounios & Beeman, 2014, for a review). Current research has made headway in understanding insight. The variety of disciplines in which insight research is pursued is both a strength and a weakness. The strength is that different theoretical perspectives are being investigated and published. A downside to this approach is that the results are as varied as the methods used to study it—with no standard way of
defining, measuring or interpreting the results. Furthermore, there is not yet a clear or consensual understanding of how insight relates to other modes of thinking and problem solving. It has often been used as a term synonymous with creative thought (e.g. Fink, Benedek, Grabner, Staudt, & Neubauer, 2007), and is contrasted with analytical thinking (Metcalfe & Wiebe, 1987), although there may well be overlap between the two.

A tacit assumption of the research suggests that—like analytical problem solving—insight is what all people experience at one time or another. Using a comparatively large sample of 1,114 respondents from the general population, the qualitative study within this thesis found that 20% of the sample reported that they do not experience insights (Ovington, Saliba, Moran, Goldring, & MacDonald, 2015). One respondent stated: “I don’t tend to experience insight. I generally analyse a problem and apply my skills, knowledge and experience to solve it” (Respondent 198). This finding suggests that some people do not experience insights, and raises the importance of understanding individual differences in the way that people approach and solve problems. Based on this finding, researchers should not assume that the participants in their research can have insights. This paper reviews the insight literature with the aim of shedding light on the wide variation in methods of studying insight, and offers a step towards greater cohesion in the field. It also highlights that many studies do not take individual differences into account; an oversight likely to impact on findings.

2.3 Scope of the review

This review discusses the cognitive research on insight, including a particular focus on individual differences. More specifically, theoretical and methodological issues (e.g. the use of insight problems and how insight is measured) will be highlighted, and it will be argued that to improve the way insight research is conducted, individual differences
must be considered. As many of the cognitive studies have investigated the temporal stages that often precede (and possibly lead to) insight, the review of each of these stages will begin within the current assumption that they form the research definition of insight. Following this, a critical review of insight problems used in research will be undertaken, along with an analysis of why these may not test what they purport to test. The later sections will examine the research on how insight may be facilitated, and then provide a review of the cognitive studies; with the final section exploring individual differences, and if these are able to predict whether people will experience an insight.

At present, insight research has attracted a great deal of attention from neuroscientists. However, this analysis will not cover neuroscience studies which have been reviewed (see Kounios & Beeman, 2014) and critiqued (see Dietrich & Kanso, 2010; Weisberg, 2013) elsewhere. Citations from the neuroscience literature will be included where applicable. Cognitive studies to be reviewed were selected on the basis of two broad criteria: first, the study must focus on insight as the phenomena of interest (as opposed to other forms of creative cognition); and second, studies must be published in a peer-reviewed journal. A database search for articles was performed through EBSCOhost, OvidSP, ProQuest, PsycARTICLES, PsychINFO, SAGE, and SCOPUS. Other papers were selected by examining the reference lists of these studies, and checking to confirm journals were peer reviewed. Philosophical works were also included as they form the foundation of some of the hypotheses that have been tested experimentally.

2.4 Defining insight

The word insight has its origins in the 12th century Middle English word insihht meaning to “see with the eyes of the mind” (Online Etymology Dictionary). Today's non-technical definition refers to insight as “the capacity to gain an accurate and deep
understanding of someone or something” and in clinical psychology “awareness by a
mentally ill person that their mental experiences are not based in external reality”
(Oxford Online Dictionary).

While there is some variance in the definition of insight, there is a common theme
in the cognitive and neuroscience approaches. Cognitive approaches suggest that insight
is the result of a temporal progression of shifting from fixation (and/or reaching an
impasse), to an unconscious restructuring of the problem, and ends with a sudden and
often surprising solution (Davidson, 1995; Dominowski & Dallob, 1995; Metcalfe,
1986a, 1986b; Metcalfe & Wiebe, 1987; Schooler et al., 1993). Insight is the result of a
spontaneous integration of the problem elements (Ellen, 1982). Insight differs from
analytical solutions in that people are unable to report the process that led to insight
(Maier, 1931), and may not even be aware they were thinking about the problem (Jung-
Beeman et al., 2004). Each of these discrete stages will be discussed further within the
context of the experimental research conducted to test them.

2.5 Preceding events: Insight versus analysis

Early empirical research on insight problem solving began with single-item problems,
often taking hours for participants to reach a solution. Scientific investigation began
with Norman Maier (1930, 1931, 1940; 1970) testing the hypothesis that past
experience can be an impediment to solving problems that require solvers to think in
alternative ways (i.e. ill-defined problems). In a well-known experiment (two-string
problem), Maier instructed participants to hold two ropes hanging from a ceiling and
then tie them together; however, they were too far apart to be reached at the same time.
In the same room, there were various items such as a table, chairs, poles, and pliers. The
solution was to tie one of the items to the end of the rope to create a pendulum. For the
participants who were able to solve the problem, Maier found that this solution
appeared suddenly and completely, rather than being the outcome of incremental learning. Results were the same regardless of whether they solved the problem without a hint or with a hint (the researcher walking past and hitting the rope forcing it to swing).

Maier (1931) argued that trial and error could not explain the results, as many people repeated the same mistakes during the solving process. Instead, he proposed that perceptual changes in the functional meaning of the items in the room must have accounted for the sudden breakthrough. For example, subjects may have gained a new perception about the affordance of a pair of pliers as a weight that can be tied to the end of a rope to form a pendulum. For some participants \( n = 61; 39.3\% \), this was achieved without the need for a hint, while for others a hint triggered a breakthrough \( (37.3\%) \). Twenty-three per cent of participants could not solve the problem, even with a hint (Maier, 1931). So although a (possibly) homogenous sample was used, individual differences were reported. Maier recruited his study participants—many of whom were doctoral students—through universities. It is possible that difficulties in solving problems such as these may be greater for individuals with a lower level of education, although research has not confirmed this.

2.5.1 Fixation, mental ruts, and experience as an impediment to problem solving

Theories sprang up about why individuals could not quickly find a solution. Gestalt psychologists labelled this impediment to problem solving “functional fixedness” or simply “fixation”, given individuals appeared to fixate on the familiar function of the item (Duncker, 1945; Duncker & Krechevsky, 1939); for example, the familiar function of pliers as a tool for gripping, rather than the potential function of pliers as a pendulum weight. Functional fixedness was demonstrated in Duncker’s (1945) box problem. In Duncker’s experiment, participants were given a box containing a candle, matches, and
thumbtacks. Their task was to attach the candle to a screen so that the wax would not drip on the table below. The solution was to melt the candle, apply wax to the box to stick the candle on, and use the thumbtacks to attach it to the screen.

Following this research, Adamson and Taylor (1952; 1954) made a small change to the task (adding an empty tack box), to demonstrate how fixedness is influenced. Adamson’s hypothesis was that if the box had a perceived function (i.e. to carry the items), it would be less likely to be used as part of the solution compared to the control group’s participants who were given the box and the items separately. Adamson found that participants were twice as likely to solve the problem when the box was empty—as opposed to full—of tacks; (i.e. the box’s function was perceived differently). These results supported Adamson’s hypothesis, which has also been supported by findings based on other types of insight problems (see Di Vesta & Walls, 1967; Katona, 1940; Scheerer, 1963). Still, 14 per cent of controls (four of the 28) did not solve the problem at all. Another interpretation of functional fixedness is that people simply do not notice the box (Glucksberg & Weisberg, 1966); that is, when the box is made more noticeable to the participant the likelihood of reaching the correct solution increases.

Similar to functional fixedness, a more recent theory labelled the mental ruts hypothesis (S. M. Smith, 1995a, 1995b) proposed that repeated exploration of an unsuccessful search path adds to an accumulating activation of this path (conditioning), decreasing the likelihood of finding the correct solution path. Thus, a lack of conditioned learning may have its advantages. As Helen Keller had no prior knowledge—and consequently no unsuccessful search path to activate, she may have had an advantage that allowed her to make the correct association between the object and the word written on her hand to form the elements of language. In contrast, a conditioned response impedes understanding of a novel problem and its solution, at least in many cases. It may be that conditioned responses are repeatedly used by some
people, and that others will search for novel responses. This theory will be returned to later.

Not all researchers agree that fixation is the reason that individuals have difficulty solving novel problems. Weisberg and Alba (1981a) conducted a series of experiments on several insight problems, including the nine-dot problem. This problem shows nine dots in the formation of a square and to solve, requires four straight lines to be drawn through all nine dots without lifting the pencil. The only way this problem can be solved is to draw the lines outside the square. This problem has been demonstrated to be particularly difficult to solve, given that people fixate on the belief that the lines must stay within the boundaries of the square (Scheerer, 1963). Weisberg and Alba removed this impediment by instructing participants to extend the lines outside the square. In further experiments, other hints were given, such as the first line. Regardless of these instructions and hints, there were still many who could not solve the problem (30%). It was only when detailed instructions were given, that the solution could easily be found. It was concluded that fixation is not the reason for the difficulty with this problem. As found in the first study of the current thesis, approximately 20 per cent of the general population reported that they did not experience insights, suggesting that individual differences in problem solving could be the reason that some people are not able to solve the nine-dot problem.

Fixation can be described in terms of problem predictions that become stuck in the cycle of problem (input), prediction (possible solution), and error detection (incorrect solution). This could suggest that fewer associative networks are involved in the solution search. That is, only memory sequences (patterns of memories created and stored through repeated experiences) with close associations are being utilised (i.e. analytical strategies). For analytical strategies, memory sequences laid down from previous learning are more easily and automatically detected. Some individuals may not
have the ability to access alternative memory sequences necessary to solve the insight problem, unless they have had previous experience with a similar problem. Similarly, these people may have difficulty in making more distant associations. Thus, a further interpretation of Weisberg and Alba’s results is that the participants who ran out of time before solving the problem were depending on analytical strategies, and that when training was given, the analytical strategies were employed because the memory sequence had been formed. Removing a known fixation may not necessarily help the solution process where other difficulties are encountered in retrieving the correct memory sequence, or when the memory sequence is not available. Individual differences would play a part here. These differences may relate not only to existing knowledge, but also the motivation to solve the problem, cognitive flexibility (Ritter et al., 2012), WM (Ash & Wiley, 2006), and personality (e.g. openness to other possible answers), among others. Some of these individual difference factors have been investigated, as reviewed below. However, there is still substantially more research needed to understand what the most significant predictors are. In sum, previous learning may hinder formation of solutions where they are the only memory sequences triggered; alternatively, other forms of learning may be necessary to facilitate the novel solution when alternative memory sequences are required.

2.5.2 Impasse

After fixation, several studies using insight problems (e.g. Maier’s two-string problem and Duncker’s candle problem) have shown that eventually the individual realises that the solution is no longer obvious. Once the individual acknowledges that applying previous known solutions to the problem do not work there is often a transition into impasse (i.e. a situation in which no progress can be made or no advancement possible) (Ash & Wiley, 2006; Dominowski & Dallob, 1995; Knoblich, Ohlsson, & Raney, 2001; S. M. Smith, 1995a). All known solutions are exhausted and the solver may experience
a sense of giving up. It is during the impasse phase that the conscious mind is no longer searching, and an unconscious restructuring of the problem may occur (Schooler et al., 1993). An impasse is likely to depend on whether the person experiences fixation or is stuck in a mental rut, but this will depend on the individual and the problem they are facing.

According to Klein and Jarosz (2011), fixation—and the need to break through an impasse—is only one way to arrive at insight. The findings of their qualitative study also suggested that experience and expertise may be necessary for some insights to occur. Apart from breaking through an impasse, they put forward two other ways that insights can be reached; detecting contradictions, and making connections. Detecting contradictions (divergent ideas) is when an individual is doubtful about something that is normally accepted as factual; as such, these insights tend to appear in those who have a high level of expertise in the subject (Klein, 2013). For example, Gladwell (2007) reported on the J. Paul Getty museum purchase of a kouros, a 6th century BC Greek statue. After extensive testing authenticated the statue, it was put on display. Art experts, however, reported that the statue did not seem right—inconsistencies in the kouros were intuitively noticed, and were credited to their expert knowledge. Further testing showed that the statue was indeed likely to be a forgery. As these sorts of insights appear to arise from expert knowledge and a suspicious mindset (Klein, 2013), this suggests that previous learning does not always lead to fixation, but facilitates breakthrough thinking. Noticing contradictions leads to a paradigm shift, which is consistent with other forms of insights (Klein, 2013). When led to believe that the statue was authentic, this expectation triggered a kind of intuitive error message when the visual input did not match memory sequences from the extensive memory network laid down from repeated experiences with these statues. The error appeared preconsciously (intuitively) at first, alerting the observers to look more closely. Experts have greater
perceptual and attentional abilities which allow them to make judgments in novel situations (Einhorn & Hogarth, 1990). They also have the ability to simplify complex problems (Shanteau, 1988).

Proposed by Klein (2013), a third type of insight that does not require an impasse is making a connection (convergent thinking), whereby a link is made with a new piece of information. For example, Darwin already possessed much of the knowledge for his theory of evolution, but it was not until after he read Malthus’s essay on the competition for scarce resources that a breakthrough realisation was triggered for him; that this competition could drive evolutionary changes (Klein & Jarosz, 2011). The temporal process leading to these insights begins with a lack of some vital piece of information on the subject, and when the information is gained, the puzzle is completed in an instant. Davidson (1995) termed these insights “selective comparison”—a new piece of information fits into existing knowledge. Sternberg and Davidson (1983) found that this ability was positively associated with intelligence (this study is reviewed later).

Another way convergent insights may occur is through the linking of seemingly unrelated pieces of information. Newton’s particle theory of motion persisted until the 1860s when Hamilton and Jacobi’s calculations (Hamilton–Jacobi theory) suggested that motion could be explained by waves rather than particles (Bohm & Peat, 2010). Hamilton described the wave-particle duality in the metaphor that light has the form of a wave but a trajectory resembling a particle. Although their calculations were consistent with particle theory, they were taken to be an artifact. It was not until a century later that Bohr hypothesised that “a particle is a wave”, at which Hamilton hinted, but did not explicitly realise. Years later, this realisation set the stage for quantum theory (Bohm & Peat, 2010). Koestler (1976) termed these insights “bisociation”—the linking of two separate frames of reference into a new paradigm. Bohm and Peat (2010) argued that these insights do not commonly occur because, “the mind [has a] tendency to hang on to
what is comfortable and secure in the subliminal infrastructure of its tacit ideas” (p. 27).

They also proposed that metaphorical thinking is the antidote to habitual thinking, which allows for new connections to be made. Analogies may also serve the purpose of creating novel solutions (Perkins, 2000), and this will be explored later. Overall, motivation to solve the problem—and ability to make connections—are necessary.

In summary, some insights may arise following an impasse when engaging in a difficult problem. Other insights may result from detecting contradictions, gaining a new piece of information, or through making connections between existing pieces of knowledge. What all of these insights have in common is that a deep paradigm shift occurs. Breaking impasse, detecting contradictions, and gaining new information is simpler than making connections between existing knowledge because of the solution error feedback. The former three insights occur because there are known errors, which trigger a further search in other memory networks. The latter insight is difficult to achieve because an error message is not sent when relevant memory sequences are not connected (i.e. the solver is not aware of the error in their thinking). For these insights to occur, the motivation to solve these problems must be great, along with a heightened ability to detect new and subtle relevant information.

2.5.3 Restructuring

One theory put forward to account for changes in conditioned responses is that of restructuring (also known as representational change). The process of restructuring is still unknown, and although some researchers suggest that restructuring is conscious, controlled, and attention-demanding (Davidson, 1995; Kaplan & Simon, 1990), others hypothesise that restructuring relies on automatic processes, such as a change in the automatic spread of activation through the semantic networks of long-term memory (Ash & Wiley, 2006; Haider & Rose, 2007; Sandkuhler & Bhattacharya, 2008). In other words, these researchers proposed that restructuring occurs outside conscious
awareness, a process that occurs in the right hemisphere of the cortex (Jung-Beeman et al., 2004). As the latter theory has been researched, this will be the focus of the review.

Given the subconscious has the capacity to process multiple chunks of information simultaneously (Csikszentmihalyi & Sawyer, 1995), connections of ideas below the threshold of consciousness are likely to occur—even in attention-demanding tasks (Haider & Rose, 2007). Additional support for unconscious restructuring is derived from studies which report that after finding the solution, solvers were unaware of the process for overcoming the impasse (Gick & Lockhart, 1995; Ohlsson, 1992; Schooler & Melcher, 1995). Moreover, a deep—rather than superficial—understanding of the problem upon having an insight occurs through the restructuring phase (Sandkuhler & Bhattacharya, 2008). Together these findings suggest that restructuring is cognitively demanding yet subjectively may appear effortless as the process occurs outside conscious control (see also 2.8.2. Working memory below). As solvers report experiencing a deeper understanding of the problem, it also suggests that restructuring has a substantial effect on learning and memory.

A question has been raised as to whether impasse and restructuring is necessary for insight to occur (e.g. Bowden et al., 2005). To illustrate, MacGregor, Ormerod, and Chronicle (2001) presented the idea of progress-monitoring. According to this theory, problem solving occurs through the process of attempting to reduce the gap between the current problem situation and the (sub)goal, via limiting the number of moves. They argued that the inability to solve the nine-dot problem is not due to fixating on the boundaries of the square, but because criterion failure was reached too late. That is, the solver realised that the solution was not achievable within the remaining moves, so a new set of moves—rather than a new representation—allowed the solver to eventually find a look-ahead strategy that took them to the goal state (solution). Whether or not a solver uses a look-ahead strategy or another strategy will depend on individual
differences in their capacity to look ahead or to seek an alternative solution (Jones, 2003). Progress-monitoring is more akin to analysis in which a conscious, staged approach is applied as a strategy to move towards a solution. Some solvers may choose to use this method, while others naturally adopt it.

Other research by Durso, Rea, and Dayton (1994) supports the unconscious restructuring hypothesis, although they also discovered that participants were implicitly aware of possible solutions prior to the actual solution. In the first of two experiments, participants attempted to solve a verbal insight problem and then later rated the similarity of all possible pairs of 14 words. These ratings were entered into a pathfinder scaling algorithm (see Schvaneveldt et al., 1985) to show a latent structure of the problem representation, whereby judgments of similarity between concepts are graphed. Two graphs were constructed to compare solvers to non-solvers. The graph for the solvers showed that two pairs of concepts important to the solution were connected, but not for the non-solvers. In the second experiment, participants rated the similarity of 12 pairs of words, including two solution-relevant pairs that distinguished solvers from non-solvers, at a number of times during the problem-solving phase. These ratings occurred before and after reading the story, twice before the solution, and immediately after the solution. The solution-relevant pairs were on average shown to be judged as less similar for the first two points, then moderately similar during the solving phase (next two points), and highly similar after the solution. It was concluded that restructuring was necessary to reach a solution, but that connections required to solve the problem are often targeted long before restructuring leads to an insight. One criticism of this methodology is that the judgments in a similarity task may have altered

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1 A man walks into a bar and asks for a glass of water. The bartender points a shotgun at the man. The man says, ‘Thank you,’ and walks out.” Solution: the man had the hiccups and the shock cured him (p. 95).
the participants’ problem-solving strategy (Novick & Sherman, 2003), although this would have affected both solvers and non-solvers.

Restructuring of currently held associations may only be one means by which insight occurs. Insight is likely to result from a variety of processes (see MacGregor & Cunningham, 2009), which may be affected by the experimental task used (nine-dot, two-string problem, rebus puzzles, riddles, Remote Associates Test [RAT] etc.). It could also be argued that the way in which people process the elements of the problem—and whether or not they have an insight as a result of the processing—will vary between individuals (subjective task difficulty, expertise, knowledge, and heritability factors). It may be necessary to gather information from participants about their previous experience with similar problems, and what they experienced during the problem-solving task. This data could shed light on the different ways cognitive shifts occur.

2.5.4 Suddenness of solution

Upon solving the problem, a strong affective response brought about by the suddenness of the solution appearing in awareness is often reported, and has become known as the Aha! experience (Davidson, 1995). The Gestalt theory of problem solving argues that insight is a result of visual information suddenly being reorganised in a new way that meets the goal (Mayer, 1995). The sudden jolt in perceptual change of information is subjectively similar to the experience of figure-ground reversals (e.g. Necker cube) where “elements at one moment are seen as one unity, at the same moment, another unity appears with the same elements” (Ellen, 1982, p. 324). For example, Helen Keller’s experience of words written on her hand suddenly changed from something incomprehensible to something meaningful, with the impact being a permanent change.

The suddenness of insight has received a great deal of research attention. For example, the experience of an unexpected solution to a problem has been studied in a
series of experiments using warmth ratings (i.e. how “close” the solver feels towards solving the problem). During a problem-solving task, subjective feelings of warmth (FOW) were recorded every 15 seconds on a scale from 0 to 10 (Metcalfe, 1986a, 1986b). Warmth ratings were measured for both insight problems and analytical problems. It was revealed that increasing levels of “warmth” prior to solution predicted failure to solve insight problems; correct answers had no prior FOW. In contrast, gradually increasing warmth ratings positively predicted the ability to solve analytical problems (e.g. trivia questions). These findings suggest that the procedural steps and conscious efforts beneficial for solving analytical problems are limited in solving insight problems.

Another characteristic feature of the suddenness of insight problem solution is the feeling of truth and confidence that the solution found is the correct one (Jung-Beeman et al., 2004). After an insight, problem solvers judge the solution as true, and express confidence in that judgment, even before systematically assessing the solution’s trueness in a formal analysis (Topolinski & Reber, 2010). Similar to Metcalfe’s (1986a, 1986b) research, subjective ratings of suddenness of solution (0 = solution appeared gradually, to 3 = solution appeared without warning) have been found to positively correlate with number of correct answers (Sandkuhler & Bhattacharya, 2008). Similarly, Novick and Sherman (2003) found that expert anagram solvers experienced more insight (sudden) solutions than novice solvers. Salvi, Bricolo, Kounios, Bowden, and Beeman (2016) compared self-report solution type (insight or analysis) on 120 compound remote association (CRA) problems (similar to the RAT). Their hypothesis was that insight solutions would be more accurate as they are solved unconsciously through an all-or-nothing process, where the solution appears after the solving is complete. Analytical solutions by contrast, are conscious processes that can turn into guesses if the process is ended prematurely. This hypothesis was supported with
solutions through insight being more accurate than analytical solutions. These findings provide some evidence for a divergence between mechanisms by which insight and analytical solutions are found.

In sum, problems that are solved through insight are notorious for their subjective difficulty, and can often take hours to reach a solution, if at all. When a solution is found, it is often experienced suddenly and comes as a whole, as opposed to analytic solutions which are incremental and in pieces. Moreover, the process of finding solutions to problems that lead to insight differ to analytic problem solving in that they guide the solver in the wrong direction by triggering the incorrect associations in memory. Fixating on incorrect associations (from past experience and conditioning) is believed to be a hindrance to reaching a solution, which inevitably leads to an impasse. During the impasse phase, an unconscious search for the solution continues, where the restructuring of old associations into new, relevant associations is necessary for success. Through a process of unconscious restructuring of faulty assumptions, the solution is reached and pops suddenly into the consciousness of the solver. Insights may also occur in experienced individuals where no impasse is reached; for example, on learning a new piece of information that fits into an existing concept. In some cases, people may simply find a new strategy (progress monitoring). More research is needed to uncover how individual differences predict the way processing occurs, and what types of people tend to have a sudden insight or solve problems through discrete, conscious, analytical steps.

2.6 Insight problems

This section does not aim to review the different kinds of insight problems used in research, as this has been done elsewhere (Cunningham, MacGregor, Gibb, & Haar, 2009; MacGregor & Cunningham, 2009; Sheth, Sandkühler, & Bhattacharya, 2009). The main aim of this section is to argue that insight problem solving varies between
individuals, and that this has largely been ignored by much of the current research. In order to provide a context for this discussion, a brief overview of some insight problems, how they are used, and by whom, are presented in Table 2.1.

Table 2.1
Insight and Non-insight Tests and Uses

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### Insight Problems

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#### Verbal insight problems

**Marriage**: A man who lived in a small town married 20 different women of the same town where polygamy is illegal. All are still living and he never divorced a single one of them, yet he broke no law! (Gardner, 1978). Answer: he was the priest marrying the couples.

**Tumour/Radiation problem**: A patient has an inoperable tumour in the middle of his body. A ray strong enough to destroy the tumour will also destroy healthy tissue and a ray at weaker strength will not be sufficient to destroy the tumour. How can the ray machine be used to destroy the tumour without damaging healthy tissue? (Duncker, 1945). Solution: direct low-intensity rays at all directions onto the tumour.

#### Other insight problems

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#### Non-insight problems

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Measuring insight has predominantly focused on the use of insight problems. The construction of insight tests may be designed to lead the solver in the wrong solution direction (ambiguous problems)—or require the creation of new or more distant associations—among other ways of triggering an insight. Most insight problems fall into three broad categories (S. M. Smith, 1995b): 1. Object-use, for example, the two-string problem where the association of the object is important to the solution; 2. Spatial problems, such as the nine-dot problem where spatial associations are required to solve the problem; 3. Verbal problems, for example the RAT (M. T. Mednick, Mednick, & Mednick, 1964; S. A. Mednick, 1962) and CRA problems (Bowden & Jung-Beeman, 2003). The RAT and CRA problems are based on the associative theory of creative thought in which forming associative elements into new combinations solve a problem, or are in some way useful. The RAT requires the participant to read three words, for example “surprise”, “line”, “birthday” and then to think of a single word that is associated with all three (answer party). As such, the RAT has become a popular test for insight research as impasse often occurs due to the difficulty of finding a word related to all three. CRA problems are similar to the RAT in that a third word is found that forms a compound with the three presented words. For example, “worm,” “shelf”, “end” (answer book). The RAT and CRA problems have become a popular way to explore insight, as many questions can be administered in a single session. They are also
considered hybrid problems as they can be solved through insight or analysis (Weisberg, 1995). The issue is that many researchers only make two distinctions—analytical problems and insight problems, and believe that when an insight problem is solved it means the solver experienced an insight. That is, they are not aware that some individuals may have used analytical strategies if they have experience with the kinds of problems used. This issue will be returned to below.

Aware of the fact that CRA problems are hybrid problems, Bowden et al. (2005) designed their tests so that participants would record against each problem whether it was an insight or no insight solution. This design allowed a stronger certainty that electroencephalography (EEG) and functional magnetic resonance imagery (fMRI) data taken from these experiments were associated with insight. Similar subjective measures of insight include warmth ratings (Metcalfe, 1986a, 1986b; Metcalfe & Wiebe, 1987). Warmth ratings indicate the feeling of gradually moving towards a solution, as “getting closer” or increasing in warmth (analytical), or not finding the answer until it comes suddenly (no warmth; insight). These measures raise an important issue in regard to the temporal aspect of insight versus analytic solutions. The measures demonstrate a divergence in the cognitive mechanisms leading up to the solution for each type. EEG use allows for discrimination between the two mechanisms temporally, but it is expensive, permitting only small samples. Subjective measures such as warmth ratings are cost-effective ways to understand the preceding behaviours, although devising an objective measure would be more favourable.

The research has almost always focused on state measures of insight versus analysis. These differences, however, may go beyond whether a person has an insight or not for a particular problem (i.e. state measures). It may also highlight that these are in fact tendencies towards a strategy type (i.e. trait insight vs. trait analysis). This important issue was raised by Bowden (1997) almost two decades ago; although it has
only infiltrated and informed some of the subsequent research. He suggested that what might be considered an insight task or an analytical task by researchers may not necessarily be perceived as such by the problem solver. Consider the example of an insight problem posed by Bowden:

Water lilies double in area every 24 hours. At the beginning of the summer there is one water lily on the lake. It takes 60 days for the lake to become completely covered with water lilies. On which day is the lake half covered? (p. 547)

This problem is defined as an insight task due to the misleading nature of the question. It is understood that people generally try to solve the problem by starting on the first day and calculating forward, making the calculation difficult. However, the answer is quite simple when one realises that to answer the problem you need to begin on day 60 and work backwards. If the water lilies double in area every day, then it will be half covered on day 59. For those experienced in puzzles, Bowden argued, this may be a non-insight task as their experience may help them to begin on the correct solution path. Insight tasks are usually quite simple once the correct solution path is chosen and this can depend on the solver’s past experience with similar problems. Expertise is built on experience, although genetics also plays a part. As Hawkins and Blakeslee (2007) argued, that which makes a person a genius will depend on the structure of the brain; including the number of neuronal cells, and the way the brain is connected. This may raise the question of how this relates to the tendency for people to have insights. Further research is needed to determine the nature of these differences.

MacGregor and Cunningham (2008) designed a light-bulb scale to measure insight as an individual characteristic. Participants were told about insight, and how it was associated with inventions and discoveries, and how most people have (to a smaller degree) had some form of insight in which they were stumped by a problem and then unexpectedly the solution appeared, resulting in an Aha! experience. Participants were instructed to move the scale on the light-bulb (0–100) to indicate how insightful they
usually were. Scores were taken twice, one week apart, and averaged to create a “trait insight” measure. The two mean scores were highly correlated ($r = 0.82$). A problem with this kind of trait measure is that it is only a single item. Also, as Yu (2005) argued, one kind of error in test-retest reliability is that of carryover effect. A respondent may remember his earlier answer, and with the motivation to appear consistent, will record the same score as the previous one. With only a single measure there is an increased likelihood of remembering an earlier score, leading to measurement error. The light-bulb scale was also used as a state measure to rate how insightful the participant was at that present moment, and then again after completing a series of insight problems (rebus puzzles, RAT, and verbal analogies). However, there is no self-report questionnaire that assesses general insight experiences from different perspectives and situations (e.g. while not thinking about the problem, after an impasse, etc.), nor do we know if everyone understands this definition of insight—or experiences insight—in the same way. An insight scale would allow researchers to compare this ability with other constructs such as general analytic ability, personality, and other traits.

Another consideration for individual differences is in relation to the type of insight problem a researcher chooses to use, whether object-use, spatial, or verbal problems. In 1978, Vernon Mountcastle pointed out that the neocortex has a uniform structure regardless of whether it is part of the visual cortex, auditory cortex, and so on (Edelman & Mountcastle, 1978). He emphasised, “that the processing function of neocortical modules is qualitatively similar in all neocortical regions … there is nothing intrinsically motor about the motor cortex, nor sensory about the sensory cortex” (p. 9). How a region performs a function will depend on how it is connected with other brain regions, and to the central nervous system. The visual cortex processes visual information because it receives input from the eyes, the auditory cortex processes information from the ears, and so on. Mountcastle argued that it is the cortical columns
that make up the basic unit of computation in the cortex, but he did not know what that function was.

Hawkins and Blakeslee (2007) subsequently developed the theory that the cortical columns were the basic units of prediction, that is, the cortex as a whole functions as a memory reservoir that is constantly drawn upon to form expectations about current events (see Hawkins & Blakeslee, 2007 for more information). The functionally similar quality that Mountcastle uncovered is what allows the cortex to change in response to its environment—Helen Keller learnt to read and write, even though she was blind and deaf. Mountcastle acknowledged that although different regions of the cortex perform the same function, its structure is genetically determined, while remaining modifiable to some degree. Thus, in relation to the three broad types of insight problems (object-use, spatial, and verbal), differences in performance should vary between individuals, meaning that the results will not be generalisable.

The neural efficiency hypothesis of intelligence states that intelligence is positively related to lower—that is, more efficient—cortical activations when performing cognitive tasks (Haier et al., 1988). Recent studies have contradicted this finding, revealing instead that moderating variables such as sex, task type or complexity, and brain region modify this relationship (see Neubauer & Fink, 2009 for a review). For example, verbally proficient females have shown the opposite EEG alpha activity to verbally proficient males while performing a verbal creativity task (Neubauer, Fink, & Schrausser, 2002; Neubauer, Grabner, Fink, & Neuper, 2005). Females showed a high alpha synchronisation during the production of original ideas, whereas males showed a low alpha synchronisation in comparison to their average verbal ability sex counterparts. The research on individual differences in insight will be explored in greater detail below. The emphasis here, is that when designing experiments
this issue should be at the forefront of the researcher’s mind, otherwise confounders in the statistical results are likely.

2.7 Facilitating insight

The complexity of insight problems and the conditions that will assist the cognitive processes that lead to finding solutions have been a focus of research. As the higher association areas are engaged in the process, it follows that the solver needs to have an optimal level of relaxation—not too relaxed, but not concerned about survival; a state in which the lower-order functions of the brain take over. To overcome fixation and other cognitive blocks, it makes sense that cognitive strategies will help, and that positive emotions will support the process—which is exactly what the research has found. However, some of these strategies mean that the insight problem is solved using analytical strategies. A review of this research will be covered in the following sections.

2.7.1 Overcoming fixation and other cognitive blocks

If functional fixedness impedes problem solving as discussed above, then one way to overcome this is to devise new strategies to reduce it. Ohlsson (1992) proposed that fixation can be overcome by adding new information about the problem/object (elaboration), or reinterpreting old information (re-encoding). Studies have shown that impasse is resolved when the initial inappropriate knowledge constraints are relaxed, or through a breakdown of perceptual chunks, known as chunk decomposition (Knoblich et al., 1999; Knoblich et al., 2001). McCaffrey (2012), however, argued that the problem with these techniques is that it is not clear how people specifically go about elaborating and re-encoding, and that chunk decomposition “does not fully overcome functional fixedness” (p. 2). Instead, McCaffrey offered a generic-parts technique whereby participants are continually asked two questions: “Can this be decomposed further?” and “Does this description imply a use?” until a solution is found. For
example, the problem of tying two rings together with only a candle would be solved in the following way: A candle is made of wax and a wick, a wick is a string and a string can be used to tie the two rings together. The generic-parts technique appears helpful in predicting the best solution for an object-use insight problem. Breaking the object down into its constituent parts assists in prompting the activation of the relevant memory sequences for solving the problem. However, these techniques stimulate analytical strategies for solving problems, particularly given that the researchers aim to assist participants to elicit relevant memories. The subjective experience of insight is a sudden understanding, not a gradual one. However, these findings do highlight how insight problems can actually turn out to be analytical problems. Moreover, some participants may already use these techniques, and not have an insight as expected.

Another technique used to overcome fixation in spatial and object-use problems is through counterexamples (Murray & Byrne, 2013). For instance, it was reported that many people have difficulty in thinking of a way to throw a ping-pong ball so that it will return, without bouncing it off an object. Fixation is believed to be a result of thinking of a ping-pong ball as an object that returns by hitting it with a bat. This difficulty was overcome by using a basketball instead (i.e. realising it can be thrown up in the air). In regard to verbal insight problems, Schwert (2007) found solutions were discovered more quickly with relevant verbal clues than unrelated clues. In addition, those who were told the clues were relevant performed better than those who were unaware the clues were relevant to the problem; likely because the appropriate memory sequence was initiated. In the case of known clues, it is difficult to ascertain whether this enhances or undermines ecological validity, since in real-world problem solving people would generally be unaware of whether a clue was relevant or not. Again, providing clues, and in particular, informing the participant that the clues are relevant such that the correct memory sequence is triggered, is artificially providing an analytical
strategy. Insight problem solving requires the individual to find their own way on to the correct solution path, where there is a sudden shift in understanding. A further discussion of clues is included in the section on analogies below.

Recent research using virtual reality technology has also uncovered ways to overcome fixation. Based on the theory that unexpected experiences lead to cognitive flexibility and creativity, Tian et al. (2011) exposed participants to unexpected schema-violations through a virtual reality device. Their results showed an increase in cognitive flexibility and insight problem solving in those who were actively involved in unexpected events, compared with those who were actively involved in normal events or vicarious active events (watching a film of the unexpected events). Other practices that enhance cognitive flexibility, such as meditation, have also been shown to improve ability to solve insight problems; this will be discussed later.

2.7.2 Incubation

As explained earlier, many real-world problems that are not easily solvable are sometimes solved after a period of incubation. S. M. Smith and Dodds (1999) referred to incubation as the phase after which the individual consciously attends to the problem, and then sets it aside before further analysis. Insight may occur either within the incubation phase, or when returning to the problem after an incubation period (S. M. Smith & Dodds, 1999).

It has been proposed that a period of incubation is important to the experience of insight (Sio & Ormerod, 2009). Within the incubation phase, it is believed that the problem is continuing to be processed at the unconscious level (Csikszentmihalyi & Sawyer, 1995). Often during this phase, the solution emerges unexpectedly, without any additional effort (Wallas, 1926). S. M. Smith (1995a) argued that incubation allows time for a decrease in competing responses, which in turn allows for a greater possibility that the correct solution will surface. This premise is based on the theory of
response competition, in which learning can negatively affect another learned response (Dyer, 1973). As more competing responses become available, the chances of retrieving the correct solution diminishes. Other research on insight found that incubation had no benefit to problem solving, except where there was exposure to the solution prior to the incubation period (Lockhart et al., 1988; M. T. Mednick et al., 1964; Seifert, Meyer, Davidson, Patalano, & Yaniv, 1996). This was found to activate the correct memory sequence before the problem was presented, thus not adequately investigating the process of solving the insight problem. However, solvers who were unable to find a solution after an incubation period may simply “give up” if they were not exposed to the solution prior to incubation, and if they displayed low effort or low motivation to find a solution (motivation will be discussed later).

Other authors have refuted the concept of unconscious processing. Instead, it has been claimed that having a break away from the problem allows the solver to direct their attention away from the false assumptions, and then return to the problem with a fresher approach (Segal, 2004). In Segal’s (2004) study, participants were given a break after impasse was reached; either a short break (four minutes), long break (12 minutes), or no break (controls). Segal found that a break improved performance, but that the results reflected no difference between the long and short break. In reality, however, a long break of greater than 12 minutes would be required for unconscious processing to improve performance. For this reason, Segal’s study does not provide a compelling argument against unconscious processes as a mechanism for improving task performance. As shown in sleep studies, greater effects on the integration of unassociated information occurs after a sleep, compared to just having a quiet break (Cai, Mednick, Harrison, Kanady, & Mednick, 2009).

In order to uncover the nuances of the incubation effect, Sio and Ormerod (2009) conducted a meta-analysis on incubation studies focusing on moderators such as
problem type, and presence of solution-relevant or misleading cues. They also included lengths of preparation and incubation periods. A greater positive incubation effect was found on divergent thinking tasks, compared to verbal and visual insight tasks. Longer incubation periods were more beneficial to task solution than incubation periods that contained a high-demand cognitive task. This allowed time for the correct memory sequence search to occur, without cognitive resources going to other higher-order tasks. Interestingly, lower-cognitive-demand tasks showed stronger incubation effects than rest periods during incubation on verbal insight problems, signifying that some low-level cognitive activity is better than none. Together, these findings suggest that incubation is beneficial to insight problem solving, however, care must be taken in regard to the type of incubation used within particular insight problems. Creative problems benefit more from incubation periods, longer incubation periods are better than shorter ones, and low cognitive load during incubation for verbal problems is more effective. Similar to the incubation hypothesis, is the theory of Explicit Implicit Interaction (EII) by Hélie and Sun (2008, 2010)—see Section 8.3 below. Overall, it seems that some people will prefer to persist on working through the problem consciously, whereas others may have the urge to “put the problem aside”, allowing time for the unconscious restructuring of the problem during this rest period.

2.7.3 Positive affect

While the Aha! experience produces positive emotions (Liljedahl, 2005), inducing positive affect prior to problem solving can also facilitate insight. Viewing positive images has been shown to have a greater effect on understanding and solving insight problems (riddles), compared to negative or neutral images (Sakaki & Niki, 2011). The mean effect size reported ranged from a medium effect of .09 to a large effect size of 24 (Cohen, 1988). Research by Isen and colleagues (Isen, Daubman, & Nowicki, 1987; Isen, Johnson, Mertz, & Robinson, 1985) also showed that when inducing positive
affect, ability to solve Duncker’s (1945) candle problem and the RAT increases, but impedes analytical problem solving (Oaksford, Morris, Grainger, & Williams, 1996; Phillips, Bull, Adams, & Fraser, 2002). Conversely, inducing negative affect does not improve insight problem solving (Isen et al., 1987; Isen et al., 1985). In support of these earlier findings, a more recent study by Rowe et al. (2007) found that positive mood improved performance on the RAT. This research converges with other studies beyond insight problem solving, revealing that positive mood facilitates global semantic processing (necessary for insight), whereas negative mood is associated with a narrower, local visual processing (Gasper & Clore, 2002).

Neuroimaging studies also demonstrate positive affect enhancement on solving insight problems. Positive mood has been shown to affect neurological processes related to insight problem solving and is associated with activations in the frontal cortex and anterior cingulate cortex (ACC), but impairs neurological processes involved in executive functions (i.e. analytical solutions; Phillips et al., 2002). Subramaniam et al. (2008) found higher positive mood rather than lower positive mood was associated with solving insight problems. More specifically, mood and insight were associated with activation in the ACC, in particular the right ACC. The role of the ACC in insight problem solving is thought to modulate the search for the least obvious solutions (Subramaniam et al., 2008).

External cues affecting a person’s evaluative state deliver the same effect as experimentally inducing mood. Soldat, Sinclair, and Mark (1997) administered analytical problems on either blue paper (known to induce negative affect and a systematic solution style) or on red paper (induces positive affect and a heuristic solution style). The group who solved problems printed on the blue paper outperformed those who solved problems on the red paper—although the effect was found only in those with low motivation and not those with high motivation. Presumably cognitive
effort boosts performance over and above affect manipulation. When reporting their mood, however, there was no difference between the groups, suggesting that external cues affected processing style outside of awareness. Similarly, Friedman and Förster (2000) tested whether manipulating internal cues would change problem-solving performance. Using arm flexion (produces bodily feedback associated with approaching positive stimuli) and arm extension (produces feedback associated with avoiding negative stimuli), they found that arm flexion increased insight processes through eliciting a heuristic processing strategy. Alternatively, arm extension was thought to produce a systematic processing strategy, impairing insight solutions.

In sum, positive mood facilitates global processes necessary for insight to occur, whereas negative mood either has no effect, or impairs insight solution but improves analytical problem solving due to the trigger of a focused and systematic processing style. Future research should investigate whether the mood findings from experimental studies are supported at the trait level, that is, whether trait positive affect predicts a disposition towards experiencing insights in daily life.

### 2.7.4 Analogies and metaphors

Hawkins and Blakeslee (2007) argued that creativity is merely making predictions through analogy, and that this occurs in all areas of the cortex. Furthermore, they proposed that creative acts lie on a continuum from “simple everyday acts of perception occurring in sensory regions of the cortex (hearing a song in a new key)” to the “rare acts of genius occurring at the highest levels in the cortex (composing a symphony in a brand-new way)” (p. 183). They have also argued that both of these acts apply invariant memory sequences to new situations—“all cortical predictions are predictions by analogy” (p. 183). New sensory inputs map on to a memory, forming an analogy that subsequently leads to a prediction about the future (Bar, 2009), or a solution to a problem, and so on.
Following this reasoning, deliberate acts of creativity should be facilitated by relevant analogies (including metaphors and thought experiments). Dunbar (1995) investigated the reasoning heuristics used by scientists for planning experiments, forming hypotheses, and evaluating the results, as well as how they accomplish conceptual changes and insights. Through interviews and observations of scientists from six laboratories, Dunbar found that negative evidence to reject hypotheses and the social context of the research was important. The central finding though, was the use of analogies—specifically, local, regional, and long-distance analogies—for problem solving (Dunbar, 1995; Welling, 2007). Local analogies are derived from the same domain—a specific analogy based on previous experience is mapped on to the current problem. Regional analogies occur when a whole system of relationships from a similar domain are mapped onto the domain of the current project. Long-distance analogies are used when a concept from a very different domain is mapped to the domain in which the scientists are working. Dunbar found that scientists tended to use local analogies to solve the problem of unsuccessful experiments by drawing on a previous successful experiment. In one laboratory, regional analogies were used to understand how retroviruses behave by transferring current knowledge of another virus with similar behavioural characteristics. It was noted that long-distance analogies were used infrequently. When they were used, it was to explain important features of the research to a new laboratory staff member. One of the laboratories being studied did not use analogies in the research process. Dunbar stated that this laboratory also made the fewest scientific discoveries, and employed scientists from similar backgrounds. On the other hand, laboratories that did use analogies tended to engage staff from very different backgrounds. This demonstrates that analogies are not only used intrapersonally to understand a novel situation or problem, but also interpersonally for communicating ideas and knowledge to others who are new, or from different research backgrounds.
Analogies are therefore automatically employed to transfer this information, and so facilitate communication between people, on a continuum from no analogy use (when similarity between colleagues is high) to long-distance analogy use (when colleagues are new or from different backgrounds). These findings also highlight that social interactions between people from different backgrounds are important for innovation.

At the simplest level, analogical transfer is automatic and implicit; but when it comes to complex problem solving, analogical transfer may not be so simple due to the requirement of drawing on more distant analogies, or on analogies that are not necessarily apparent. Repeated experiments have shown that when people are presented with a story, or engage in a solution-relevant task that incorporates analogies to solve the subsequent insight problems, the transfer does not always occur (Gick & Holyoak, 1983; Perfetto, Bransford, & Franks, 1983; Weisberg et al., 1978). The solution is not always apparent unless people are explicitly told the story or the task was relevant to the solution. Lockhart et al. (1988) argued that the analogical transfer is not made when there is a lack of appropriate conception—they found that analogies do not facilitate solution finding unless a clue enables appropriate re-conception after a period of working through the problem. In real-world problems, a relevant clue is not always obvious unless the solver is motivated to solve the problem, and looking out for clues that may help in some way.

In summary, particular factors have been shown to increase problem solving performance, but do not necessarily trigger an insight. For overcoming fixation in an object-use problem, mentally breaking the object down into its constituent parts or using counterexamples has been demonstrated to facilitate the solution process, but these are analytical strategies. Schema violations appear to reduce rigid thinking and improve insight problem solving. Time away from the problem (incubation) allows for further unconscious processing, particularly for a longer period with a low cognitive load.
Positive affect has also been found to facilitate a more global processing necessary for making long-distant connections between remote associations. Analogies guide us through novel experiences on a daily basis, and this is also true for insight problem solving. However, the analogical transfer does not occur unless there is an appropriate conception of the problem, and this may vary between individuals.

2.8 Cognitive approaches to insight

Research on the cognitive aspects of insight have focused predominantly on three theories: first, theories on how faulty cognitions prevent solution success and ways to reduce these; second, the degree to which WM is involved in the production of insight solutions; and third, the interaction between implicit and explicit processes.

2.8.1 Progress monitoring theory versus representational change theory

MacGregor et al. (2001) argued that individuals tend to employ two general problem-solving heuristics when searching for a solution. First, “maximisation” is a visual attempt to solve a spatial problem before applying an action, through a look-ahead strategy. For example, with the nine-dot problem, the visual strategy is to make as much headway as possible by attempting to cross through the greatest number of dots in a single move, as well as visualising the number of moves that can be made ahead. When maximisation fails (criterion failure) an impasse occurs in which the second problem-solving heuristic strategy—the search for new moves—is automatically employed. This temporal process is termed “progress monitoring” (also discussed under Section 2.5.3, Restructuring). Awareness of criterion failure is important for success, with the solver being more likely to change strategies that lead to the correct solution if aware of this failure.

Alternatively, in representational change theory (RCT; Ohlsson, 1992) Knoblich et al. (1999) proposed that the solver initially forms a representation of the problem that is
unlikely to succeed—spreading activation through memory initially activates the incorrect (stronger) associations required to solve the problem (because more distant associations are required). Impasse allows for this representation to be changed so that the correct associations are retrieved and success is obtained; a process that takes time. One way the initial representation fails is when unnecessary constraints are placed on the problem, or information is missing from the representation. Knoblich et al. concluded that when constraints are relaxed and/or chunked objects of the problem are decomposed (e.g. a sentence can be broken down into individual words), impasse can be overcome. Using these strategies with the matchstick algebra problem, Knoblich et al. and Öllinger et al. (2008) found that problems with local constraints could be solved more easily than those with global constraints. Moreover, loose chunk problems (chunks that can be broken down into further chunks) can be solved more quickly than tight chunks (chunks that cannot be broken into further chunks).

A critical evaluation of the Knoblich et al. (1999) study by Weller et al. (2011) was that the matchstick problems were presented on a computer screen so that participants were not able to physically manipulate them. Weller et al. argued that by interacting with the environment the solver can offload cognitive and WM effort through manipulating the environment, much like real-world problem solving. Following this reasoning, they tested two groups on the matchstick problem. One group attempted to solve the problem by looking at it on a piece of paper and reporting aloud which stick needed to be moved (static group) whereas the second group was able to move the stick to solve the problem (interactive group). Their results showed that as the problems became harder, the more likely the interactive group was able to solve the problem than the static group. Conversely, the static group performed better on a numeracy task.

Jones (2003) compared progress monitoring and RCT in a single study, allowing an unlimited number of moves. Both theories were tested using the car park problem. The
object of the problem is to move a taxi—that is obstructed by other cars—out of a car park. The aim is to move the cars in such a way as to make it possible for the taxi to exit. The results showed that RCT was a better predictor of performance on the car park problem than progress monitoring. What both theories do not consider is the need to control for other factors, particularly individual differences in distractibility, processing resources, motivational level, WM capacity, and experiences with similar problems.

2.8.2 Working memory

The relationship between WM and problem solving has been widely investigated (see Wiley & Jarosz, 2012, for a review). WM allows the solvers to focus their attention by narrowing their search through a problem space, and to resist distraction (Wiley & Jarosz, 2012) within a limited capacity (Baddeley, 1992). For these reasons, WM is believed to have greater involvement in analytical problem solving. On the other hand, for insight problems, the limited capacity of WM may be an impediment to finding solutions due to the need to activate wider or less focused associations. Moreover, no amount of WM capacity will solve functional fixedness. Support for the limited role of WM has come from several studies. In Lavric et al.’s (2000) study, participants simultaneously solved analytic and insight problems while counting auditory stimuli. Counting auditory stimuli interfered with their ability to solve analytic problems (Wason’s selection task; Wason, 1966) but not insight problems (candle and two-string problem). As no independent channel processing occurred, the results suggest that insight problem solving relies less on WM capacity.

Although these findings were based on only a single task of each problem type, Gilhooly and colleagues (Gilhooly & Fioratou, 2009; Gilhooly & Murphy, 2005) findings supported this theory with a larger number of both analytic and insight problems. Based on a dual-systems approach, Gilhooly and colleagues proposed that insight solutions are retrieved via System 1, which is automatic and occurs outside
awareness. Analytic solutions on the other hand, occur via System 2 (WM), which is active and consciously directed. As these two systems interact (Domash, 2010), System 2 may play a particular role in the initial search strategy involved in the insight solutions. Gilhooly and colleagues established a significant relationship between System 2/WM and ability to solve insight problems. However, their interpretation of these results was not that System 2 alone is involved in insight solutions, but rather their interaction—the role of System 2 is to allow switching (strategies) and inhibition (of automatic but misleading strategies).

Similarly, Ash and Wiley (2006) investigated the role of WM in insight using problems with many moves available (MMA) and few moves available (FMA) to distinguish between the initial search phase and restructuring phase. The MMA problems allow for a greater number of moves and therefore a more exhaustive search, delaying the restructuring phase. The FMA problems decrease the number of possible moves resulting in a shorter processing time before reaching impasse. The results showed a relationship between WM and MMA, but not with FMA. According to Ash and Wiley, these findings support the idea that success with the FMA problems depended on the restructuring phase, given restructuring in insight is an automatic process that does not require controlled attention. The resulting correlation between WM and MMA, however, is a function of WM demands on attentional control in the initial search phase. Following these studies, Fleck (2008) observed that WM capacity and fluid intelligence were related to analytical problem solving, but took this one step further to assess whether insight solutions (three verbal and one spatial) depended on short-term memory ability (verbal and spatial); however only verbal short-term memory—along with fluid intelligence—facilitated insight performance. Fleck suggested that spatial short-term memory might rely on executive functions. While it has been argued that fluid intelligence and WM are related (Engle, Tuholski, Laughlin,
Fleck’s results supported other studies showing these as separate, with overlapping components (Ackerman, Beier, & Boyle, 2005). Alternatively, some researchers have asserted that WM may be conducive to the insight solution, not just in the initial search phase. Using the nine-dot problem, Chein et al. (2010) tested whether spatial WM, based on MacGregor et al.’s (2001) look-ahead model, was related to the success of the nine-dot solution. Over a series of three experiments, Chein et al. found those who solved the nine-dot problem were more likely to exhibit a high spatial (but not high verbal) WM capacity. In the first experiment, few participants were able to solve the nine-dot problem (~10%). In the second experiment, hints were given which successfully increased achievement (46%). To demonstrate that the modified version of the nine-dot problem still elicited insights, the third experiment incorporated FOW ratings. As the average time for the increase in FOW was 15 seconds to solution, Chein et al. concluded that the modified version (hints provided) of the nine-dot problem was an insight task. Similarly, Murray and Byrne (2005) found a relationship between ability to solve insight problems and WM (Digit span: $r = .39$ and Sentence span: $r = .51$), and attention switching ($r = .51$), but no relationship with selective attention and sustained attention. Although not reported, it would be expected that a relationship between WM would be evident with both selective attention and sustained attention; that is, WM may be needed for encoding different aspects of the insight problem rather than just on the ability to focus. Further research is needed to determine whether this is the case.

Others have also argued for the necessity for WM to solve insight problems. Across two of four studies, De Dreu, Nijstad, Baas, Wolsink, and Roskes (2012) used 10 RATs as insight problems, and instructed participants to recall strings of two (low cognitive load) or five (high cognitive load) digits after each problem. Participants under the low load performed better than those under the high load. The authors concluded that this
approach supported the hypothesis that WM is involved in insight. A limitation of the study is that the researchers assumed the RAT requires an insight solution; however, others have discovered that many people solve RATs through analytical strategies (e.g. Jung-Beeman et al., 2004), which may also be an explanation for their results. This further highlights the necessity to determine whether participants are having insights or not.

WM (and analytical thinking) is certainly needed to encode and think about a problem in the initial solving phase, particularly if the problem is complex. A problem would not likely be solved by insight if the elements of the problem were not encoded sufficiently. WM, however, would not be implicated in real world insight solutions which come unexpectedly—when the problem is far from the mind of the solver—when they are not consciously thinking about the problem. It must also be stated that the experience of having an insight solution is one that many people claim they have never had (Ovington et al., 2015). Complex problems solved through insight have many seemingly unassociated aspects which require a connection to be made—this often goes beyond the capacity of WM alone. As Bor, Duncan, Wiseman, and Owen (2003) argued, individual differences are present in the task’s subjective difficulty. Those who show greater ability in chunking (encoding information into chunks) experience a reduction in memory task demands.

Aside from WM capabilities, other broader cognitive styles must also be important to the production of insight. DeYoung, Flanders, and Peterson (2008) tested convergent thinking (characteristic of analytical thinking), divergent thinking (characteristic of creative thinking; Wua & Zhanga, 2010) and breaking frame (i.e. ability to overcome fixation) as a predictor of insight problem solving (using verbal insight problems). Later in the analysis, convergent thinking was broken down into WM (as associated with fluid intelligence), verbal/crystallised intelligence, and analytic problem-solving ability. The
reported results suggested that all three abilities independently predict insight ability. Capability of solving insight—but not analytic—problems predicted ability to break frame and think divergently, whereas both insight and analytic scores predicted WM and verbal intelligence. Those who favour analytical thinking, and who do not experience insights, may lack the ability to break frame, and think divergently.

2.8.3 Insight and implicit versus explicit processing

Hélie and Sun (2010) proposed an EII theory based on Graham Wallas’s (1926) four-stage model. In this paradigm, Wallas argued that a new idea has three stages. The first stage, preparation, involves the problem being consciously investigated in great depth or “in all directions” (p. 80). The second stage is incubation, whereby the problem is temporarily suspended from conscious thought, while unconscious processing continues. The third stage is illumination, in which the solution or idea arises and solves the problem, with this often being accompanied by a sense of positive affect. Wallas then added a fourth stage, verification, which consists of a conscious effort to test the solution’s correctness. Wallas also acknowledged intimation, in which a subject has a feeling akin to an intuitive sense, or an external hint may trigger the solution.

In Hélie and Sun’s (2010) EII model it was posited that explicit processes (Wallas’s preparation phase) and implicit processes (incubation phase) interact during the solution search period until insight is reached by the process of explication—making the output available for verbal report. Using the computational model, CLARION (connectionist learning with adaptive rule induction online)—a cognitive architecture program used to artificially simulate tasks in cognitive psychology (Hélie & Sun, 2010)—Hélie and Sun (2008) tested insight in problem solving and the overshadowing effect. Specifically, they artificially simulated the interaction between implicit and explicit processes on an insight problem. The results of 8,000 CLARION-based simulations showed an increased probability of solving the problem with increasing noise in the implicit
association retrieval. High noise levels reduced the probability differences, leading to a more thorough search of the problem space, whereas a low noise level exaggerated the probability differences leading to a narrower search of possible responses. Narrower searchers typically retrieve stereotypical responses required for analytic problems, and thorough searchers tend towards creative responses needed for insight. Overall, the model supports an explicit-implicit interaction on insight problem solving (for more information see Hélie & Sun, 2010). It is not clear, however, whether this finding models the way all people attempt to solve insight problems, or whether it represents one way problems are solved, particularly for those who do have insights.

A physiological approach to understanding the divergence between insight and analytical processes has been to measure heart rate (HR) while solving creative problems with a less-defined structure, and analytical problems with a well-defined structure (Jaušovec & Karin, 1995). Creative and subjectively difficult problems are associated with increased HR (Tikhomirov, 1983) and systolic blood pressure (Fredericks, Choi, Hart, Butt, & Mital, 2005), compared to a lower cognitive workload. Jaušovec and Karin (1995) discovered that well-defined problems show a gradual increase of HR (e.g. 91 gradually rising to 101 beats per minute) leading to solution, whereas ill-defined problems reveal an abrupt increase in HR (e.g. approximately 92 beats per minute, abruptly rising to 101 beats per minute in the last 15 seconds before solution). Jaušovec and Karin (1995) concluded that analytical problem solving is incremental and conscious (as indicated by HR scores), and insight problem solving is sudden and thus unconscious; at least until the point of solution when it becomes conscious (indicated by sudden HR rise). While it may be argued that an abrupt increase in HR is due to the excitement caused by the Aha! effect, HR did not exceed the level generated by analytical solutions. Moreover, the study also included FOW ratings designed by Metcalfe and Wiebe (1987). The FOW ratings followed the same pattern of
HR rise, that is, a gradual increase for analytical problems and an abrupt increase in the final 15 seconds prior to insight solutions. The strength in using a HR measure over FOW ratings is that the results can be recorded without interrupting the problem solver during task performance. What is not clear is if HR measures are useful for all insight problems. The nature of insight tasks is that they are meant to be subjectively difficult which would—based on the theory that increased HR is positively associated with mental effort—lead to an increased rather than decreased HR. As argued throughout this review, an insight problem for one person may be an analytical problem for another.

In summary, cognitive research has focused on supporting one of three theories on how insights are generated. Progress monitoring posits that solutions to insight problems occur when an incorrect strategy is initially employed—although most likely a strategy that works well in analytical tasks. When a new strategy is adopted, likelihood of success increases. On the other hand, RCT is based on the idea that restructuring the initial faulty representation to the correct one occurs following an impasse. Restructuring is easiest when the problem contains local constraints and loose chunks, rather than problems with global constraints and tight chunks. Off-loading cognitive effort with spatial problems by interacting with the objects of the problem also increases success compared to holding the problem and possible solutions in WM. One study using unlimited moves found RCT was a better predictor of performance than progress monitoring. None of these studies controlled for distractibility, processing resources, motivation, WM capacity, and previous experience with the problems.

The role of WM is apparent in solutions to analytical problems, but for insight problems, the role of WM is still not clear. Researchers agree that the initial search phase involves WM, but disagree whether WM is involved during the restructuring/impasse phase and solution. Further research is required to determine how WM is involved with the consideration of potential mediators such as task type (spatial,
verbal etc.), the way insight is measured (subjective experience or solution to task), and individual differences (e.g. WM capacity).

Finally, unconscious processing functions to a greater degree in insight solutions, compared with analytic solutions—probably the result of requiring a larger and more global processing ability to handle the complexity and novelty of insight problems. This theory has received some opposition however, with the argument that a break away from the problem is what is useful to finding novel solutions. Still others argue that insight problem solving is the interaction between implicit and explicit processes. It is likely that some individuals rely on more conscious, focused strategies, while others automatically put the problem aside and allow the unconscious to take over the solving process.

### 2.9 Insight and individual differences

Throughout this review it has been suggested that insight is a particular ability that some individuals possess to a greater degree than others. WM capacity has already been discussed in this review; however, other authors have also considered this question. Research by Martinsen (1993, 1994, 1995) and Martinsen and Kaufmann (1991) uncovered some empirical support for individual differences in cognitive style between insight and analytical problem solving, while Sternberg and Davidson (1983) proposed a relationship between insight and intelligence. Fink and Neubauer (2008) tested cognitive arousal theory in relation to creativity as mediated by introverted-extraverted personality types. More recently, trait mindfulness became a focus for possible influences on insight ability (Ostafin & Kassman, 2012). These studies will be reviewed in turn.
2.9.1 Cognitive style: Assimilators versus explorers

Martinsen and Kaufmann (1991) contended that differences between analytical thinking and insight reflect individual differences in cognitive style. Specifically, Martinsen (1993, 1994, 1995) and Martinesen and Kaufmann (1991) investigated the theory of assimilative and explorative (A-E) cognitive styles (Kaufmann, 1989) by investigating how they differ in terms of insight problem solving and creativity. The basis for A-E theory is the notion that individuals differ in the degree to which past experience or novelty-seeking influences their cognitive activities (Kaufmann, 1979). Assimilators depend on previous experience and cognitive short cuts, whereas explorers prefer to seek new ways of solving problems and different solutions. Based on this theory, Martinsen and Kaufmann (1991) argued that analytical thinkers would show an assimilator style and insight thinkers would demonstrate an explorer style. In the first of these studies (Martinsen & Kaufmann, 1991), a sample of 148 all-male military personnel were tested on two object-use insight problems (the two-string problem and the hat-rack problem). The subjects were divided into four groups, with each group given different instructions to solve the problems. Two groups were asked to analyse (i.e. using known principles to find the solution), and to either think verbally or think visually. The other two groups were instructed to use an exploratory strategy (i.e. trial and error), and to either think verbally or think visually. Participants were then identified as “assimilators” or “explorers” using the assimilator-explorer questionnaire (Kaufmann, 1989). The results showed that all participants tended to visualise the strategy regardless of instructions (visualise or verbalise). Assimilators were found to perform better when instructed to use an explorer strategy and explorers were found to perform better when instructed to use the analyse strategy (i.e. the opposite strategy to what they would normally use). The authors suggested that assimilators were encouraged to break set and search for new solution paths, whereas explorers were
encouraged to restrain their tendencies to find novel solutions. What the findings offer is that changing the automatic ways people tend to problem solve, allows them to see the problem differently—an important component of insight. Whether the results are generalisable is difficult to confirm due to the homogeneity of the sample (all-male military personnel).

In a later study using the same insight problems, Martinsen (1993) discovered that assimilators performed better with a high level of experience (low novelty) and explorers performed better with less experience (high novelty). According to Martinsen, these results suggest that past experience does not always interfere with insight performance (i.e. fixedness), when the solver displays an assimilator cognitive style. Thus, fixedness may be a greater burden in those who solve creative problems with an explorer style. An additional study repeated these findings while controlling for gender and intelligence (Martinsen, 1995); however, for those who fell in the middle of the A-E dimension, performance was lower than for those at the more extreme ends of the dimension. Another explanation for these results is that the problems can be solved through insight or analysis. Thus assimilators with a high level of experience performed better because they were able to solve the problems analytically, whereas explorers performed better with less experience because they used strategies more akin to insight problem solving.

A further study investigated the degree to which motivation disrupted insight problem-solving performance (Martinsen, 1994). This study was based on Atkinson’s (1980) theory of optimal motivation, in which strength of motivation coupled with ability can either be optimal, too high, or too low when approaching a task. Martinsen (1994) argued that having both a high approach motivation (i.e. motive to succeed) and high competence in the task would lead to over-motivation. The basis for this hypothesis centres on the research findings that increased drive (Glucksberg, 1962),
high cortical arousal (Martindale, 1989), and extrinsic motivation (McGraw & McCullers, 1979) negatively impact the creative thinking process. From this perspective, it was expected that extreme explorers would show high competence on insight tasks, and if coupled with high motivation, would lead to an over-motivated state and thus disrupt performance. Conversely, extreme assimilators who are less competent in insight tasks would show an optimal level of motivation if approach motivation was also high. As a result, the hypothesis was made that these individuals would perform well. In support of this view, Martinsen found that explorers performed worse when motivation was high; however, assimilators performed better with a high level of motivation. If explorers are using strategies that lead to insight, then positive mood will facilitate this process, as reviewed earlier. Furthermore, if assimilators are using analytical or focused strategies, then a certain level of anxiety will facilitate this process. While mood was not measured in this study, it would be of interest to know if this affected the result.

2.9.2 Intelligence

Intelligence refers to intellectual functioning (Corsini, 1994) and is largely inherited (Bouchard & McGue, 1981). From the earliest work (Spearman, 1904), it has been proposed that intelligence is not a single type of cognitive functioning, but can be divided into types of intelligences (Gardner, 2006). Gardner’s eight types include visual-spatial, verbal-linguistic, logical-mathematic, musical-rhythmic, bodily-kinesthetic, interpersonal, intrapersonal, and naturalistic. Sternberg’s (1985) triarchic theory of intelligence types include practical, creative, and analytical. More recently it has been argued that human intelligence depends on how well the cortex can make predictions (Hawkins & Blakeslee, 2007) through retrieval of similar patterns in memory from the past (auto-associative recall). With insight problems, auto-associative recall leads to an incorrect prediction, followed by an error message until the correct
prediction is made. Previous research on children showed that a higher intelligence quotient (IQ) predicts ability to solve insight problems (Davidson & Sternberg, 1984; Sternberg & Davidson, 1983). Davidson and Sternberg defined insight ability as being able to selectively encode (relevant information is encoded whereas irrelevant information is discarded), selectively combine (relevant information is combined in new and productive ways), and selectively compare (new and old information is combined in a novel way). Using verbal insight tests to measure each of these abilities, they found that gifted children significantly outperformed non-gifted children. However, as this theory has not been subject to further study, firm conclusions cannot be drawn.

Ansburg (2000) defined insight skill as “the ability to comprehend relations and the ability to generate an integrated representation of the problem” (p. 144). Testing this definition, fluency of thought was measured using the RAT, and the ability to comprehend relations was measured using verbal analogies and a series of completion tests. Insight capability was tested using verbal insight problems. Moderate correlations were found between insight ability and these constructs ($r = .31$ to $.47$). As reviewed earlier, the RAT is often used as a measure of insight, and may explain the significant relationship between it and verbal insight tests. Thus, the RAT and verbal insight tests are likely to be measuring a similar (yet somewhat distinct) underlying construct. This method of measurement could make it difficult to discriminate between fluency of thought, as measured by the RAT, and insight ability, as measured by verbal insight problems. This could be rectified by using a fluency of thought measure that does not also produce insights.

### 2.9.3 Personality

Another variable that may influence whether or not an individual frequently experiences insights is personality. Personality refers to individual differences in behaviour, affect/feeling, and patterns of thinking that are enduring over time, across situations.
(Major et al., 2000), and agreed by different observers (Costa & McCrae, 1992). The five factor model of personality assesses 30 traits, with each factor comprised of six traits (Costa & McCrae, 1992). The five factors include openness to new experiences, conscientiousness, neuroticism, extraversion, and agreeableness. Although there are number of different Big-Five scales focusing on different traits, evidence shows they contain convergent validity (Costa & McCrae, 1992). While no explicit link between insight and personality has been made, openness is the strongest and most consistent predictor of creativity across different measures and types of creativity (see King, et al., 1996).

Following on from Martindale’s (1999) theory that original ideas are more likely to occur in individuals who generally exhibit lower cortical arousal, Fink and Neubauer (2008) hypothesised that extraverts, who generally exhibit lower cortical arousal, would have more creative ideas compared to introverts (as measured by the NEO-Five Factor Inventory; Costa & McCrae, 1992). Participants with a $T$ mean score below 47.7 were classified as introverts and scores above 61.2 as extraverts. Using a series of tests, including two verbal insight tests, they gave each participant two unusual situations that needed an explanation. Participants had three minutes to think of as many different causes or consequences as possible. In support of their hypothesis, Fink and Neubauer found that extraverts exhibited the largest amounts of alpha power, and produced more unique ideas than introverts.

There are several issues with Fink and Neubauer’s (2008) conclusion that extraverts are more creative—or perhaps more insightful—than introverts. Anecdotally, it does not explain why well-known introverts such as Albert Einstein, Sir Isaac Newton, Charles Darwin, and J. K. Rowling (Cain, 2012) came up with such unique, insight-based ideas. Csikszentmihalyi (1997) argued that highly creative people tend “to express both traits at the same time” (p. 65)—to write, paint, or design experiments requires spending a
great deal of time alone. Studies have shown that teenagers who do not like to spend time alone do not develop their creative talents as well as those who do enjoy alone time (Csikszentmihalyi, 1997). The importance of sharing ideas is also important in the discovery process—it is finding the equilibrium between time alone and time with others that matters.

Time constraints are also essential considerations in comparing introverts and extraverts in experiments. Gorla, Chiravuri, and Meso (2012) found that, in general, introverts show greater comprehension abilities than extraverts; however, the opposite pattern emerged with time constraints of under five minutes. The reason, Gorla et al. argued, is that introverts are deeper thinkers—which takes time. Recall now that in the Fink and Neubauer (2008) study, only three minutes of completion time for insight tasks was allocated to participants; a time period which favours extraverts over introverts in task performance. If more time had been allowed, a different result might have ensued.

### 2.9.4 Steep versus flat associative hierarchies

As insight performance depends on searching for more distant associations (global processing), another individual difference to consider is in relation to attentional capacity (Mendelsohn, 1976). When attention is focused, fewer neural nodes are highly activated, which exerts a strong lateral inhibition on other nodes, preventing them from becoming activated (Martindale, 1995). On the other hand, during defocused attention, activation is weaker but more dispersed between nodes so that less lateral inhibition occurs. Thus, activation of nodes in short-term memory is greater in defocused attention than in focused attention. Using RAT problems as an example to illustrate the difference between focused and defocused attention will help here. Reading the RAT words initially activates nodes from associative hierarchies (habitual responses), in which the most obvious answers are retrieved from memory (Hull, 1943). During
focused attention, the words will activate few nodes, forming a steep associative hierarchy. When attention is less focused, more nodes will be activated but to a lesser degree, forming a flat associative hierarchy. Defocused attention shows that an individual can attend to more combinations of ideas than a narrow focused attention (Dykes & McGhie, 1976; Mendelsohn & Griswold, 1966). From an individual differences perspective, Martindale (1989) argued that creative individuals simultaneously activate more neural nodes than uncreative people, regardless of whether these nodes are activated during focused attention or in short-term memory. These people are said to exhibit a flat associative hierarchy, that is, they respond in a more variable fashion and thus will be more successful at making remote associations. Conversely, those with a steep associative hierarchy will respond in a more stereotypical way, continuing to provide the dominant response. Presumably this means that these individuals are less likely to move out of fixation, or to stay in a mental rut. Conversely, those with a flatter associative hierarchy will more easily shift from habitual responses and restructure their thinking.

Following on from Wallas’s (1926) four-stage approach to insight, Martindale (1995) differentiated individuals as those with a high associative hierarchy (non-creative) or those with a flat associative hierarchy (creative). In the preparation phase when the solver is focusing on the problem at hand, attention must be focused, meaning that few nodes are highly activated and the problem dominates consciousness. These activated nodes are required to encode the ideas thought to be relevant. However, creative solutions are those which diverge from the current expectations. During the incubation phase, the nodes of the creative individual will continue to stay partially activated. In uncreative individuals these activated nodes become deactivated—the problem is forgotten. Thus, inspiration strikes when a node relating to the problem’s solution is activated and matches the partially activated node relating to the encoded
problem. Mind-wandering, through activation of the default mode network (Fox, Spreng, Ellamil, Andrews-Hanna, & Christoff, 2015), has been shown to be more conducive to creative problem solving (Baird et al., 2012), and may assist a defocused state, or to increase a flatter associative hierarchy. This has yet to be studied. The final verification stage is when attention is focused again on the new idea and examined for faults. If this accurately reflects the differences between creative and uncreative people, then the practical question arises as to whether individuals can train themselves in such a way to facilitate a flatter associative hierarchy. One way may be through mindfulness practice.

2.9.5 Mindfulness

In recent years, psychologists have used mindfulness as a treatment for psychological problems, particularly anxiety disorders (Kabat-Zinn, 2003). With its roots in Buddhism, mindfulness is the practice of focusing attention and awareness on our internal and external environment (Germer, 2004). Mindfulness is core to meditation practice (Olendzki, 2005), but can also be practiced in day-to-day living without meditation (Langer, 2000; Langer & Moldoveanu, 2000). Lutz, Greishcar, Rawlings, Ricard, and Davidson (2004) found that Buddhist monks with long-term experience in compassion meditation, exhibited higher levels of gamma-band activity at rest compared to controls; during meditation, the difference increased dramatically. Gamma has been shown to facilitate memory encoding and subsequent recall (Herrmann, Fründ, & Lenz, 2010). In relation to insight problem solving, a sudden burst of gamma 0.3 seconds before insight occurs has been reported in EEG studies (Jung-Beeman et al., 2004). Gamma activity is also associated with correct insight solutions (Sandkühler & Bhattacharya, 2008; Sheth et al., 2009), and when successfully applying a prior hint (Sheth et al., 2009). Davidson stated that, “Most of them [Buddhist monks] showed very large increases [in gamma signal], and some showed extremely large increases of the
sort that have never been reported before in the neuroscience literature [...]. It’s like a continuous *Aha!* moment” (Begley, 2007, p. 235). These findings are quite striking and show that meditation practice should be taken into consideration by those who are interested in ways of influencing insight occurrence.

A recent study that directly compared mindfulness effects on insight ability found that trait mindfulness predicted better insight—but not analytical—problem solving, even after controlling for positive affect (Ostafin & Kassman, 2012). Training participants in mindfulness also improved the ability to solve insight—but not analytical—problems. The reason by which mindfulness improves insight problem solving is that it reduces habitual responding (from experience), and increases flexible thinking—thereby limiting functional fixedness that hinders insight performance. This argument suggests that if previous experience (i.e. habitual responding) is involved in fixedness, which leads to an impasse during the problem-solving phase, then mindfulness, which reduces habitual responses, should also reduce fixedness, and would therefore circumvent impasse. Certain mind states such as mindfulness may answer the question: Does impasse always precede insight?

Mindfulness has also been shown to increase visual sensitivity, which in turn may increase detection of subtle differences, and therefore improve insight ability through noticing novel solution-relevant information that would otherwise go undetected. Brown et al. (1984a, 1984b) tested practitioners of mindfulness meditation for their visual sensitivity after a three-month retreat in which they practiced for 16 hours per day. Visual sensitivity was measured by the detection threshold of a single light flash, and the discrimination threshold of successive light flashes. Duration of light flashes varied between 0.5 and 50 milliseconds. Prior to the retreat, no differences in visual sensitivity were found between the meditation group and controls (staff who worked at the retreat). After the retreat, the mindfulness groups showed a significant increase in
visual sensitivity compared to the pre-test, whereas no increase was found for controls. Follow-up questions confirmed that participants had noticed changes in their perceptual abilities.

Overall, individual abilities and traits do make a difference in how people perform on insight tasks. While personality traits—and possibly intelligence—cannot be modified, future investigation into whether training people to think more flexibly or mindfully can influence insight experience is a worthwhile endeavour.

2.10 Recommendations

From a review of the literature, it is clear that assuming certain tasks will trigger an insight is problematic for at least two reasons. First, some people may not be capable of having insights, for reasons that are not yet clear. This hypothesis requires further research. Second, solving the problem may not necessarily indicate that the type of solution was an insight. Some individuals may have successfully developed techniques that allow them to break the problem down in such a way that they can solve it through analysis. This is also an important avenue for future research. Based on these two points, two important recommendations for insight research are warranted.

The first recommendation is to take self-report data on solution type. While this is currently being employed by a few researchers, most researchers are not recording this type of data. This method will ensure the validity and reliability of the tasks. It will also make the findings from different studies comparable. At the moment, comparing findings is difficult because the method of measuring insight varies. Incorporating self-report data will improve the integrity of the research as a whole. An alternative is to develop an objective measure of insight. At this stage in the research, there is no objective measure that can ensure an insight has occurred.
The second recommendation is to control for non-insightful people. If the focus of a study is purely insight—as opposed to a comparison of insight and non-insight responses—then filtering out or controlling for those who do not have insights is recommended. As with neuroscientists who only recruit right-handed participants to avoid confounding the data, it may be necessary for a researcher to only recruit those who can have insights. A way to ensure this would be to include a filtering question that asks potential participants whether they have insights. In relation to this point, identifying those who do not have insights and investigating the ways they solve insight problems, would be an important avenue for future research. Some interesting research questions could include identifying the techniques they use to solve problems, whether they tend to give up on solving the problem, and whether their brain functions differently to insightful people.

2.11 Literature review summary and conclusion

The difference between insight and analysis predominantly concerns the degree to which the solution process is unconscious or conscious, respectively. The accepted definition of insight has evolved from the experimental research, and loosely encompasses the phenomena as a sudden breakthrough in a difficult or ambiguous problem. The time between problem presentation and solution may include a trigger of an incorrect memory pathway and/or fixation on the incorrect solution, an impasse, and an unconscious restructuring of the problem elements. When the correct memory pathway is triggered (or a new piece of information is encountered that fits the goal), the solution pops suddenly into the conscious mind of the solver. Analytical processes, on the other hand, are described as conscious, discrete stages of working through the problem until arriving at a solution.
Researchers have devised several types of insight problems that are either deliberately ambiguous, or require current thinking to be restructured in order to solve the problem, or require a search for more distant associations. If the problem is solved, then it is assumed that an insight has occurred. This assumption becomes problematic if the person has had experience with the same—or similar—problems, as experience is the foundation of analytical problem solving. Some researchers have recognised that most insight problems are likely to be hybrid problems (can be solved either through insight or analysis). Even fewer researchers have combated this methodological issue by taking self-report data about whether the participant solved the problem through insight or no insight. Self-report data should be taken in all experimental studies to ensure that insight—and not another way of solving a problem—is actually being investigated.

Individual differences in insight ability have been studied. Some researchers have suggested that individual differences in WM capacity predict ability to solve insight problems. Many insights occur when not thinking about the problem, thus WM ability is likely to be involved more in encoding the elements of the problem and exhausting incorrect solutions, rather than being involved in the insight solution. Flatter or more diffuse associative hierarchies are argued to be a better predictor of creative ideas, as flatter associative hierarchies encompass more remote associations that may meet the problem goal. Similarly, facilitation of global processing also encourages the search for more distant associations required to find the solutions that are beyond current assumptions. Facilitators of global processing include positive affect and mindfulness. Another facilitator of global processing, flow states, was raised in the introduction and will be tested in Chapter 6.

Insight research has uncovered many of the cognitive and neurological processes of how Aha! moments occur, and how they differ from other types of problem solving, namely analysis. While insight has been acknowledged as an ability, only a few studies
have investigated predictors of this ability. The future of insight research should include investigation into further abilities related to insight as skill. These findings will provide at least two benefits: a profile of the insightful person, and possible ways to improve ability to have insights.
Chapter 3
Research method
3.1 Chapter overview

This chapter discusses the research design and development of the questionnaire. It also covers the questions and scales that were included in the study, as well as the study methodology. Ethics approval, a description of the participants, and a demographic profile of the study subjects are reported. The scales included in the questionnaire are then reported and discussed. To make the study time-efficient and cost-effective, shorter versions of longer scales were chosen where possible. The final section covers the procedure of the study.

3.2 The research design

A mixed-method design (QUANT > QUAL) was implemented to investigate individual differences in insight problem solving. The design involved the collection of data at a single point in time (i.e. cross-sectional study) using a self-report (questionnaire) method. The qualitative component of the study utilised open-ended questions embedded in the questionnaire. The rationale for collecting qualitative and quantitative data was that using only one of these methods was not sufficient to understand the complexity of insight experiences. Combining these methods allows a more complete picture of where and when insights occur, and the type of people who experience them more frequently.

Combining quantitative and qualitative data may be viewed as problematic in that they emerge from two distinct, and even opposing, epistemologies (Richardson, Goodwin, & Vine, 2011). However, the qualitative data collected in the current study does not strictly align with the epistemologies of qualitative research—that is, it attempts to balance idealism with realism epistemologies (Hayes, 2000). The self-report scales were selected to meet the aims of the study—to assess dispositional factors including personality, subjective experiences around mindfulness and flow, as well as

...
emotions. As subjective experiences are the aim of the study, it would not be appropriate to employ objective measures.

3.3 Common method variance

Common method variance (CMV) or monomethod bias, refers to the idea that relationships between variables are inflated when measured with the same method (Spector, 2006). Identification of CMV began with Campbell and Fiske (1959) who argued that a degree of variance in measurement can be attributed to the method used in the study. While this issue can relate to any study method, in more recent times it has predominately been applied to cross-sectional self-report measures. Spector and others (e.g. Carifio & Perla, 2007) argue that CMV has become an automatic criticism of these measures, to the point that it has become an “urban legend” (p. 222), that is, there is some truth but its problems have become “distorted and exaggerated as it passed from person to person” (p. 222). Spector acknowledges two aspects to its truth. First, the way something is measured affects the data it produces. For example, questions that elicit social desirability can have a negative effect on the data—but not all self-report questions are affected by social desirability (e.g. demographic variables). Second, using the same method to assess two (or more) variables with a common source of bias will inflate the correlation (e.g. two measures that are affected by social desirability), assuming they are measuring related constructs (Spector, 2006).

Problems with the CMV argument are that method alone does not produce the same bias across all measures using the same method (e.g. social desirability and acquiescence). Moreover, according to Spector’s (2000) review of the literature, there is no evidence that mono-methods suffer from inflated correlations any more than multi-methods. Multi-methods—that is, using different methods to measure the same construct—are often proposed as an antidote to CMV. A limitation with multi-methods
is that it is time consuming and expensive, and may not produce a different outcome to the time- and cost-effective use of mono-methods (Doty & Glick, 1998). Self-reports are the best method for measuring people’s internal states, such as emotions, attitudes and perceptions; which is the aim of this thesis. There are methods to control for CMV (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003); however, Spector argues that these have limitations, and are likely to be “controlling for something that does not exist” (p. 230).

3.4 Development of the questionnaire

The questionnaire was designed around the aims of the thesis with a combination of open and closed questions. The open questions were designed to acquire information about experiences of insight—where and when they occurred, and participant perceptions. The strength of open questions is that they allow participants to express their own opinions (i.e. good ecological validity) and to gather data on personal experiences and perspectives of the insight phenomena. These questions were placed at the start of the questionnaire to gain answers that were not biased by the remaining questionnaire; this also provided a context for what the study was about. A final open question was placed at the end of the questionnaire in order to capture any thoughts that may have arisen during the completion of the study. The open questions are described below, and the themes that emerged from the results are reported in Chapter 4.

Scales (closed questions) were carefully selected on the basis of their ability to assess dispositions to specific experiences (i.e. mindfulness, flow, and emotion) and personality. The scales used (described below) have good validity and reliability, as well as being highly established and accepted in the literature. No self-report scale was available to measure the propensity towards experiencing insight. Therefore, an additional aim was to construct a psychometric scale for this purpose. The construction
of the scale is fully discussed in Chapter 5. The items for this scale were placed immediately after the open questions on insight, followed by the remaining scales. The selected scales, along with a description and their psychometric properties—including the insight scale—are described below.

3.5 Ethics statement

The Charles Sturt University Arts Ethics Committee approved the study (approval No. 113/2012/65). After reading the information sheet about the study, participants indicated consent by clicking on “Begin study” which forwarded them to the questionnaire. The participant was able to exit the study at any time. No information regarding personal identity was collected.

3.6 Participants

The 1,114 Australian respondents were recruited through an online market research database that represents the Australian population. The sample consisted of 559 females and 555 males. Ages ranged from 18 to 85 years with the modal age category being 35–44 years. Highest level of education attained ranged from high school to the doctoral level. Participation was voluntary, with a small monetary incentive of approximately two dollars for study completion. Participant recruitment aimed to be a representative sample of the Australian population based on Australian Bureau of Statistics’ (ABS) data (2015). Table 3.1 reports the demographic profile of the sample in comparison with statistics obtained from the ABS.
Table 3.1
Demographics of the Sample Including a Comparison With the Australian Bureau of Statistics (Except Occupation)

<table>
<thead>
<tr>
<th>Gender</th>
<th>n (%)</th>
<th>ABS%</th>
<th>Occupation</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>555 (49.8)</td>
<td>49.6</td>
<td>Management</td>
<td>47 (4.2)</td>
</tr>
<tr>
<td>Female</td>
<td>559 (50.2)</td>
<td>50.4</td>
<td>Business and financial</td>
<td>48 (4.3)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td>Computer and mathematical</td>
<td>37 (3.3)</td>
</tr>
<tr>
<td>18–24</td>
<td>167 (15.0)</td>
<td></td>
<td>Architecture and engineering</td>
<td>14 (1.3)</td>
</tr>
<tr>
<td>25–34</td>
<td>213 (19.2)</td>
<td></td>
<td>Life, physical, and social sciences</td>
<td>14 (1.3)</td>
</tr>
<tr>
<td>35–44</td>
<td>193 (17.4)</td>
<td></td>
<td>Community and social service</td>
<td>15 (1.4)</td>
</tr>
<tr>
<td>45–54</td>
<td>175 (15.7)</td>
<td></td>
<td>Legal</td>
<td>13 (1.2)</td>
</tr>
<tr>
<td>55–64</td>
<td>129 (11.6)</td>
<td>15–64yrs: 66</td>
<td>Education, training, and library</td>
<td>74 (6.6)</td>
</tr>
<tr>
<td>65–74</td>
<td>124 (11.2)</td>
<td></td>
<td>Arts, design, entertainment, sports, and media</td>
<td>30 (2.7)</td>
</tr>
<tr>
<td>&gt; 74</td>
<td>111 (10.0)</td>
<td>65+yrs: 16.4</td>
<td>Healthcare practitioners and technical</td>
<td>37 (3.3)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td>Health care support</td>
<td>26 (2.3)</td>
</tr>
<tr>
<td>High school</td>
<td>358 (32.1)</td>
<td>26 (15–17yrs)</td>
<td>Protective service</td>
<td>5 (0.5)</td>
</tr>
<tr>
<td>Certificate/Diploma</td>
<td>334 (30.0)</td>
<td>21</td>
<td>Food preparation and serving</td>
<td>30 (2.7)</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>293 (26.3)</td>
<td>17</td>
<td>Building and grounds cleaning and maintenance</td>
<td>10 (0.9)</td>
</tr>
<tr>
<td>Master’s degree</td>
<td>68 (6.1)</td>
<td></td>
<td>Personal care and service</td>
<td>16 (1.4)</td>
</tr>
<tr>
<td>Doctoral</td>
<td>11 (1.0)</td>
<td>5.6 (+Master’s)</td>
<td>Sales and related</td>
<td>65 (5.8)</td>
</tr>
<tr>
<td>Other</td>
<td>50 (4.5)</td>
<td></td>
<td>Office and administrative support</td>
<td>75 (6.7)</td>
</tr>
<tr>
<td>State (residence)</td>
<td></td>
<td></td>
<td>Farming, fishing, and forestry</td>
<td>7 (0.6)</td>
</tr>
<tr>
<td>New South Wales</td>
<td>336 (30.2)</td>
<td>32.0</td>
<td>Construction and extraction</td>
<td>24 (2.2)</td>
</tr>
<tr>
<td>Victoria</td>
<td>256 (22.3)</td>
<td>25.0</td>
<td>Installation, maintenance, and repair</td>
<td>12 (1.1)</td>
</tr>
<tr>
<td>Queensland</td>
<td>249 (22.4)</td>
<td>20.1</td>
<td>Production</td>
<td>11 (1.0)</td>
</tr>
<tr>
<td>South Australia</td>
<td>102 (9.2)</td>
<td>7.1</td>
<td>Transportation and materials moving</td>
<td>25 (2.2)</td>
</tr>
<tr>
<td>Western Australia</td>
<td>110 (9.9)</td>
<td>10.9</td>
<td>Student</td>
<td>46 (4.1)</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>9 (0.8)</td>
<td>1.0</td>
<td>Retired</td>
<td>206 (18.5)</td>
</tr>
<tr>
<td>Tasmania</td>
<td>26 (2.3)</td>
<td>2.2</td>
<td>Other</td>
<td>227 (20.4)</td>
</tr>
<tr>
<td>Australian Capital Territory</td>
<td>26 (2.3)</td>
<td>1.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.7 Materials

The first section of the questionnaire contained questions regarding participant demographics (see Table 3.1), and open-ended questions requiring written responses in
the respondents’ own words. In order to ensure that the respondent had a common understanding of insight, the questionnaire defined insight as “the moment in which an idea or a solution arises suddenly and unexpectedly”. It was also advised that “an insight may occur while working on the problem or when not thinking about the problem at all (i.e. while attending to something different entirely)”. After responding to demographic questions, respondents were asked if they had ever had an insight [yes/no]. This question was designed to filter participants who do not experience insights from answering the next two open-ended questions. Thus, if they answered yes, they were then asked, “do they generally occur at a particular place?” The next question aimed to uncover what their insights mean to them, by asking, “do you consider your insights to be more or different to the explanation given above?” If answering yes, the respondent completed the sentence “I consider my insights to be...” The final question in the survey asked all participants if they would like to make any concluding remarks on their experiences of insight.

Further hypothesis testing required the use of a self-report scale that could measure the propensity towards experiencing insights. No scale was able to be obtained for this purpose, thus 15 questions on insight experience were included in the second part of the questionnaire. The initial 15 items were constructed through informal interviews with individuals who commonly experience insights and with experts in psychological research. Items were also constructed from descriptors of insight experience in the insight literature, for example the Aha! experience, solutions that come unexpectedly (Metcalfe & Wiebe, 1987), the occurrence of insight during or after sleep (Wagner, Gais, Haider, Verleger, & Born, 2004), and non-conscious problem solving (Schooler et al., 1993). A summary of the final scale follows.

**Dispositional Insight Scale:** The DIS is a five-item questionnaire with adequate psychometric properties (Ovington, Saliba, & Goldring, 2016). Alpha reliability is .74.
An example item is *I’m someone who experiences Aha! moments*. Responses were recorded on 7-point Likert scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Possible scores ranged between 5 and 35. Further information on the construction and psychometric properties of the DIS are reported in Chapter 6. The remaining sections of the questionnaire included the following psychometric scales.

**Cognitive Style Index (CSI):** Cognitive style is an individual trait that represents the way we tend to organise and process information (Messick, 1984). The CSI measures two bipolar styles of thinking: intuition and analytic. The 38-item measure is scored on a trichotomous scale—*true; uncertain; false*. The 17 intuitive items are reverse scored and added to the 21 analytic, positively scored items. High scorers are considered to show a greater analytical cognitive style, while low scorers are more intuitive. An example of an intuitive item is *I prefer chaotic action to orderly inaction*. An example of an analytic item is *I always pay attention to detail before reaching a conclusion*. Alpha reliability ranges from .84 to .90 (Allinson & Hayes, 1996). Insight and intuition have been found to have similar characteristics and are contrasted against analytical thinking (Metcalfe & Wiebe, 1987). The CSI was used to assess convergent validity with the DIS.

**Need for cognition (NFC):** NFC is the tendency to engage in and enjoy effortful cognitive activities (Butler, Scherer, & Reiter-Palmon, 2003; Cacioppo & Petty, 1982; Cacioppo, Petty, & Chuan Feng, 1984). In the current study, the short 18-item NFC scale was used to make the questionnaire easier and more concise for respondents. The short version correlates highly with the longer, 34-item NFC (*r* = .95, *p* < .001; Cacioppo et al., 1984). Items are scored on a 9-point scale from −4 (*very strong disagreement*); 0 (*neither agreement nor disagreement*); +4 (*very strong agreement*). The reported Cronbach’s alpha for the 18-item NFC is .90. An example of one item is *I find satisfaction in deliberating hard and long for hours*, while a reverse item example
is I only think as hard as I have to. The NFC scale was used to assess convergent validity with the DIS.

**Positive and Negative Affect Scale (PANAS):** A third measure, the PANAS (Watson, Clark, & Tellegen, 1988) was also included based on theoretical grounds, given positive affect is known to facilitate insight solutions (Subramaniam et al., 2008). The PANAS (Watson, et al., 1988) is a 20-item scale (10 items for positive affect and 10 for negative affect) that assesses the extent to which people experience positive or negative emotions. The scale can be used to measure affect recently or in general; the current study sought to obtain a “trait” measure, thus the latter was used. The question was worded as: “This scale consists of a number of words and emotions. Read each item and then mark the appropriate answer. Indicate to what extent you generally feel this way, that is, how you feel on the average.” Examples of positive emotions included: **enthusiastic, interested and determined**; examples of negative emotions included: **scared, hostile and nervous**. Responses were recorded on a 5-point Likert scale (**very slightly or not at all, a little, moderately, quite a bit and very much** respectively). Possible scores can range between 10 and 50 for each subscale. Alpha reliability for positive affect is .88 and negative affect is .87. Test-retest reliability (after an eight-week retest interval) for general emotions is reported as .68 for positive affect and .71 for negative affect. To further validate the DIS, it is expected that a relationship will be found with positive affect but not negative affect. The PANAS was also used to test whether dispositional affect predicts dispositional insight.

**Freiberg Mindfulness Inventory (FMI):** The FMI (Walach, Buchheld, Buttenmüller, Kleinknecht, & Schmidt, 2006) comprises 14 items, loading onto a single factor that measures degree of mindfulness awareness. The question stated: “The purpose of this inventory is to characterise your experiences of mindfulness. Please use the last 30 days as the time-frame to consider each item. Provide an answer for every
statement as best you can. Please answer as honestly and spontaneously as possible. There are neither ‘right’ nor ‘wrong’ responses. What is important to us is your own personal experience”. Responses were rated as, rarely, occasionally, fairly often, almost always. An example item is, **I see my mistakes and difficulties without judging them.** One item was reverse scored (**I am impatient with myself and others**). Possible scores can range between 14 and 56. Alpha reliability is good at .86. A strength of the FMI is that it can be used to measure dispositional mindfulness, and mindfulness in those who do not have previous meditation experience.

**Dispositional Flow Scale-2 (DFS-2):** The DFS-2 (Jackson, Martin, & Eklund, 2008; Martin & Jackson, 2008) is a nine-item scale used to measure flow as a disposition, as opposed to a state. Each question represents one of the nine flow dimensions: challenge-skill balance, action-awareness merging, clear goals, unambiguous feedback, concentration on task at hand, sense of control, transformation of time, and autotelic experience. The question stated, “think of a time when you were working on a difficult problem you had to find a solution to” followed by, “when I participate in this activity...” An example item is, **I do things spontaneously and automatically without having to think.** Responses were recorded on 5-point Likert scale where, 1 = never to 5 = always. Possible scores can range between nine and 45. Alpha reliability ranges from .78 to .92 (Jackson et al., 2008). The short DFS-2 has an acceptable correlation with the full 36-item scale, mean $r = .76$ (Jackson & Eklund, 2002; Jackson et al., 2008).

**Arousal Predisposition Scale (APS):** The APS is a 12-item scale measuring arousability (Coren, 1990; Coren & Mah, 1993). Questions relate to common behaviours and self-perceptions; thus responses are recorded according to the frequency at which these behaviours are believed to occur (never, seldom, occasionally, frequently, always). Item 1 is reverse scored (**I am a calm person**), all other items are
positively worded (e.g. *I am easily frustrated*). The scale has been validated against physiological measures of autonomic and affective arousability. Split-half reliability has been reported as .83 (Coren, 1990). High arousability is indicated by a score of greater than 40, and low arousability is a score of less than 30 (Hicks, Conti, & Nellis, 1992).

**Ten-Item Personality Inventory (TIPI):** The TIPI is a shortened version of the Big-Five Inventory (BFI) measuring extraversion, agreeableness, conscientiousness, emotional stability (instead of neuroticism), and openness to new experiences. The short version of the scale was selected due to its time and cost efficiency (Ehrhart et al., 2009) while still correlating strongly with the full BFI, $r = .65 - .87$ (Gosling, Rentfrow, & Swann, 2003). Each item has two descriptors following the stem “I see myself as…” Responses were rated on a 7-point scale from 1 (*disagree strongly*) to 7 (*agree strongly*). One item for each personality variable was positively worded, and the other negatively worded. For example, extraversion is worded as, *extraverted, enthusiastic* and *reserved, quiet* (reverse). Due to having only two items per trait, Cronbach’s alpha are low: extraversion, $\alpha = .68$, conscientiousness $\alpha = .50$, agreeableness $\alpha = .40$, emotional stability $\alpha = .73$ and openness to new experience $\alpha = .45$. However, the scale maintains good validity due to items being derived from the original Big-5 inventory (BFI). The TIPI has been extensively validated (Gosling et al., 2003), and used in several peer-reviewed studies (e.g. Back et al., 2010; Batey, Furnham, & Safiullina, 2010; Bunevicius, Katkute, & Bunevicius, 2008; Hodson & Costello, 2007; Robinson, Demetre, & Corney, 2010; Sharpe, Martin, & Roth, 2011).

### 3.8 Procedure

Potential participants were emailed an invitation to take part in the study along with a link to the questionnaire. All data were collected online. Participants provided
demographic information, and all questions on the scales required a response to ensure there was no missing data.

The following definition was presented to ensure participants understood what an insight was: “For the purpose of this study, an ‘insight’ is the moment in which an idea or a solution to a problem arises suddenly and unexpectedly. Insights often occur when working on a problem for a long period of time without a solution being found, and then without any warning the solution comes unexpectedly. An insight may occur while working on the problem or when not thinking about the problem at all (i.e. while attending to something different entirely).” The subsequent sections of the questionnaire included the open-ended questions on insight experiences, followed by the psychometric scales described above. The questionnaire was completed in 30 minutes, on average.

3.9 Conclusion

This study is a mixed-method design using a single data collection. The questionnaire contained well established scales with good psychometric properties, and open questions, assessing insight and its associated traits—as hypothesised by the current thesis. A large sample of participants, representative of the Australian population, took part in the study. The following four chapters describe the results of the study. Each chapter starts with a comprehensive literature review on the area. Much of the literature in these reviews is drawn from outside the insight research, which was the focus of the main literature review. These chapters also include the hypotheses and materials specific to the study, results, and discussion. Data analysis procedures for each study are described in detail in their respective chapters. Data used to test these hypotheses are taken from the above questionnaire.
Chapter 4

Study 1: Do people really have insights in the shower? The when, where, and who of the Aha! moment
4.1 Chapter overview

While there are well-known anecdotes and documented insight cases by renowned scientists and inventors, little is known about the experiences of insight in the general population. The present study aimed to determine people’s self-reported experience of insight in their daily lives. Eighty per cent reported having insights. These respondents reported demographic information and answered three open-ended questions on where their insights occur, what insights are, and other thoughts on insight. A higher percentage of those who have insights are, female, younger, highly educated, and involved in occupations including, management, sciences, arts, and service professions. The qualitative results uncovered eight major themes, reflecting on the places people have insights: at night, at work, in the shower, at home, when it is quiet, when using transport, while exercising, and in nature. Two major themes emerged on what insights are: something from the subconscious, and a result of (not) thinking. Finally, three major themes emerged from the third question on thoughts subjects wished to share on insight: the improvement of insight with age, the importance of analysing the details of the problem, and the unexpectedness of the solution. Results are discussed in the context of the current experimental research on insight.

4.2 Introduction

Insight is defined as the sudden understanding of a problem and its solution (Mayer, 1995), often after a period of incubation (Gilhooly, Georgiou, & Devery, 2013), or when an impasse has been reached while working on a difficult or ambiguous problem (Dominowski & Dallob, 1995). The process of overcoming the impasse usually occurs outside of awareness (Gick & Lockhart, 1995)—the solution arrives unexpectedly and also as a whole (Maier, 1930). These unexpected solutions often arise at a time when not thinking about the related problem, and can result in an *Aha!* moment or Eureka
experience. Insight problems are inherently difficult due to the lack of a clear problem-solving strategy or a faulty conception of the problem; when restructuring of the concepts leads to a correct understanding, the solution pops into awareness (Weisberg, 1995). In contrast, analytical solutions are arrived at through conscious, discrete stages (Metcalfe & Wiebe, 1987), and rely on previously learned solutions. Analytical problems are clear, and relatively easy to comprehend—as such, no restructuring is required. Some problems are classified as hybrid problems, in that they can be solved through insight or analysis (Weisberg, 1995). How the solver reaches the solution will depend on their level of experience with the problem, or their initial representation of the problem (Bowden, 1997).

Another characteristic feature of insight is the subjective (intuitive) sense of correctness in the solution (Ohlsson, 1992). There are numerous examples of insights associated with well-known figures (e.g. Isaac Newton and J. K. Rowling). Other insights by prominent people have contributed profoundly to modern society. For example, Alexander Fleming’s discovery of penicillin, and mathematician Henri Poincare’s contribution to geometric theory (Irvine, 2014). Alfred Russel Wallace described his realisation about the law of natural selection, which answered the origin of the species question, as a “sudden flash of insight” (Linnean Society of London, 1908). In all of these examples, the solution came unexpectedly, as a whole, and solved a problem (e.g. creative, theoretical, or made a discovery).

Many of these documented insights came from scientists and inventors. It might be the case that this population has more insights than the general population, given their careers require them to solve problems on a daily basis. It may be the case that everybody experiences insights to varying degrees. This, however, is yet to be investigated.
The times and places when Eureka moments occur seem to share some common features—for example, while travelling or bathing, and often late at night or early in the morning. For example, J. K. Rowling was on a train when “the idea for Harry Potter simply fell into my head” (Rowling, n.d.). Kary Mullis was driving when, “Dear Thor! I exclaimed. I had solved the most annoying problem in DNA chemistry in a single lightning bolt” (Mullis, 1993; he had invented the polymerase chain reaction (PCR), which was to win him the Nobel Prize). Physiologist Walter Cannon (1976) reported that as a child he would sleep on the problem of how to fix a broken toy, and the correct solution would “appear at daybreak” (p. 63). Experimental research has demonstrated some evidence that REM (rapid eye movement) sleep increases insight problem solving (Stickgold & Walker, 2004; Walker, Liston, Hobson, & Stickgold, 2002).

While there is anecdotal evidence of time and place—as noted above—this has not been the focus of empirical research into insight. Instead, it has investigated mood and cognitive states. Currently, the research has found that a positive mood (Subramaniam et al., 2008), mind-wandering (Smallwood & Schooler, 2014), intelligence (Davidson & Sternberg, 1984), and mindfulness (Ostafin & Kassman, 2012) can increase the likelihood of these experiences. Non-invasive brain stimulation has also been shown to significantly improve insight problem solving (Chi & Snyder, 2011).

Mood and cognitive states lend themselves well to empirical research, as they can be induced and measured empirically. However, the data collected from these studies concern the insights that occur while the experiment is being conducted (i.e. while the respondents are attending to the problem); when in reality, natural insights often occur when people are not attending to the problem. This is a limitation, as insights that occur spontaneously in natural times and places are not measured; nor are the broader questions asked, such as how many insights, in what context, and where they occur. For this reason, perhaps the most appropriate means of investigating insight with real-world
meaning is through qualitative methods, which seek participants’ self-reports on actual spontaneous insight experiences. Self-report measures are appropriate for measuring experiences and perceptions where the topic of interest has no perceivable negative consequence (McCroskey, Daly, & McCroskey, 1984). It is not expected that questions concerning insight experience will be perceived as having a negative consequence; neither is it anticipated that such questions will elicit socially desirable responses. Moreover, due to the intensity with which an insight is experienced, it is not likely that people will have difficulty in remembering these events. A recent qualitative study on insights in the general population by Klein and Jarosz (2011) obtained 120 examples of insight through interviews, media accounts, and other sources. From these results, they found that typically, one of three types of pathways led to an insight. One occurred through detecting contradictions in information that appears to be related, while a second was the result of a breakthrough after an impasse. The third pathway was the consequence of seeing a connection between seemingly unrelated concepts. However, this study did not examine the circumstances of time and place, and the individual’s experiences of natural insights.

4.3 Study aims

The overall objective of the study is to report the experiences of insight in the general population, and to provide any further ideas about the nature of insight that have not been considered previously. Specific aims of the current study are four-fold; the first takes a quantitative approach, and the final three will be approached qualitatively. The first aim is to investigate the “who”; that is, whether all people in the sample experience insights, and if not, to find out what proportion of the population do have insights. If only a proportion of people have insights, then a demographic profile of these people will be constructed. The second aim is to uncover and report the circumstances, time,
and concurrent activity in which insights occur (i.e. the “where and when”). If the anecdotes are correct, it is expected that respondents will report more experiences of insight at night (e.g. going to sleep, during the night, and upon waking). Insight experiences may also be reported more commonly while in the shower or bath, or while travelling. The third aim is to report the “what”—people believe insights are, in their own words; to investigate the “meaning” of insights in the general population. The final aim is to uncover people’s general thoughts about their insights, in order to investigate these experiences further.

The current study will seek to have these questions answered through an online questionnaire using open-ended responses. This method, while not as in-depth as traditional qualitative approaches, has the advantage of covering a wider sample of the population, and therefore a wider array of experiences.

### 4.4 Method

#### 4.4.1 Participants and procedure

The participants and procedure are described in Chapter 3, Sections 3.6 and 3.8.

#### 4.4.2 Materials

For a full description of the materials, see Chapter 3, Section 3.7. In summary: In order to ensure that the respondents had a common understanding of insight, the questionnaire defined insight as “the moment in which an idea or a solution arises suddenly and unexpectedly”. It was also advised that “an insight may occur while working on the problem, or when not thinking about the problem at all (i.e. while attending to something different entirely)”. After responding to demographic questions, subjects were asked if they had ever had an insight. If they answered yes, they were then asked, “do they generally occur at a particular place?” The next question aimed to uncover what their insights mean to them, by asking, “do you consider your insights to be more
or different to the explanation given above?” If answering yes, the respondent completed the sentence “I consider my insights to be...” Finally, respondents were given the chance to make any concluding remarks on their experiences of insight.

4.5 Data analysis

The results of the second question (do they [insights] occur at particular place? [yes/no]) were entered into a cross-tab analysis with demographic information to identify any trends within the demographic categories. Open-ended responses were compiled and coded for time and location of insight. QSR NVivo 10 was used to code the data for themes. A second researcher then received a coding manual and training in applying the developed code definitions to the data. The second researcher used this process to check the coding in order to maintain quality and consistency among the themes identified by the principle investigator, and to ensure there was no unnecessary overlap across themes. The second researcher made the same judgments as the principle investigator 95.1 per cent of the time. Any disagreements in coding were then discussed to reach consensus between the two coders across all coded data.

4.6 Findings and discussion

Following an overview of the findings, the findings and discussion comprise three sections, followed by suggestions for future studies, implications of the results limitations of the study, conclusion, and summary. The first section meets the first aim, which explores the trends in the proportion of insight experiences within and between demographics (gender, age, education, and occupation). The second section meets the second and third aim by reporting the findings on where and when people tend to have their insights, and what they believe insights are. The third section meets the fourth aim, which analyses respondents’ general views about their breakthrough moments.
4.6.1 Overview of findings

The quantitative results show that not all respondents reported experiencing an insight. It was found that a greater percentage of those who have insights are female, younger, highly educated, and involved in occupations including management, sciences, arts, and service professions. The qualitative results uncovered eight major themes, reflecting on the places people have insights. In order of popularity of location, these were: at night, at work, in the shower, at home, when it is quiet, when using transport, while exercising, and in nature. Two major themes emerged from the question on the personal meaning of insight: something from the subconscious/unconscious, and a result of (not) thinking. Finally, three major themes emerged from the last question regarding final thoughts on insight: the improvement of insight with age, the importance of analysing the problem prior to an incubation period or sleep, and the unexpectedness of the solution.

4.6.2 Insight occurrence according to demographics

It was not assumed, in this study, that everybody experiences insights—indeed, the results show that some do not. Eighty per cent (n = 891) of respondents answered yes to the question, “have you ever had an insight?” which is surprising given that it is taken for granted in the experimental research that all people have insights, at one time or another. To explore this further, the responses were tabulated according to demographics in order to reveal any significant patterns within and between gender, age, education, and occupation. The results are reported in Table 4.1. Females reported having more insights than males, and more of the younger (18–44-year-old) respondents had insights than the older (45 and over) groups. As education level increased, so did the percentage of people who have insights—although this dropped at the doctoral level. Only 11 respondents held a doctoral degree, making it difficult to generalise this result.
Age does not appear to account for this effect, as the results show that younger people on average have more insights.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>n</th>
<th>n (%)</th>
<th>Gender</th>
<th>n</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal care and service</td>
<td>553</td>
<td>462 (77)</td>
<td>Male</td>
<td>16</td>
<td>15 (94)</td>
</tr>
<tr>
<td>Physical and social sciences</td>
<td>561</td>
<td>427 (82)</td>
<td>Female</td>
<td>14</td>
<td>13 (93)</td>
</tr>
<tr>
<td>Arts, design, entertainment</td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>28 (93)</td>
</tr>
<tr>
<td>Management</td>
<td>167</td>
<td>137 (82)</td>
<td></td>
<td>44</td>
<td>40 (91)</td>
</tr>
<tr>
<td>Healthcare practitioners</td>
<td>213</td>
<td>177 (83)</td>
<td></td>
<td>37</td>
<td>33 (89)</td>
</tr>
<tr>
<td>Community and social service</td>
<td>193</td>
<td>159 (82)</td>
<td></td>
<td>15</td>
<td>13 (87)</td>
</tr>
<tr>
<td>Food preparation and serving</td>
<td>175</td>
<td>132 (75)</td>
<td></td>
<td>30</td>
<td>26 (87)</td>
</tr>
<tr>
<td>Farming, fishing and forestry</td>
<td>129</td>
<td>100 (78)</td>
<td></td>
<td>7</td>
<td>6 (86)</td>
</tr>
<tr>
<td>Construction</td>
<td>124</td>
<td>99 (80)</td>
<td></td>
<td>24</td>
<td>20 (83)</td>
</tr>
<tr>
<td>Sales</td>
<td>111</td>
<td>83 (75)</td>
<td></td>
<td>66</td>
<td>54 (82)</td>
</tr>
<tr>
<td>Computer and mathematics</td>
<td></td>
<td></td>
<td></td>
<td>37</td>
<td>30 (81)</td>
</tr>
<tr>
<td>Office and administrative support</td>
<td>75</td>
<td>61 (81)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protective services</td>
<td>357</td>
<td>257 (72)</td>
<td></td>
<td>5</td>
<td>4 (80)</td>
</tr>
<tr>
<td>Transport</td>
<td>334</td>
<td>272 (81)</td>
<td></td>
<td>25</td>
<td>20 (80)</td>
</tr>
<tr>
<td>Student</td>
<td>293</td>
<td>250 (85)</td>
<td></td>
<td>46</td>
<td>37 (80)</td>
</tr>
<tr>
<td>Business and financial</td>
<td>69</td>
<td>59 (86)</td>
<td></td>
<td>48</td>
<td>38 (79)</td>
</tr>
<tr>
<td>Education, training and library</td>
<td>11</td>
<td>9 (82)</td>
<td></td>
<td>14</td>
<td>11 (79)</td>
</tr>
<tr>
<td>Architect and engineering</td>
<td></td>
<td></td>
<td></td>
<td>75</td>
<td>58 (77)</td>
</tr>
</tbody>
</table>
A Pearson’s chi-square test of contingencies (with \( \alpha = .05 \)) was used to statistically evaluate whether the demographic variables (gender, age, and education) are related to whether or not people experience insights. The chi-square test for gender was statistically significant, \( \chi^2 (1, N = 114) = 9.54, p = .002 \), however, the association between gender and insight was small, \( \phi = .09 \). The chi-square test for age was non-significant, \( \chi^2 (6, N = 1112) = 6.98, p = .32, \phi = .08 \). The chi-square test for education (excluding those who selected other) was statistically significant, \( \chi^2 (4, N = 1,064) = 20.86, p < .001 \), with a small effect size, \( \phi = .14 \). In sum, females and level of education was positively associated with having insight experiences.

A question also remains regarding whether education plays a role in the quantity of insight experiences. No research on the connection between education and insightfulness has been conducted to date. A previous study on children showed that intelligence is related to characteristics thought to enhance insight experiences (see Davidson & Sternberg, 1984). The results of this study show education level possibly contributes to greater numbers of people having insight experiences. However, as intelligence was not measured in the current study, a direct comparison with Davidson

<table>
<thead>
<tr>
<th>Occupation</th>
<th>n</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health care support</td>
<td>26</td>
<td>20 (77)</td>
</tr>
<tr>
<td>Retired</td>
<td>206</td>
<td>157 (76)</td>
</tr>
<tr>
<td>Installation, maintenance and repair</td>
<td>12</td>
<td>9 (75)</td>
</tr>
<tr>
<td>Building/grounds maintenance</td>
<td>10</td>
<td>7 (70)</td>
</tr>
<tr>
<td>Legal</td>
<td>13</td>
<td>9 (69)</td>
</tr>
<tr>
<td>Production</td>
<td>11</td>
<td>6 (55)</td>
</tr>
</tbody>
</table>
and Sternberg’s study cannot be made. However, as education level is related to intelligence (Ceci, 1991), these results do accord with their findings.

Particular occupations will also require people to solve problems; at times, this may lead to insightful solutions. In regard to occupation, over 90 per cent of people from management, physical and social sciences, arts and entertainment, and service professions reported experiencing insights. At the lower end of the insight spectrum were legal (69%), and production (55%) occupations. Again, small numbers within each of the categories makes this difficult to generalise, but demonstrates interesting results that could be investigated further. People who experience the enjoyment of having insights may be attracted to a particular job role that allows them to problem-solve. Alternatively, particular job roles may provide a space in which people have insights. This is purely speculative—further research is needed to uncover a causal link.

A surprising and significant finding was the number of respondents who reported not ever having experienced an insight (20%). As one respondent commented:

I don’t tend to experience insight. I generally analyse a problem and apply my skills, knowledge and experience to solve it. (*Respondent 650*)

This suggests that insight may not be an experience all individuals are capable of having or are *aware* of having. This raises the question of “what” makes a person prone to insight, and why some either do not have insights or are not aware of them. It may also reflect a difference in the importance people place on their insights—for some, their insights are deeply significant to their life; while for others, insights are another (not-so-special) way of solving a problem. Further research is required to understand what makes people more insightful than others. The current study was able to form a foundation for answering this question.
4.6.3 The importance of place and time when insights occur, and what they mean

The anecdotal literature on breakthrough solutions centres on reports of people having insights when asleep, in the shower, and in other situations when their mind relaxes. In this study, we were interested in whether the general population tends to have insights in a particular place (or time of day). Additionally, we sought to investigate what these insights mean to them, beyond the definition given in the questionnaire. Findings for the questions, “do they occur at a particular place?” and, “do you consider your ‘insights’ to be more or different to the explanation given above?” are reported in Table 4.2. Some respondents gave more than one response; thus the percentages do not add up to 100 per cent. To analyse the results further, a cross-tab analysis on the three most popular themes (night-time, at work, and the shower) with demographic variables was performed (see Table 4.3). Results for occupation showed no significant theme pattern, thus it was not included in further analyses.

Table 4.2
Places and Times Insights Occur, and their meaning

<table>
<thead>
<tr>
<th>Category</th>
<th>Thematic category</th>
<th>Key terms</th>
<th>Characteristic Level 3 responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. Place (or time) of insight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>At night (79%)</td>
<td>Night OR sleep OR bed OR dreams OR waking</td>
<td>During my sleep</td>
</tr>
<tr>
<td>P2</td>
<td>At work (32%)</td>
<td>Work OR desk OR working on problem</td>
<td>In the workplace</td>
</tr>
<tr>
<td>P3</td>
<td>In the shower (30%)</td>
<td>Shower</td>
<td>In the shower</td>
</tr>
<tr>
<td>P4</td>
<td>Home (24%)</td>
<td>Home OR cleaning</td>
<td>In the kitchen and at home</td>
</tr>
<tr>
<td>P5</td>
<td>Quietness (16%)</td>
<td>Quietness OR meditation OR relaxing</td>
<td>Away from our children/noise</td>
</tr>
<tr>
<td>P6</td>
<td>Transport (13%)</td>
<td>Bus OR driving OR train</td>
<td>Driving in the car</td>
</tr>
<tr>
<td>Category</td>
<td>Thematic category</td>
<td>Key terms</td>
<td>Characteristic</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------</td>
<td>-----------</td>
<td>----------------</td>
</tr>
<tr>
<td>P7</td>
<td>Exercise (11%)</td>
<td>Exercise OR walking</td>
<td>Doing exercise</td>
</tr>
<tr>
<td>P8</td>
<td>In nature (6%)</td>
<td>Nature</td>
<td>Camping, in nature, gardening, mowing […]</td>
</tr>
</tbody>
</table>

Q2. I consider insights to be…?

| I1       | From the subconscious (59%) | Subconscious/unconscious OR sudden OR intuition | Result of priming the subconscious mind with sufficient material for it to cogitate |
| I2       | A result of thinking or when not thinking (43%) | Thoughts OR not thinking OR ideas | Result of my mind working on the problem even though I am not consciously thinking about it |
| I3       | Random (16%) | | Random anywhere anytime |
| I4       | Knowledge and experience (14%) | | Based on my knowledge and experience |
| I5       | Guidance (13%) | Divine OR God OR gift | Guidance from the divine (God) |
| I6       | A solution (11%) | Solution | Possible solutions to problems |
| I7       | Sleep (10%) | From sleeping | A result of sleep |

*Note. P = Place; I = Insight is…*
### Table 4.3
Cross-tabulation for Demographics and Insights Occurring at Night, at Work, and in the Shower

<table>
<thead>
<tr>
<th>Gender</th>
<th>Night</th>
<th>At work</th>
<th>Shower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male (74)</td>
<td>25 (34%)</td>
<td>16 (22%)</td>
<td>6 (8%)</td>
</tr>
<tr>
<td>Female (67)</td>
<td>32 (48%)</td>
<td>7 (10%)</td>
<td>12 (18%)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–24 (24)</td>
<td>6 (25%)</td>
<td>5 (21%)</td>
<td>5 (21%)</td>
</tr>
<tr>
<td>25–34 (34)</td>
<td>14 (41%)</td>
<td>4 (12%)</td>
<td>4 (12%)</td>
</tr>
<tr>
<td>35–44 (26)</td>
<td>11 (42%)</td>
<td>6 (23%)</td>
<td>6 (23%)</td>
</tr>
<tr>
<td>45–54 (16)</td>
<td>6 (38%)</td>
<td>4 (25%)</td>
<td>-</td>
</tr>
<tr>
<td>55–64 (13)</td>
<td>5 (38%)</td>
<td>1 (8%)</td>
<td>-</td>
</tr>
<tr>
<td>65–74 (14)</td>
<td>8 (57%)</td>
<td>1 (7%)</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>74+ (14)</td>
<td>7 (50%)</td>
<td>2 (14%)</td>
<td>2 (14%)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school (35)</td>
<td>10 (29%)</td>
<td>7 (20%)</td>
<td>2 (6%)</td>
</tr>
<tr>
<td>Certificate/ Diploma (37)</td>
<td>19 (51%)</td>
<td>5 (14%)</td>
<td>5 (14%)</td>
</tr>
<tr>
<td>Bachelor’s degree (51)</td>
<td>18 (35%)</td>
<td>9 (18%)</td>
<td>9 (18%)</td>
</tr>
<tr>
<td>Master’s degree (7)</td>
<td>1 (14%)</td>
<td>1 (14%)</td>
<td>1 (14%)</td>
</tr>
<tr>
<td>Doctoral (3)</td>
<td>3 (100%)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other (8)</td>
<td>6 (75%)</td>
<td>1 (13%)</td>
<td>1 (13%)</td>
</tr>
</tbody>
</table>

**Places and times insight solutions occur**

Sixteen per cent ($n = 141$) of those who have had an insight reported that they usually occur in a particular place, or at a particular time. Of those who have insights in a particular place or time, more than three-quarters reported that their insights occurred at night, including while in bed, during sleep or dreams, and upon waking—while waking most often occurs in the morning, it was still included in the night-time theme due to the
carryover effects of sleep. This theme was by far the most common, and is consistent with the experimental research on sleep influences on breakthrough thinking (see Stickgold & Walker, 2004; Wagner et al., 2004). The current results also reinforce the idea that sleep is not about being ‘offline’, but a time when the brain is active in a particular way—one that is conducive to problem solving.

From a demographic perspective, almost half of the women and a third of the men experienced insight at night or upon waking. The youngest age category (18–24 years) formed the smallest percentage (25%) of those who have insights at night; however, of the older age groups (65 years and over), half or more have insights at night. For highest education obtained, all doctoral level respondents had insights at night; while half of those with a certificate/diploma education, and approximately one-third of those with a high school or bachelor degree have insights at night.

The next most popular theme concerned people having insights at work or at their desks. In regard to this last point, it is difficult to ascertain whether people were working on the problem at the time of the insight, or if they were attending to something other than the problem at hand. Within this category, a couple of respondents indicated they were working on the problem at the time they had an insight into the solution. If the insight did not occur while working on the problem, it may have resulted from mind-wandering or off-task thinking, which is anecdotally known to lead to creative ideas (Poincaré, 1952). Mind-wandering can either be an awareness of thoughts that are unrelated to the task at hand, or without awareness (i.e. zoning out; Smallwood, Beach, Schooler, & Handy, 2008). Off-task thinking often occurs while driving, reading, or during any activity where the person loses focus on the task at hand (Smallwood & Schooler, 2014). For a review of the research on mind-wandering, see Schooler et al. (2011).
Another possibility is that people have insights as a result of discussing problem-relevant ideas with others in the workplace. Either way, insights can emerge either at a time when not thinking about the problem, or during the problem-solving phase. Perhaps the best way to understand these insights contextually, would be to have people record them immediately afterwards, along with information about what activities they were engaged in at the time. As this was a common theme, further research is warranted. From the demographics, it appeared that to a greater degree, males rather than females in the 25–54-year age category (i.e. working age group) with a high school or bachelor degree qualification, have insights at work.

Having insights in the shower was also a common occurrence. As with Archimedes sinking into his bath, these people found the shower was a place to find solutions to problems. Following closely behind the shower, many simply stated they had insights at home while relaxing or cleaning. It is believed that relaxation—resulting from activities such as showering—is crucial to fostering insights (Lehrer, 2008). While relaxed—as with sleep—the right hemisphere becomes more active than the left hemisphere. Numerous studies have reported activity in areas of the right hemisphere just prior to insight occurrence (e.g. Bowden & Beeman, 2003). It has been suggested that the right hemisphere engages in coarse semantic coding (i.e. activates a large semantic field), which activates a search for more distant abstract solutions required to solve more complex problems, like the ones solved via insight (Beeman & Bowden, 2000). Demographically, females—more frequently than males—in the 18-24 and 35-44-year-old age category, with a certificate or master’s degree, have insights in the shower.

Insights while driving—or travelling on a bus or train—also emerged in the responses (13%). Recall from the introduction that Mullis was driving when he invented the PCR and J.K. Rowling was on a train when the idea for the Harry Potter series suddenly came to her. What role travelling has in triggering these flashes of inspiration
is unknown. Mind-wandering, which often occurs while travelling, may have a role to play here. Another possible reason could be auditory in nature; that is, the humming of the bus or train, or the shower noise, might reduce the number of stimuli attended to, easing people into a more creative and uninhibited thinking state. How travelling contributes to a mind-state open to new ideas may prove a fruitful avenue for future empirical studies, and could be investigated through experience sampling methods (ESM) (Csikszentmihalyi & Larson, 1987).

Some respondents stated that exercise triggers breakthrough thoughts. No research to date has made a connection between exercise and Eureka moments. The role exercise plays in triggering insights may also share something with mind-wandering, in that people (who exercise regularly) allow their mind to engage in other thoughts while the body automatically employs physical actions. Other possibilities are that exercise leads to stress reduction (Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991). Stress reduction decreases negative affect and improves positive affect. Both cognitive and neuroscience studies have shown that positive mood increases insight solutions, but not analytical solutions (Isen et al., 1987; Subramaniam et al., 2008). A third possibility is that exercise may induce a “flow state” which is characterised as “losing oneself” in the current activity (i.e. complete absorption leads to a loss of self-consciousness; Csikszentmihalyi, 1991). Flow states occur in activities that demand a high level of concentration, but only when personal skill can meet the task challenge (Engeser & Rheinberg, 2008). Hypnotic susceptibility is one trait that has been shown to positively correlate with flow states during exercise (Grove & Lewis, 1996). A hypnotic flow-like state may share similar features with mind-wandering and deeply relaxing activities, which encourage insights. Future studies on the cognitive processes that people engage in while exercising may shed light on the connection with breakthrough ideas.
For the remaining 84 per cent who did not indicate whether they had insights at a particular place, it is difficult to differentiate whether they do not experience breakthrough thoughts at specific times, or if they could not think of particular times while answering the question. Upon reflection, we could have asked explicitly which of these was the case for respondents; future research should consider such an approach.

The dictionary definition of insight is, “a moment of sudden and great revelation or realisation” (Oxford Online Dictionary). The research definition derives from the temporal progression of shifting from fixation (of old ideas), to an impasse in which unconscious restructuring of the problem occurs, and then ends with a sudden and an often surprising solution (Davidson, 1995). To the general population, it may be an umbrella term that means many things, from a sudden idea or remembering something, to a life-changing “epiphany”. Teasing out the nuances in this phenomenon could bring greater clarity in regard to what meaning individuals ascribe to their insights, and how insight differs from other ways of solving problems. For example, a conscious, systematic, “formulaic” approach—where the solution is expected to arrive in a controlled way—differs to the insight solutions that occur suddenly and unexpectedly, and which may even be a solution to a problem that has not been given much thought.

In reply to the question about whether participants considered their insights to be more—or different—to the definition given (“[insight is] the moment in which an idea or a solution arises suddenly and unexpectedly”), 15 per cent indicated yes. However, when asked to elaborate on this, five per cent replied “same as explanation”, reducing the 15 per cent down to 10 per cent of those who have experienced insights previously (n = 125).

The most common theme that emerged from the responses was that insights are sudden or unexpected (same as the definition given in the questionnaire), or come from the unconscious/subconscious. As two respondents stated:
[Insights are] indicative of the fact that information processing & problem solving sometimes go on unconsciously, even while sleeping. *(Respondent 92)*

Subconscious thoughts ... sometimes they just nag for a solution. *(Respondent 572)*

This theme is in accordance with the research on insight, which has found that creative idea generation can occur while not actively seeking a solution (e.g. Snyder, Mitchell, Ellwood, Yates, & Pallier, 2004). There was also the acknowledgment that relaxation facilitates the process:

A solution to a problem that I have been having for a while and out of nowhere the solution just comes. It usually comes to me when I am doing something that relaxes me. *(Respondent 292)*

As another stated, we can have the solution without awareness until the insight shines a light on it:

Solutions to problems that you have been thinking for some time (even years) and the answer is sometimes in front of your ‘nose’. *(Respondent 797)*

These last two comments reflect a type of insight that has not gained any attention from research due to the difficulty in measuring them—insights that come after a lengthy incubation period—and that occur when attending to another task. Further qualitative research would help to uncover details about the situations and contexts in which these insights occur.

The second major theme that appeared around ‘thought’ was that insights were contingent with thinking about the problem:

Analysing the problem from all angles, and trying to obtain help or information to solve the problem. *(Respondent 825)*

At the other end of the spectrum, some believed that insights were contingent with *not* thinking about the problem:

They often come to me when I stop actively thinking about the problem. *(Respondent 14)*

Others felt that insights were essentially new ideas:
Fresh ideas. (Respondent 925)

More or less an idea that solves a problem. (Respondent 176)

Creative ideas. (Respondent 439)

This theme also encompassed a particular form of thought:

... sometimes a bit of lateral thinking. (Respondent 614)

More lateral thinking/problem solving. (Respondent 824)

Due to thinking outside the square. (Respondent 45)

Five further ideas about what insights are, in order of popularity, were: random, from knowledge and experience, guidance or from God or divine, a solution to a problem, and a result of sleep. Insights for some respondents appeared to be something “random”. Randomness of insights accords with the research literature; this theme converges with the unexpectedness of insights (Metcalf, 1986), and that for some people they do not necessarily appear at a particular place or time. As three respondents stated:

Random, anywhere anytime. (Respondent 549)

Random, usually triggered by an event with nothing to do with the question or problem, yet related in some obscure way. (Respondent 702)

Some respondents felt their insights were something “divine” or a gift from God or the universe:

Divine guidance offered when trying to look within. (Respondent 22)

Sometimes, a gift from the universal energies. (Respondent 789)

Others indicated that their insights were just a solution to a problem:

Part of how I solve problems. (Respondent 936)

Occasionally a solution to a problem will come into my mind when I am, say, playing golf. (Respondent 1023)
Again, relaxation and sleep came through in the responses to what insights are. One respondent stated that insight is:

Results of my mind being preoccupied with some problem and the solution comes usually at night either when I’m asleep (it comes in my dream), or I wake up with the solution. *(Respondent 691)*

### 4.6.4 General views about insight

The optional open-ended question placed at the end of the questionnaire asked, “is there anything else you would like to say about insight...?” The question was designed to capture any last-minute thoughts about insights the participants may have had. One hundred and fifteen respondents replied to this question. Comments included the identification of factors that led to their insights—in particular a greater occurrence with age; solutions arising after analysis of the problem followed by an incubation period; during sleep; and insights occurring unexpectedly.

#### Age and insight

The quantitative results showed that more of the younger respondents experienced insights. However, a number of respondents felt their insights improved with age:

I feel my insights improving as I get older and this makes me feel good about ageing. *(Respondent 47)*

Insight improves with age. *(Respondent 260)*

For some older individuals, it may be the quality of their insights changing rather than their frequency, as one respondent stated:

As I age I feel my insight is maturing/changing. I feel I am better able to [put] issues in perspective & value emotions & people over personal promotion. *(Respondent 488)*

The perception that experience—which comes with age—is what is conducive to breakthrough ideas was expressed by other respondents:

Age and experience are major contributing factors. *(Respondent 553)*

It is something that age and experience bring about—but not (the process) consciously. *(Respondent 668)*
Another respondent noted that age, wisdom, and compassion are important:

> Age does make us wiser and much more compassionate, I think. This by its very nature gives us a greater insight to life occurrences. *(Respondent 1003)*

While fewer of the older participants reported having insights compared to younger participants, there is empirical evidence to support that some older participants feel their insights improve as they age. Kim, Hasher, and Zacks (2007) presented a series of stories to younger and older participants with several distractor words contained within five stories. Some of the distractor words were answers to a subsequent creative task, the RAT (S. A. Mednick, 1962). The RAT presents three weakly related words with the objective of finding a single word that can be added to each to form a new word². The RAT is frequently used in insight research as the solutions are often experienced as an insight (see, Bowden & Jung-Beeman, 2003). The results of Kim et al.’s study showed that older participants—who are known to be more vulnerable to distractions resulting from age-related declines—benefited more significantly than the younger participants from the solution-related distractors. In real-world insights, noticing new information relevant to an unsolved problem—that might otherwise go unnoticed—may act as a trigger for the insight solution. The participants also believed that life experience is key to improving insights. As fewer older participants reported having insights at all, this suggests that age effects differ between individuals; some people stop experiencing insights as they get older, whereas others have better quality insights.

**Analysis, incubation and sleep**

While insight research currently focuses on incubation effects (Sio & Ormerod, 2009), others argue that REM sleep is more conducive to insight solutions (Cai et al., 2009). In the results of this study, respondents highlighted the need for the encoding

² RAT example: room, bubble, salts (answer: bath)
phase/analysis phase of insight problem solving—that is, understanding the problem. As stated by a number of respondents, *Aha!* moments require the details first:

> Sometimes I love looking at the details, then stand back, time/sleep or whatever and say ah ha...need the details first. *(Respondent 21)*

As another respondent stated:

> Sometimes solutions come when I sleep on them most times when I ponder them for a while then do something else and come back to them. *(Respondent 93)*

Additionally, one respondent noted that attempting different solutions to difficult problems often led to an impasse, and a period of time away from the problem. After that break, the solution often appeared:

> As an engineer my whole life is problem solving. I find that I often can work at a project all day and not get an answer, but I can wake up in the night write down a good idea and fall back to sleep. *(Respondent 540)*

This is analogous to the research on incubation periods, which are often necessary for bringing breakthrough moments to the surface. For a critical review of incubation, see Sio and Ormerod (2009). Campbell (1960) put forward a blind-variation-selective-retention theory to account for the process between problem awareness and solution in creativity and discovery (see Perkins, 1998, for a critical discussion; Simonton, 2011, for a more simplified review and extension to the theory).

> These statements often emphasised the need to “sleep on it”:

> I am often amazed at how some solutions come to mind. I often solve problems in my sleep I wake up and the solution is in my mind. *(Respondent 163)*

One respondent felt that solutions after sleep differ in quality to insight:

> Answers to problems after sleep, diversion etc. are quite different from ‘insight’ experience which is a sudden total illumination of a concept. *(Respondent 402)*

**Unexpected solutions**

For this question, respondents reinforced the acknowledgment of those insights that come unexpectedly:
Ideas can come at any time and in any situation and often when I’m not trying. (Respondent 227)

Experiences of insight come suddenly when I am engaged in another activity, not even thinking about the situation. (Respondent 279)

This theme was evident from all three of the open-ended questions put to respondents in the survey, and is consistent with a large research focus on this characteristic of insight (Davidson, 1995).

4.7 Strengths and limitations

A limitation of this study is that while no time limit for completion of the questionnaire was given, participants may not have allowed sufficient time to reflect on the open-ended questions, as provided by traditional qualitative studies. However, the purpose of the study was to gain a large number of responses in order to establish some degree of confidence about how, when, and what insights are to people in the general population. The corollary to this is that unlike in-depth interviews, we were not able to explore and clarify responses; as a result, much of the context was lost. For example, people reported having insights while at work or at their desk, but we were not able to follow up on what they were doing at the time the insight occurred. They may have been working on the problem, or discussing something with colleagues, or their minds may have been wandering somewhere else at the time of the breakthrough moment. Future studies may consider a deeper analysis of insight experiences, including the context of the situation, the degree to which it impacted on participants’ lives or thoughts about a particular issue, and the accuracy of the solutions, to suggest a few potential variables.

The strength of the study includes the characteristics of the sample and the originality of the findings. First, the sample was large for a qualitative study, which allowed for breadth of—and some confidence in—the results. Second, the sample was derived from the general population, not a university, on which previous research has
relied. This condition allowed responses to be obtained from people with various educational backgrounds, occupations, and age ranges. Where insights transpire may be important to understanding what triggers their occurrence, or at least increases the likelihood of their occurrence. No other research to date has empirically investigated this.

4.8 Implications for theory and future research

The views of the general population are consistent with those of the research community—insight problem solving is difficult, sometimes comes after an incubation phase, and is sudden. The results also support research on how sleep improves insight solutions. Insights were implicitly and explicitly described as a special way to solve problems (i.e. different to other ways of arriving at a solution), something important, surprising, and helpful. The results also inform a focus for future research. Additional ideas centre on the importance of analysis of the problem (the details), relaxation (expressed by researchers but not empirically studied), and that insights often arrive spontaneously when attending to task-irrelevant activities. The findings have implications for experimental work into insight, which presumes that all respondents have insights. Future research may benefit from screening respondents who report not having insights—alternatively, researchers may be interested in studying them specifically. Moreover, experimental work tends to examine insights in contexts that are incongruent with those that respondents report (i.e. “natural” insights that occur in the shower etc.). Thus, future research into the development of a self-report scale—which can identify the degree to which people experience insights in their daily life—is warranted.
4.9 Conclusion

The findings of the current study indicate that the subjective experience of insights for people are varied in meaning. Some respondents indicated that they do not have insights. Others were very much aware of their insights and readily shared their experiences. The need for relaxation and quietness came through in all three of the questions. Whether it is at night, upon rising in the morning, in the shower, at home, or in nature, having quiet time allows the mind to relax enough for breakthrough moments to occur. The responses also reveal the suddenness of these experiences, and that they often arrive when thinking about something other than the problem at hand. Many respondents also perceived that insights originate from the subconscious, or as a result of unconscious processing.

The profile of a more “insightful” person was discovered to be younger, highly educated, and female. Should further research continue to accord with this profile, employers and managers may wish to target these people for the roles and situations where insights are beneficial. As one of the respondents stated:

I found insightful people are more interesting to be with and work with. They are more calm, patient, innovative, inspirational and motivating. They may occasionally land in trouble because they are risk-takers and have bad audit experiences but in the long run, they are more successful and achieve leadership peaks. (Respondent 889)

4.10 Summary of findings and implications for theory

The current study made several unique contributions to the literature. First, it established that not everyone has insights, with 80 per cent of the sample reportedly having them. This gives support to the argument that insight is an individual difference, and should be classified as a trait. Second, the study began the process of establishing which demographics distinguish insightful from non-insightful people (i.e. individual differences between groups). Through cross-tab analysis, it was found that a greater
proportion of those who fell into the insight group reflected the demographic profile of being female, younger, and highly educated. Their non-insightful counterparts were male, older, and not as highly educated. Third, the study has added to the understanding of when insights occur in those who have them (i.e. similarities and individual differences within the insight group). For example, many reported that insights tended to occur at a particular place and/or time, while others stated their insights could happen at any time. The most important time of the day was at night (before, during, or immediately after sleep), and important places for insights to occur were in the shower and at work. A fourth understanding gained by this study was an awareness of how the general public perceive their insights. Participants showed that they had a similar understanding of insight to researchers, reporting that insights appear to come suddenly from the unconscious mind. While more of the younger participants reported having insights, some older participants reported that their insights improved as they got older.

While these findings make a fruitful contribution to the literature, they also raise further important questions around two broad issues; the first of these being the need to identify traits that signify a disposition towards global cognitive processing. Global processing is necessary for the distant searchers who make connections between the elements of the problem and solutions that are necessary for insight (Subramaniam, et al., 2008). Narrower processing is characteristic of a more non-insightful—or analytical—style of thinking. However, an impediment to this investigation was that there was no self-report tool which could measure insight as a disposition. Thus, the next stage in the study involves constructing such a tool that can achieve the objective of having a DIS. The second broad issue concerns the individual differences within these groups, particularly among insightful people.
Chapter 5
Study 2: Dispositional Insight Scale:
Development and validation of a tool that measures propensity toward insight in problem solving
5.1 Chapter overview

This chapter reports the development of a brief self-report measure of dispositional insight problem solving: the DIS. An EFA and CFA revealed a five-item scale, with all items loading onto a single factor. Internal consistency was acceptable with a Cronbach’s alpha of .74. The DIS showed convergent validity with other constructs that are theoretically related to insight: high NFC, intuition, and positive affect. Normative data for the scale are also reported. The DIS appears to be useful for measuring a disposition towards insight in problem solving.

5.2 Introduction

Recorded attempts to understand human problem solving from a philosophical perspective date back to at least the days of Aristotle (384–322 BC). Scientific experiments on problem solving, however, did not emerge until the late 19th century, and focused mainly on animal models. In Thorndike’s (1898) experiments, cats, for example, found solutions to problems as a result of trial-and-error learning. Thorndike concluded that humans also learn through association; when a new problem arises, there is simply an extension or modification of the old associations. Mayer (1995) termed these problems “routine problems” due to the repetitive use of the same or similar solution on related problems. Later, Gestalt psychologists recognised that not all problems are necessarily solved in this way, but that novel solutions sometimes appear—often suddenly and unexpectedly, that is, as an insight or Aha! moment (see Mayer, 1995). An insight can be defined as the moment a solution that previously eluded the solver arrives suddenly and completely (Bowden, 1997; Metcalfe, 1986b; Metcalfe & Wiebe, 1987), with a sense that the solution is the correct one (Jung-Beeman et al., 2004). Insight solutions often arise from “non-routine” problems; that is, problems with which the solver does not have experience, nor a pre-existing solution
Over the past decade, a surge of research has emerged to try to understand how cognitive and neural processes differ between routine and insight solutions.

Investigative research on the temporal process of problem awareness to insight solution has led experimental scientists to artificially propagate insights by presenting ill-defined problems and comparing these results with the process of solving well-defined problems that require analytical, step-by-step procedures. (e.g. DeYoung, Flanders, & Peterson, 2008). An ill-defined problem leads the solver in the wrong solution direction, requiring the creation of new associations. An example of such a problem is: a man in a small town married 20 different women of the same town. All are still living and he never divorced. Polygamy is unlawful but he has broken no law. How can this be? Answer: He is a priest who marries couples (Gardner, 1978). A well-defined problem sets the solver on the correct solution path, and is solved through a series of conscious steps; for example, mathematical problems (see Figure 5.1). Insights commonly occur when solving ill-defined problems (thus, they are often interchangeably known as insight problems), whereas well-defined problems are usually solved through analytical methods.

**Figure 5.1** The process of moving from problem to solution: Insight versus analytic
Insight, however, is a subjective experience. Researchers have constructed insight problems on the basis that cognitive restructuring of the elements of the problem is required to solve the problem (Davidson, 2003). When the problem is solved, it is presumed that an insight has occurred. Insight problems may not necessarily be solved with an insight. There is a possibility that certain people, who may have experience with these sorts of problems, are able to solve them analytically and not experience the kind of Aha! moment unique to insight solutions (Bowden & Jung-Beeman, 2007). To resolve this issue, Bowden et al. (2005) used hybrid problems in their neuroscience experiments. Hybrid problems are those that are commonly known to be solved through either an insight or analytically (Weisberg, 1995). Participants are instructed to record against each problem solved whether or not the solution was an insight or no insight. This allowed a stronger probability that EEG and fMRI data taken from their experiments were in fact relating to an insight. Similar subjective measures of insight include warmth ratings (DeYoung, Flanders, & Peterson, 2008; Jaušovec & Karin, 1995; Metcalfe, 1986a, 1986b; Metcalfe & Wiebe, 1987). Warmth ratings indicate the feeling of gradually moving towards a solution, as “getting closer” or increasing in warmth (analytical solution), or not finding the answer until it comes suddenly (no warmth; insight solution). Overall, these methods are designed for experimental research and measure state insight.

A single-item measure of both state and trait insight was designed by MacGregor and Cunningham (2008) in the form of a light-bulb scale. In this single study, participants were told of how insight was associated with inventions and discoveries but that most people have, to a smaller degree, had some form of insight in which they were stumped by a problem and then unexpectedly found the solution, resulting in an Aha! experience. To obtain a trait measure of insight, participants were asked to move the scale on a light bulb (0-100) to indicate how insightful they usually were. A state
measure was also taken from the light-bulb scale by asking the participant to rate how insightful they were at that present moment, and then again after completing a series of problems (rebus puzzles, RAT and verbal analogies). To assess test-retest reliability of the trait measure, a second score was taken one week later. The two scores were highly correlated ($r = .82$). No other study has further investigated this measure.

The difficulty with this kind of trait measure is that it is only a single item. As argued by DeVellis (2011, p. 12) many theoretical variables “require a respondent to construct, interpret, judge, compare, or evaluate less accessible information” such that “one item may not capture the complexity of the phenomenon of interest” or with the same level of precision. A second problem, as proposed by Yu (2005), is that carryover effects confound test-retest reliability—a respondent may remember their earlier answer and, motivated to appear consistent, will record the same score as the previous one. With only a single measure, this confounder increases the likelihood of measurement errors. The problem of carryover effects can be minimised when tests have alternative or parallel forms, but this is not possible with single item tests. Moreover, insight is a complex construct, and unlikely to be reliably measured through the kind of self-report found in single-item questions. No self-report questionnaire exists which can evaluate insight experiences as a disposition, while at the same time reducing response bias. Additionally, there is no measure that can examine insight from different perspectives and in a variety of ways (e.g. while not thinking about the problem, the unexpectedness of the solution etc.) beyond state measures of insight. The current study aimed to report the preliminary construction and validation of a measure (the DIS) of insight as a thinking (problem solving) style.
5.3 Method

5.3.1 Development of the questionnaire

The initial 15 items were constructed through informal interviews with individuals who commonly experience insights, and with experts in psychological research. Items were also constructed from descriptors of insight experience in the insight literature, for example the *Aha!* experience, solutions that come unexpectedly (Metcalf & Wiebe, 1987), the occurrence of insight during or after sleep (Wagner et al., 2004), and non-conscious problem solving (Schooler et al., 1993). Items were scored on a 7-point Likert scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

5.3.2 Validity testing

The uniqueness of the DIS means that concurrent validity is difficult to assess. Two measures were chosen to assess convergent validity, the CSI, and the short 18-item NFC scale (see Chapter 3, Section 3.4 for details on the psychometric properties). Cognitive style is an individual trait that represents the way we tend to organise and process information (Messick, 1984). The CSI measures two bipolar styles of thinking, intuition and analytic. High scorers are considered to show a greater analytical cognitive style, while low scorers are more intuitive. Insight and intuition have been found to have similar characteristics, and are contrasted against analytical thinking (Metcalf & Wiebe, 1987).

NFC is the tendency to engage in and enjoy effortful cognitive activities (Butler et al., 2003; Cacioppo & Petty, 1982; Cacioppo et al., 1984). In the current study, the short 18-item NFC was used to make the questionnaire easier and more concise for respondents. The NFC scale was used to assess convergent validity with the DIS (see “Validation of the construct” below, for an explanation).

A third measure, the PANAS (Watson et al., 1988) was also included based on theoretical grounds (see Chapter 3, Section 3.4) as positive affect is known to facilitate
insight solutions (Subramaniam et al., 2008). To further validate the DIS, it is expected that a relationship will be found with positive affect, but not negative affect (see Section 5.4 for further information).

5.3.3 Participants and procedure

The participants and procedure are described in Chapter 3, Sections 3.6 and 3.8.

5.4 Data analysis

Examination of the histograms and boxplots revealed several outliers on the DIS items, causing a negative skew of the data (skewness = −.224; Kolmogrov-Smirnov = .048, $p < .001$). Although these statistics are sensitive in large samples, it was decided to remove these outliers as the sample is large enough to withstand their removal; that is to err on the side of caution. Forty-five scores were removed, leaving $n = 1,069$. The final sample was divided into two groups for statistical analysis using odd/even participant identification numbers. The first group ($n = 535$; 266 females and 269 males) was utilised for the EFA, and the second group ($n = 534$; 270 females and 264 males) for the CFA.

5.5 Results

5.5.1 Exploratory factor analysis

Maximum likelihood extraction was used and fixed to just one factor in order to identify a global score of insight as a disposition. Five of the 15 items loaded adequately onto the single factor, accounting for 49 per cent of the variance in the questionnaire data, which is satisfactory when aiming to explain variance with as few factors as possible (Garson, 2013). The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was acceptable at .79, showing that there is likely to be a factor structure underlying the
data. As shown in Table 5.1, factor loadings for all five items loaded at .50 and above for the EFA³.

Table 5.1  
Insight Solution Scale Item Factor Loadings for Exploratory Factor Analysis, Confirmatory Factor Analysis, and Item-Total Correlation Coefficients

<table>
<thead>
<tr>
<th>Item</th>
<th>EFA factor loadings</th>
<th>CFA factor loadings</th>
<th>r</th>
<th>Alpha if item deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When solving a problem, I often find solutions come when I don’t think about it (i.e. unexpectedly)</td>
<td>.61</td>
<td>.63</td>
<td>.508</td>
<td>.690</td>
</tr>
<tr>
<td>2. I tend to solve problems unconsciously</td>
<td>.60</td>
<td>.54</td>
<td>.503</td>
<td>.692</td>
</tr>
<tr>
<td>3. Ideas pop into my mind when I’m doing mundane activities (e.g. housework)</td>
<td>.73</td>
<td>.73</td>
<td>.597</td>
<td>.658</td>
</tr>
<tr>
<td>4. I’m someone who experiences Aha! moments</td>
<td>.58</td>
<td>.55</td>
<td>.471</td>
<td>.704</td>
</tr>
<tr>
<td>5. I find solutions to problems while going on a relaxing walk or similar activity</td>
<td>.50</td>
<td>.52</td>
<td>.431</td>
<td>.718</td>
</tr>
</tbody>
</table>

Note. EFA = exploratory factor analysis; CFA = confirmatory factor analysis

5.5.2 Confirmatory factor analysis

Statistics were implemented using IBM Statistical Package for the Social Sciences (SPSS) analysis of moment structures (AMOS) graphics. A CFA was performed to confirm whether the five-item, single factor of insight from the EFA can be supported. The results show that the five-item DIS has a good model fit, with all items loading above .50 (see Table 5.1) onto a single factor ($\chi^2 = 5.11$, $df = 5$, $p = .40$, RMSEA = .006, CFI = 1.00, and SRMR = .017 [$df =$ degrees of freedom; RMSEA = root mean-square error of approximation; SRMR = standardised root mean-square residual]). Thus, all five items were retained to form the DIS.

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³ See Appendix D for the EFA factor loadings for the original 15 items.
5.5.3 **Reliability analysis**

The DIS obtained acceptable reliability (.74); given that it has only five items, a high reliability would not be expected (DeVellis, 2011). Unlike Cronbach’s alpha, inter-item correlations are not affected by the number of items (Briggs & Cheek, 1986), and are therefore a more appropriate form of reliability for small scales. For the DIS, the inter-item correlation was .36, which falls into the optimal range of .2 to .4 (Briggs & Cheek, 1986). Table 5.2 shows the statistical properties of the DIS. Table 5.1 reports the item-total correlation coefficients of the scale, and the alpha coefficient if an item is deleted. The data show that all items have a medium to large item-to-total correlation, and that internal reliability would be reduced if any of the items were removed.

<table>
<thead>
<tr>
<th>DIS (5 items)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
</tr>
<tr>
<td>24.38</td>
</tr>
<tr>
<td><strong>Item mean</strong></td>
</tr>
<tr>
<td>4.88</td>
</tr>
<tr>
<td><strong>SD</strong></td>
</tr>
<tr>
<td>4.29</td>
</tr>
<tr>
<td><strong>Standard error</strong></td>
</tr>
<tr>
<td>.19</td>
</tr>
<tr>
<td><strong>Kurtosis</strong></td>
</tr>
<tr>
<td>.24</td>
</tr>
<tr>
<td><strong>Skewness</strong></td>
</tr>
<tr>
<td>-.42</td>
</tr>
<tr>
<td><strong>Range (theoretical)</strong></td>
</tr>
<tr>
<td>9–34 (5–35)</td>
</tr>
<tr>
<td><strong>Cronbach’s alpha</strong></td>
</tr>
<tr>
<td>.74</td>
</tr>
<tr>
<td><strong>Mean item-inter-correlation</strong></td>
</tr>
<tr>
<td>.36</td>
</tr>
</tbody>
</table>

*Note. SD = standard deviation; DIS = Dispositional Insight Scale*

5.5.4 **Validation of the construct**

As this scale is unique from other creative and divergent thinking measures, it was not possible to make a direct comparison with a similar measure. Thus, comparative measures were chosen based on similarity or **convergence** with insight, and on theoretical underpinnings of the construct.
Correlations with other constructs

In order to assess the convergent and discriminatory validity of the DIS, two scales—the CSI and the NFC—were chosen for making the comparison. The CSI measures two cognitive styles; analytical and intuitive. Intuition is considered to be the opposite of analytical thinking, but related to insight (Metcalfe & Wiebe, 1987), in that intuition is holistic thinking, or seeing the whole situation at once (Allinson & Hayes, 1996) in a similar way to insight. The CSI measures intuitive thinkers as less structured in their approach to work than analytical thinkers. This may also apply to people who solve problems through insight, as these solutions are less methodical than analytical solutions. In order to make separate comparisons with the insight and analytic subscales, the CSI were summed separately for intuition and analytical items respectively. As seen in Table 5.3, the intuition items of the CSI are approaching a medium relationship with the DIS; however, the analytic items are not related. As expected, propensity for insight (as measured by the DIS) is not related to an analytical solution style.

The NFC items include both enjoyment of effortful thinking and dislike of effortful thinking (reverse code items). For the purpose of this study, the items were also separated—without reverse coding—and categorised as “high need for cognition”, and “low need for cognition”, respectively, in order to make a direct comparison. As insight solutions often follow an “exhaustion of the faulty problem space” (Ash & Wiley, 2006, p. 67)—that is, after all possible solutions have been exhausted and an impasse is reached—it is expected that insight solvers need to engage in effortful thinking for insights to occur (not necessarily for all insights). As seen in Table 5.3, high NFC related moderately to the DIS, and low NFC showed no relationship.
Table 5.3
Correlations of the Dispositional Insight Scale with Other Constructs

<table>
<thead>
<tr>
<th>Scale</th>
<th>DIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSI</td>
<td>.12*</td>
</tr>
<tr>
<td>Intuitive</td>
<td>.24**</td>
</tr>
<tr>
<td>Analytic</td>
<td>−.08</td>
</tr>
<tr>
<td>NFC</td>
<td>.18**</td>
</tr>
<tr>
<td>High NFC</td>
<td>.30**</td>
</tr>
<tr>
<td>Low NFC</td>
<td>−.08</td>
</tr>
<tr>
<td>PANAS</td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>.25**</td>
</tr>
<tr>
<td>NA</td>
<td>.03</td>
</tr>
</tbody>
</table>

*Note. CSI = Cognitive Style Inventory; NFC = Need for Cognition; PANAS = Positive and Negative Affect Scale
*p < .01; **p < .001

To further support the validity of the DIS, it was compared with trait affect. Positive emotions are related to global cognitive processing and flexibility needed for insights to occur (Baumann, 2005), and for creative problem solving (Isen et al., 1987). Neuroscience experiments have demonstrated that inducing state positive affect increases insight solutions, and negative affect increases analytical solutions (Kaufmann & Vosburg, 2002; Subramaniam et al., 2008). Therefore, the DIS was compared to a general affect measure (PANAS). As shown in Table 5.3, positive affect has a significant medium relationship with the DIS, however, negative affect has no relationship.

Finally, for the question: have you ever had an insight? 212 respondents indicated no and 857 indicated yes. An independent t-test was performed to compare statistical differences between these groups on the DIS. Those who reported not experiencing insights scored significantly lower ($M = 21.77$, $SD = 4.23$) than those who did report having insights ($M = 25.03$, $SD = 3.88$; $t (1067) = 10.77$, $p < .001$, two-tailed). The magnitude of the differences in the means show a large effect size, $d = 0.83$. 
5.5.5 Normative data for the Dispositional Insight Scale

The distribution of DIS scores is shown in the form of cumulative percentages in Table 5.4. There were differences in insight disposition between females and males. The females showed a mean disposition to insight of 24.71 ($SD = 3.68$), which is .64 points higher than the males’ average of 24.07 ($SD = 3.61$). The means are significantly different ($t (1067) = 5.01, p < .001$; with a small effect size $d = 0.31$). A one-way analysis of variance (ANOVA) was performed to investigate whether there were differences between age categories. No significant difference was found $F (6, 1060) = 1.35, p = .23$. The normative data reported will allow researchers wishing to use the DIS to identify disposition to insight in problem solving, to interpret scores of individual participants more easily.
Table 5.4
Normative Data for the Dispositional Insight Scale

<table>
<thead>
<tr>
<th>DIS score</th>
<th>Total sample</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>10</td>
<td>0.3</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>12</td>
<td>0.6</td>
<td>0.2</td>
<td>1.0</td>
</tr>
<tr>
<td>13</td>
<td>1.2</td>
<td>0.8</td>
<td>1.6</td>
</tr>
<tr>
<td>14</td>
<td>1.8</td>
<td>1.0</td>
<td>2.8</td>
</tr>
<tr>
<td>15</td>
<td>2.8</td>
<td>1.7</td>
<td>4.1</td>
</tr>
<tr>
<td>16</td>
<td>3.6</td>
<td>2.4</td>
<td>5</td>
</tr>
<tr>
<td>17</td>
<td>5.2</td>
<td>4.6</td>
<td>5.9</td>
</tr>
<tr>
<td>18</td>
<td>7.2</td>
<td>6.1</td>
<td>8.3</td>
</tr>
<tr>
<td>19</td>
<td>10.8</td>
<td>8.2</td>
<td>13.4</td>
</tr>
<tr>
<td>20</td>
<td>18</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>21</td>
<td>24.3</td>
<td>18.9</td>
<td>29.7</td>
</tr>
<tr>
<td>22</td>
<td>32.1</td>
<td>26.4</td>
<td>37.8</td>
</tr>
<tr>
<td>23</td>
<td>39.3</td>
<td>32.9</td>
<td>45.7</td>
</tr>
<tr>
<td>24</td>
<td>48.7</td>
<td>40.9</td>
<td>56.4</td>
</tr>
<tr>
<td>25</td>
<td>60</td>
<td>51.9</td>
<td>68</td>
</tr>
<tr>
<td>26</td>
<td>69.5</td>
<td>63.5</td>
<td>75.5</td>
</tr>
<tr>
<td>27</td>
<td>77.3</td>
<td>72.3</td>
<td>82.3</td>
</tr>
<tr>
<td>28</td>
<td>84.4</td>
<td>81.4</td>
<td>87.4</td>
</tr>
<tr>
<td>29</td>
<td>89.1</td>
<td>86.6</td>
<td>91.5</td>
</tr>
<tr>
<td>30</td>
<td>93.9</td>
<td>92.4</td>
<td>95.3</td>
</tr>
<tr>
<td>31</td>
<td>96.7</td>
<td>95.6</td>
<td>97.7</td>
</tr>
<tr>
<td>32</td>
<td>98.6</td>
<td>98.2</td>
<td>98.8</td>
</tr>
<tr>
<td>≥ 33</td>
<td>99.7</td>
<td>99.3</td>
<td>99.9</td>
</tr>
<tr>
<td>Total n</td>
<td>1,069</td>
<td>536</td>
<td>533</td>
</tr>
</tbody>
</table>

Note. The DIS scores are listed against the cumulative percentages for a total sample of 1,069 Australian residents with separate listings for females and males.

5.6 Discussion

The aim of the present study was to describe the development and preliminary validation of a scale that can measure the propensity to experience insights. The results demonstrate support for the DIS as an acceptable measure of insight as a problem-solving style, with good internal reliability. The DIS showed convergent validity with other constructs that are theoretically related to insight: high NFC, intuition, and
positive affect; and discriminant validity with analytical thinking style, and negative affect. The resulting five items tap into the unconscious processing aspect of insight, as well as the suddenness of the solution, and the helpfulness of engaging in relaxing activities associated with the experience.

The benefit of the DIS is that it is a brief five-item self-report measure that can be incorporated into a questionnaire without adding an encumbrance of time to complete. While the aim of the study was to construct a brief global measure of propensity to experience insight with a unidimensional scale, one limitation is that propensity for insight may in reality contain several factors associated with different ways of arriving at an insight, as suggested by Klein and Jarosz (2011). Future research may investigate the propensity to have insights as a multidimensional construct. Further research measuring test-retest reliability would also be desirable. As stated earlier, the aim was to provide a very brief, easy-to-complete scale of insight propensity; in this way, the DIS will be a useful tool for problem solving researchers interested in identifying people who are predisposed to experiencing insights. As such, the conciseness of the scale—and the fact that it is the only measure of its kind—adds strength to the current study. However, a limitation of the scale is that the sample tested consisted of Australian residents only. Future research should also validate the scale in other countries.

The insight phenomenon is rapidly gaining attention as innovation becomes a necessity for the survival of success in business and other organisations. Insight aligns greatly with the creative cognition approach (e.g. S. M. Smith, 1995b), thus creative researchers may find the DIS a useful tool for identifying insightful people. Many large corporations are currently focused on recognising and employing innovative individuals; therefore, the DIS will be an invaluable tool for organisational psychologists for this purpose. The DIS will also allow insight researchers to investigate
insight beyond the cognitive mechanisms alone and to consider how this ability relates
to other individual differences.

5.7 Summary of findings and implications for theory

The objective of constructing a measure for assessing disposition to insight was
achieved. This brief five-item scale with adequate internal reliability and validity will be
of significance to other researchers interested in investigating insight as an individual
difference. Construct validity of the DIS showed positive relationships with positive
affect, NFC, and intuition, as expected. The conciseness of the scale means that
dispositional insight can be measured cost-effectively, and without a significant increase
in time for participants to complete the study. The scale can be used to compare other
skills and traits that may be important to understanding what insight is, and whether
insights can be increased or their quality improved by measuring at different time-
points. For the purpose of this thesis, the DIS will first allow an investigation into
whether the modifiable skills—flow and mindfulness, as well as positive affect—
predicts a higher degree of insightfulness.
Chapter 6
Study 3: Disposition toward flow and mindfulness predict dispositional insight
6.1 Chapter overview

Global cognitive processing is known to be conducive to insight problem solving, while local processing assists analytical problem solving. Two factors that are known to facilitate global processing in experimental research are state positive affect and mindfulness. This study aimed to investigate whether positive affect and mindfulness—at the dispositional level—will have an effect on a disposition towards insight. This concept was extended, with dispositional flow also investigated. Flow encompasses an intrinsic motivation to meet the goal, a resilience to negative emotions resulting from difficult activities, and access to extension memory (similar to global processing). It was expected that positive affect, mindfulness, and flow disposition would have a positive effect on a disposition towards insight. Two SEM tests were performed; the first included positive affect, mindfulness, and flow as the criterion variables. The second SEM repeated this, but with the nine components of flow separately added to the model, to test which of these had the greatest effect on insight. In the first model, mindfulness and flow were shown to have an effect on insight; positive affect showed no effect. In the second model, positive affect showed a marginal effect, while mindfulness continued to show an effect. The subcomponents of flow—merging of action and awareness, unambiguous feedback, and transformation of time—had the strongest effect on insight, followed by autotelic experience. Clear goals were shown to negatively affect insight. Results are discussed in the context of previous research, and how positive affect may not be the best predictor of insight when considering the effects of mindfulness and flow.

6.2 Introduction

As established in Chapter 4, 20 per cent of the study participants reported that they did not experience insights. There may be several reasons why people do not experience
insights. As discussed in the literature review, problems which are solved through an insight are highly novel, complex, and ambiguous (Davidson & Sternberg, 2003). Prior to insight, solvers may experience a state of fixation or a mental rut, in which the persistence of an incorrect solution remains (Davidson, 2003; S. M. Smith, 1995b). A reason for this persistence is that the solver is relying on analysis to solve the problem (i.e. consciously solving the problem triggers close associative memories based on what the solver believes is most likely to be the solution). Analytical strategies trigger an incorrect memory pathway, which the solver must eventually resist; in order to break out of fixation, the solver must relax these constraints in order for restructuring of associative networks to occur (Kershaw, Flynn, & Gordon, 2013). The restructuring process requires a search for more distant associations. Therefore, to have an insight, at least three things need to occur. First, the solver must move from local to global processing. Second, they must persist with the problem, and overcome frustration. Third, they need to break out of their mental rut. In this chapter, three traits have been identified that will facilitate each of these processes.

The first of these traits is positive affect. Positive affect has been shown in a number of studies—both in the creativity and insight research—to facilitate the global processing needed to search for more distant associations in memory (e.g. Baumann & Kuhl, 2005a; Baumann & Scheffer, 2010; Carver & Scheier, 1990; Eubanks, Murphy, & Mumford, 2010; Isen et al. 1987; Isen et al., 1985; Rowe et al., 2007; Sakaki & Niki, 2011; Subramaniam et al., 2008). The second trait is autotelic personality (or dispositional flow). People with autotelic personalities seek out and enjoy challenging tasks, and have the confidence to overcome the difficulties that arise as a result of the challenge (Baumann, 2012; Csikszentmihalyi, 1991). When it comes to breaking out of fixation and mental ruts, the third characteristic, dispositional mindfulness, is well known for increasing cognitive flexibility and sensitivity to detecting new information
(Langer & Moldoveanu, 2000). The research on positive affect and mindfulness was briefly reviewed in Chapter 2. In this chapter that review will be extended with additional research related to the current research question. The research on dispositional flow will also be introduced for the first time.

### 6.3 Affect and solution type

As argued previously, analysis is the process of retrieving memory sequences more “locally”, and insight relies on making more “distant” (or global) connections with other memory sequences (Fleck & Weisberg, 2013; Gilhooly & Fioratou, 2009; Jung-Beeman et al., 2004). The local versus global processing has been studied in the context of facilitators including affect. Positive affect has been shown to support global, but not local processing (Gasper & Clore, 2002). Research by Isen et al. (1987) and Isen et al. (1985) found that increasing positive affect aids solving Duncker’s (1945) candle problem and the RAT (S. A. Mednick, 1962). Both are known to require creative solutions; often this may be through an insight. Other studies show increasing positive affect reduces ability to solve analytical problems (Oaksford et al., 1996; Phillips et al., 2002). Conversely, Isen at al. (1987; 1985) found negative affect does not improve insight problem solving. More recently, Rowe et al. (2007) found positive affect increases RAT performance, supporting earlier findings.

In neuroimaging studies, positive mood has also been found to enhance neurological activations involved in insight solutions—namely activations in the frontal cortex and ACC —but impairs executive functions known for their involvement in analytical solutions (Phillips et al., 2002). Subramaniam et al. (2008) reported that an increase in positive affect was associated with activation in the right ACC. Greater activity in the ACC prior to problem presentation has been shown to predict subsequent insight solutions in hybrid problems—that is, those that can be solved with either
insight or analytical methods (Kounios et al., 2006). From their findings, Subramaniam et al. (2008) concluded that positive affect modulates activity in the ACC in preparation for—and during the search for—the least obvious solution.

Others disagree that positive affect only facilitates global thinking, arguing that it can also facilitate local or closely associated memories. Baumann and Kuhl (2005b) argued that positive affect increases flexibility in thinking; that is, the capacity to switch between local and global where necessary; and importantly, to restrain habitual tendencies (Kuhl & Kazén, 1999). Their research found that priming positive mood enabled a significantly faster response to local targets, compared with neutral and negative emotional priming (Baumann & Kuhl, 2005b). The cognitive flexibility hypothesis claims that positive affect enables access to extended semantic networks, whereas negative affect reduces flexibility, and therefore, extension memory. This idea will be returned to and explained further in the discussion of dispositional flow research.

When considering the degree to which affect influences insight experience, it appears that this effect may only be quite small. Baas, De Dreu, and Nijstad (2008) conducted a meta-analysis on the relationship between affect and creativity, with a separate analysis on insight studies. The study included both correlational and experimental studies, and found small effect sizes on mood and insight: positive versus neutral mood ($r = .18$), positive versus negative mood ($r = .11$), and happiness versus sadness ($r = .08$). Non-significant effect sizes were also found with: negative versus neutral, and neutral versus fear.

6.4 Dispositional flow (autotelic personality) and insight

To remain with a challenging problem that make take many hours or even longer for the insight to occur, it is important for the solver to be able to persist with it, and overcome
any frustration that may arise as a result. Flow states, and autotelic experiences, encompass characteristics which would, theoretically, facilitate insight. The word “autotelic” comes from the Greek, *auto* meaning “self” and *telos* meaning “goal” (Csikszentmihalyi, 2000). An autotelic act is one that requires a great deal of effort and energy, with little external reward; however, autotelic activities bring immediate intrinsic rewards. An autotelic experience is defined as, “a psychological state, based on concrete feedback, which acts as a reward in that it produces continuing behaviour in the absence of other rewards” (Csikszentmihalyi, 2000, p. 23). Autotelic acts are part of the flow experience, which is described as high concentration and absorption in an activity, where awareness and actions merge together forming a loss of self-consciousness, transformation of time, and feeling of tremendous enjoyment and fulfilment (Baumann & Scheffer, 2010). Conditions which encourage flow experience include clarity of goals, unambiguous and immediate feedback, and a perceived balance between the challenge and the skills that meet this challenge (Baumann & Scheffer, 2010). The nine facets of flow and their description (Csikszentmihalyi, 2000) are summarised in Table 6.1.
Table 6.1
*A Description of the Nine Facets of Flow*

<table>
<thead>
<tr>
<th>Facets of flow</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenge-skill balance</td>
<td>Skills meet the needs of the perceived challenges.</td>
</tr>
<tr>
<td>Merging of action and</td>
<td>The observer feels at one with their environment; experience is non-</td>
</tr>
<tr>
<td>awareness</td>
<td>dualistic; loss of “ego”.</td>
</tr>
<tr>
<td>Clear goals</td>
<td>Set goals enable feedback on the progress towards that goal.</td>
</tr>
<tr>
<td>Unambiguous feedback</td>
<td>Field of perception is restricted; acutely aware of the result of</td>
</tr>
<tr>
<td></td>
<td>possible actions; no inner conflict over the demands of the activity.</td>
</tr>
<tr>
<td>Concentration on task</td>
<td>Focused attention on the present; lack of awareness of the past,</td>
</tr>
<tr>
<td></td>
<td>future, and surroundings.</td>
</tr>
<tr>
<td>Sense of control</td>
<td>The “perceived” control is a result of feeling “at one” with the</td>
</tr>
<tr>
<td></td>
<td>environment; no awareness of control, but also not concerned by</td>
</tr>
<tr>
<td></td>
<td>having no control (absence of worry).</td>
</tr>
<tr>
<td>Loss of self-consciousness</td>
<td>Also described as a loss of ego; transcends individuality; also</td>
</tr>
<tr>
<td></td>
<td>may become intensely aware of internal processes.</td>
</tr>
<tr>
<td>Transformation of time</td>
<td>Awareness of time is lost.</td>
</tr>
<tr>
<td>Autotelic experience</td>
<td>Enjoyment of the activity for the sake of itself; about the journey, not</td>
</tr>
<tr>
<td></td>
<td>the destination.</td>
</tr>
</tbody>
</table>

Beyond the state theory of autotelic acts, there is an acknowledgment that some individuals are predisposed to autotelic acts, which is known as autotelic personality, or dispositional flow. Autotelic people are described as those who enjoy activities regardless of external rewards (Csikszentmihalyi, 2000), and who seek out difficult tasks with the objective of keeping perceived challenges high (Baumann & Scheffer, 2010). Autotelic people, however, are confident in their ability to master these challenges, in order to keep perceived skills high. These people tend to seek out activities which result in flow states (Asakawa, 2004). While highly challenging activities often result in low positive affect (seeing difficulty), autotelic people tend to be resilient to this state in which overcoming the challenge (mastering difficulty) leads to a high positive affect (Baumann & Scheffer, 2010). In contrast, non-autotelic people require external incentives to be motivated (Csikszentmihalyi, 2000), and tend to see only difficulty in challenging tasks (Nakamura & Csikszentmihalyi, 2002).
Dispositional flow not only describes individuals who seek out challenging problems and persist with finding solutions, but also refers to other cognitive qualities that are important to insight problem solving. Dispositional flow encompasses the qualities of extension memory, which are: implicit representation of extended associative networks, detection of semantic coherence (Baumann & Kuhl, 2002), and formation of coherent, motive-congruent goals (Baumann & Kuhl, 2005a, 2005b). Implicit representation of extended associative networks describes how incoherency can be resolved by searching more distant associations outside conscious awareness. This is explained in the same way insights are hypothesised to occur. For example, a CRA (Bowden & Jung-Beeman, 2003) problem containing the word triad *hound, pressure, shot* appears incoherent (i.e. distantly associated), as it is not immediately obvious that a fourth word can form a compound with all three (answer: *blood*). A more coherent problem, such as *cottage, swiss, cake* is easily solved because these words are associatively closer, and thus can be solved through immediate conscious access to representations in memory (answer: *cheese*). Implicit self-representations are disrupted by negative emotions; although this has been shown to be attenuated in those who can down-regulate negative emotions, such as autotelic people (Baumann & Kuhl, 2002). Those who regularly experience flow are able to detect semantic coherence where incoherence would normally be perceived.

Kuhl (2000) argued that extension memory, although characterised as a “feeling”, is a high-level (rational) intuitive system. This feeling encompasses tacit knowledge (emotion combined with cognition) that drives behaviour without any conscious effort, that is, a feeling that an action is correct without knowing why. In contrast, Kuhl claimed that impulsivity, and irrational thinking are part of low-level intuitive behaviour (i.e. automatised), and are associated with negative affect.
Extension memory theory suggests that autotelic people process information in a parallel-holistic fashion, and the extension of associative networks allows multiple constraints simultaneously and integrates conflicting demands (Baumann, 2012). As with insight experience (Kounios & Beeman, 2014), activation of extended semantic networks is predominantly shown by right hemisphere activations (Beeman et al., 1994). Taken together, it clear that dispositional flow would facilitate the cognitive processes necessary for insights.

### 6.5 Mindfulness and insight

A brief review of the experimental research investigating the connection between mindfulness and insight was discussed in the literature review. Here, further exploration of the importance of investigating this connection from a dispositional insight perspective will be undertaken. Mindfulness, from a Buddhist standpoint, is described as conscious awareness of the reality of the present moment (Hanh, 1991). From a Westernised cognitive perspective, mindfulness is defined as “the self-regulation of attention, which involves sustained attention, attention switching, and the inhibition of elaborative processing” (Bishop et al., 2004, p. 233). Furthermore, mindful learning is defined as the act of drawing novel distinctions (Langer, 1997, 2000). Mindful learning increases sensitivity to context and perspective, creating more flexible cognitive processes. In relation to the facilitation of insight, mindfulness breaks down or reduces the formation of rigid mind-sets (i.e. seeing from only a single perspective). Langer (2000) contrasts this state to a mindlessness state in which the individual acts automatically, based on previous learning, rather than meeting the present moment. This description is similar to the early research on insight, in which many participants were found to repeat the same mistakes, rather than break out of a mind-set to achieve a new perspective (Maier, 1940). Those who can (relatively) quickly move to a new solution
on insight problems appear to possess a state of mind much like mindfulness—they seek novelty, generate new and useful information, and produce novel solutions by seeing multiple perspectives (Bodner, 2000). Mindful people are flexible and readily engage with the task, and have a tendency to notice the details (Bodner, 2000). While empirical evidence has not shown this, it is predicted that because mindfulness is the act of not bringing preconceived ideas to the present experience, it facilitates the identification of objects in unexpected contexts (Bishop et al., 2004).

Mindfulness can be measured after practicing a session on mindfulness meditation as a “state” (Lau et al., 2006), or as a general “trait” (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). Trait mindfulness is the tendency and readiness to sustain attention to what is occurring in the present moment (Brown & Ryan, 2003). However, mindfulness is also considered a skill which can be increased with practice (Bishop et al., 2004).

Using a small sample ($n = 71$ and $86$) of undergraduate university students, a two-part study showed a relationship between trait mindfulness and insight problem solving, but not non-insight problem solving (Ostafin & Kassman, 2012). The hypothesis was built on the fixation theory of insight—that is, past experience interferes with adapting to the present problem by relying on habitual problem-solving strategies (S. M. Smith, 1995a). Mindfulness meditation aims to reduce habitual responding and therefore facilitate creative cognition (Bishop et al., 2004). In the first experiment a small relationship between insight and trait mindfulness was found $r (86) = .25, p = .02$ (Ostafin & Kassman, 2012). The second experiment controlled for state and trait positive affect (related to both mindfulness and creative cognition). Mindfulness was discovered to significantly predict insight performance, even after controlling for positive affect. The researchers also assessed whether brief mindfulness training would improve insight performance. They found that training further improves insight
performance, while controlling for trait mindfulness. However, the study assessed
ability to solve insight problems (i.e. creative problem solving), not whether the
participants experienced an insight. Furthermore, the study also omitted to control for
experience with the type of problems used, which could potentially have created a
confounder if participants had had experience in solving these types of problems (i.e. in
experiencing an analytical solution, rather than an insight).

Two neuroscience studies (one informal) made a serendipitous connection between
long-term meditators and insight. In one study, Davidson conducted an EEG study on
eight long-term Buddhist practitioners, measuring their brain activity while at rest and
during compassion meditation (Begley, 2007). Davidson stated: “Most of them
[Buddhist monks] showed very large increases [in gamma signal], and some showed
extremely large increases of the sort that have never been reported before in the
neuroscience literature ... It’s like a continuous Aha! moment” (Begley, 2007, p. 235).
In another study, Kounios and Beeman (2015) reported on an informal study where a
Zen meditator agreed to solve a list of CRA problems. They stated that at first he
experienced some difficulties using a focused strategy, but with his superior self-control
as a result of long-term meditation, he was able to switch to a broader cognitive
strategy. Once this occurred, he was able to solve these problems quickly and easily
through continuous insights. While these findings were not formally published, they
provide some evidence that mindfulness increases insight experiences.

6.6 Aims and hypotheses

The aim of the study was to test the following hypothetical model using SEM (see
Figure 6.1). The traits: positive affect, flow, and mindfulness lead to an increase in
dispositional insight; while trait negative affect does not have an effect on insight. In the
first study (Chapter 4), females and those with higher education levels reported having
insights more than males and lower-educated participants; thus, these variables will be controlled for in the current analysis. As the DFS-2 encompasses the nine facets of flow disposition, a separate analysis will be conducted with these individual variables entered into the model along with mindfulness and affect to investigate which facets of flow specifically affect insight. Thus, the hypotheses are:

H₁: Positive affect will have a positive effect on dispositional insight, and negative affect will have no effect on dispositional insight.

H₂: Dispositional flow will have a positive effect on dispositional insight. It is expected that the nine flow components will have a positive effect on dispositional insight. One exception may be clear goals—feedback on the progress towards a (problem) goal. This is characteristic of analytical problem solving; insight problem solving is known for its lack of clarity.

H₃: Trait mindfulness will have a positive effect on dispositional insight.

---

**Figure 6.1** Proposed structural equation model

### 6.7 Method

#### 6.7.1 Participants and procedure

The participants and procedure were described in Chapter 3, Sections 3.6 and 3.8.
6.7.2 Materials

The following scales were included in the analysis: the DIS (Ovington, Saliba, & Goldring, 2016); the brief PANAS (Watson et al., 1988), which measures affect as a trait; the FMI (Walach et al., 2006), and the DFS-2 (Jackson et al., 2008; Martin & Jackson, 2008). A strength of the FMI is that it can be used to measure mindfulness in those who do not have previous meditation experience; while for the DFS-2, each question represents one of the nine flow dimensions: challenge-skill balance, merging of action and awareness, clear goals, unambiguous feedback, concentration on task at hand, sense of control, loss of self-consciousness, transformation of time, and autotelic experience. A typical DFS-2 question states: “Think of a time when you were working on a difficult problem which you had to find a solution to”, followed by: “When I participate in this activity...”.

6.8 Data analysis

A correlation was initially performed to identify direct relationships between the variables. For the SEM, a path analysis model using composite variables was performed. This method was chosen as existing scales were used to measure the predictor variables, thus conducting a full SEM was not practical. Maximum likelihood estimation (MLE) was used to estimate the model. Four predictor variables—flow (DFS-2), mindfulness (FMI), positive and negative affect—and two controls—gender and education were entered into the model, with insight (DIS) as the outcome variable. As the nine-item DFS-2 measures the nine facets of flow, a second model was performed with each of these variables entered into the model separately, along with a composite score of FMI, and the PANAS. This analysis will determine which facets of flow have the greatest effect on insight. A significance level of .05 was used for all analyses.


6.9 Results

Data for the descriptive and correlation analysis were performed using IBM SPSS statistics version 22.0. SEM was performed using IBM SPSS AMOS 22. The means, standard deviations, mean confidence intervals (CI), and Cronbach’s alpha for the scales are reported in Table 6.2.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Mean (SD)</th>
<th>Mean confidence interval</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIS</td>
<td>24.38 (4.35)</td>
<td>24.12–24.64</td>
<td>.74</td>
</tr>
<tr>
<td>FMI</td>
<td>36.31 (6.79)</td>
<td>35.90–36.72</td>
<td>.85</td>
</tr>
<tr>
<td>DFS-2</td>
<td>31.75 (4.35)</td>
<td>31.49–32.01</td>
<td>.77</td>
</tr>
<tr>
<td>PA</td>
<td>31.13 (6.31)</td>
<td>30.75–31.51</td>
<td>.90</td>
</tr>
<tr>
<td>NA</td>
<td>20.81 (6.53)</td>
<td>20.42–21.20</td>
<td>.91</td>
</tr>
</tbody>
</table>

Note. SD = standard deviation; DIS = Dispositional Insight Scale; FMI = Freiberg Mindfulness Inventory; DFS-2 = Dispositional Flow Scale-2; PA = positive affect; NA = negative affect

Correlations between insight, the sub-components of the DFS-2, mindfulness, positive affect, and negative affect are reported in Table 6.3. Dispositional insight showed significant small correlations with individual flow characteristics, and moderate correlations with other measures except for negative affect, where no relationship was found. Large positive correlations were found between mindfulness, flow, and positive affect. All of these measures were negatively related to negative affect, but only to a small degree. The subcomponents of dispositional flow show small to moderate correlations with mindfulness and positive affect, and small negative correlations with negative affect, except for merging of action and awareness, and transformation of time, which have a weak positive correlation.
Table 6.3

Correlations between the Subcomponents of Dispositional Flow Scale-2, Freiburg Mindfulness Inventory, Full Dispositional Flow Scale-2, and Dispositional Insight Scale

<table>
<thead>
<tr>
<th></th>
<th>DIS</th>
<th>FMI</th>
<th>DFS-2</th>
<th>PA</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenge-skill balance</td>
<td>.16</td>
<td>.37</td>
<td>.64</td>
<td>.36</td>
<td>-.26</td>
</tr>
<tr>
<td>Merging of action awareness</td>
<td>.21</td>
<td>.15</td>
<td>.46</td>
<td>.19</td>
<td>.06*</td>
</tr>
<tr>
<td>Clear goals</td>
<td>.16</td>
<td>.42</td>
<td>.70</td>
<td>.46</td>
<td>-.25</td>
</tr>
<tr>
<td>Unambiguous feedback</td>
<td>.24</td>
<td>.36</td>
<td>.66</td>
<td>.37</td>
<td>-.18</td>
</tr>
<tr>
<td>Concentration on task</td>
<td>.17</td>
<td>.35</td>
<td>.65</td>
<td>.35</td>
<td>-.18</td>
</tr>
<tr>
<td>Sense of control</td>
<td>.15</td>
<td>.44</td>
<td>.72</td>
<td>.42</td>
<td>-.21</td>
</tr>
<tr>
<td>Loss of self-consciousness</td>
<td>.13</td>
<td>.29</td>
<td>.55</td>
<td>.25</td>
<td>-.20</td>
</tr>
<tr>
<td>Transformation of time</td>
<td>.22</td>
<td>.18</td>
<td>.45</td>
<td>.11</td>
<td>.08*</td>
</tr>
<tr>
<td>Autotelic experience</td>
<td>.24</td>
<td>.42</td>
<td>.65</td>
<td>.44</td>
<td>-.14</td>
</tr>
<tr>
<td>FMI</td>
<td>.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DFS-2</td>
<td>.31</td>
<td>.54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>.26</td>
<td>.58</td>
<td>.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA</td>
<td>-.01*</td>
<td>-.27</td>
<td>-.22</td>
<td>-.07*</td>
<td></td>
</tr>
</tbody>
</table>

Note. ns = not significant; DIS = Dispositional Insight Scale, FMI = Freiburg mindfulness inventory, DFS-2 = dispositional flow scale-2, PA = positive affect, NA = negative affect.

* p <.05; all other correlations are significant at p <.01

6.9.1 Structural equation model

A curve estimation was performed for all the estimations in the model. It was determined that all relationships were sufficiently linear to test covariance-based SEM, except for negative affect. Multicollinearity between independent variables was then assessed. All variable inflation factor (VIF) scores were less than 3, which is ideal. The SEM analysis contained observed variables only (i.e. no latent variables) with a univariate regression model (one dependent variable [insight] and four independent variables [flow, mindfulness, positive affect, and negative affect]). Two controlling variables, gender and education, were added to the model as it was shown in the first study (Chapter 4) that females who are highly educated are associated with dispositional insight.
6.9.2 Model fit for the two models

As shown in Table 6.4, both models adequately met the threshold for a good model fit. A Chi-square minimum discrepancy function C (CMIN) of greater than 1.0 and less than 2.0 is the best fit (Model 2), and less than 3.0 is a good fit (Model 1) (Gulliksen & Tukey, 1958). Both $p$-values exceeded .05, also suggesting the model is a good fit (Hooper, Coughlan, & Mullen, 2008). The comparative fit index (CFI) (Bentler, 1990) compares the performance of the model to a baseline model (i.e. the null model). Scores can range from 0 to 1 with scores close to 1 indicating a good fit. Scores can be greater than 1 which means the model is over-specified. CFI is superior to other incremental fit indices in that it is not sensitive to sample size (Bentler & Chou, 1987). The goodness-of-fit statistic (GFI), an alternative to cChi-square, measures the proportion of variance that can be accounted for by the estimated population covariance (Tabachnick, Fidell, & Osterlind, 2001). The adjusted GFI statistic (AGFI) adjusts the GFI according to the $df$ (Tabachnick et al., 2001). Both statistics range from 0 to 1, with values over .90 indicating well-fitting models (Hooper et al., 2008). The root mean-square residual (RMR) measures the square root of the difference in the residuals of the sample covariance matrix and that of the hypothesised model (Tabachnick et al., 2001). A more easily interpretable statistic is the standardised RMR (SRMR) where a statistic of less than .08 is considered favourable (Hu & Bentler, 1999). The root mean-square error of approximation (RMSEA; Chen, Curran, Bollen, Kirby, & Paxton, 2008; Steiger, 1998) accounts for the error of approximation in the population, and reduces the rigorous requirement for the Chi-square that the model is an exact indicator of the population. A value of less than .05 indicates a close fit, suggesting that the model is acceptable (Browne & Cudeck, 1993). A test of the RMSEA-obtained value, the PCLOSE, is a $p$-value assessing whether the RMSEA is a close fit, as opposed to an exact fit (Browne &
Cudeck, 1993). If the PCLOSE is greater than .05, the close fit hypothesis can be accepted.

Table 6.4
Model Fit Summary for the Two Models Predicting Insight

<table>
<thead>
<tr>
<th>Measure</th>
<th>Threshold</th>
<th>Model 1 results</th>
<th>Model 2 results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-square/df</td>
<td>&lt;3 good</td>
<td>2.88/2</td>
<td>1.43/7</td>
</tr>
<tr>
<td>p-value for the model</td>
<td>&gt;.05</td>
<td>.056</td>
<td>.186</td>
</tr>
<tr>
<td>CFI</td>
<td>&gt;.95 great</td>
<td>.993</td>
<td>.998</td>
</tr>
<tr>
<td>GFI</td>
<td>&gt;.95</td>
<td>.997</td>
<td>.998</td>
</tr>
<tr>
<td>AGFI</td>
<td>&gt;.80</td>
<td>.987</td>
<td>.987</td>
</tr>
<tr>
<td>SRMR</td>
<td>&lt;.08</td>
<td>.020</td>
<td>.014</td>
</tr>
<tr>
<td>RMSEA</td>
<td>&lt;.05 good</td>
<td>.042</td>
<td>.020</td>
</tr>
<tr>
<td>PCLOSE</td>
<td>&gt;.05</td>
<td>.550</td>
<td>.976</td>
</tr>
</tbody>
</table>

Note. df = degrees of freedom; CFI = comparative fit index; GFI = goodness of fit index; AGFI = adjusted goodness of fit index; SRMR = standardised root mean-square residual; RMSEA = root mean-square error of approximation

6.9.3 Model 1: Flow and mindfulness predict insight

Mindfulness and flow were the only variables that had a significant effect on insight. Positive and negative affect did not have a significant effect, and thus were removed from the model. For the controlling variables, only gender (not education) made a significant impact on the results, with females scoring higher. Standardised regression weights for the path analysis are reported in Figure 6.2. As the figure shows, mindfulness has only a small effect (.19) on insight, and flow (.22) has a mild effect (McGaw & Glass, 1980). The results suggest that increasing mindfulness and/or flow would only have a mild effect on improving the ability to have insights. Regression (unstandardised) weights are reported in Table 6.5. The squared multiple correlation showed that only 16 per cent of the variance in insight can be accounted for by dispositional flow and mindfulness. However, a Cohen’s $f^2 = .190$ [95% CI = .136 - .250] indicates a medium global effect size for the population (Cohen, 1988, p. 413).
Figure 6.2  Standardised regression weights for flow and mindfulness predicting insight while controlling for gender

*Note*. 1 = Female; 2 = Male

### 6.9.4 Model 2: Subcomponents of flow, positive affect, and mindfulness predict insight

In the second model, the nine sub-traits of dispositional flow were entered into a second analysis along with affect (positive and negative), and mindfulness, in order to investigate which of these traits have the greatest effect on dispositional insight. The final model included (see Figure 6.3): merging of action awareness, clear goals (negatively affected), unambiguous feedback, transformation of time, autotelic experience, positive affect and mindfulness, while controlling for gender. Again, all predictors show weak effects on insight. A summary of the model fit is reported in Table 6.3. Regression (unstandardised) weights are reported in Table 6.5. The squared multiple correlation showed that 19 per cent of the variance in insight can be accounted for by the above variables, with a Cohen’s $f^2 = .235$ [95% CI = .156 - .325] indicating a medium global effect size in the population (Cohen, 1988, p. 413).
Figure 6.3  Standardised regression weights for five of the flow components, positive affect, and mindfulness, while controlling for gender

Note. 1 = Female; 2 = Male

Table 6.5
Squared Multiple Correlations, Regression Weights (Confidence Intervals), Standard Error, and Critical Ratios for the Two Models

<table>
<thead>
<tr>
<th></th>
<th>SMC</th>
<th>Estimate [95% CI]</th>
<th>Standard error</th>
<th>Critical ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow</td>
<td>.158</td>
<td>.211** [.148–.273]</td>
<td>.032</td>
<td>6.581</td>
</tr>
<tr>
<td>Mindfulness</td>
<td></td>
<td>.115** [.076–.154]</td>
<td>.020</td>
<td>5.605</td>
</tr>
<tr>
<td><strong>Model 2</strong></td>
<td>.188</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Merging of action and awareness</td>
<td>.619** [.325–.913]</td>
<td>.150</td>
<td>4.142</td>
<td></td>
</tr>
<tr>
<td>Clear goals</td>
<td></td>
<td>-.447* [-.839–-.055]</td>
<td>.200</td>
<td>-.2.241</td>
</tr>
<tr>
<td>Unambiguous feedback</td>
<td>.630** [.256–1.00]</td>
<td>.191</td>
<td>3.297</td>
<td></td>
</tr>
<tr>
<td>Transformation of time</td>
<td>.629** [.357–.901]</td>
<td>.139</td>
<td>4.527</td>
<td></td>
</tr>
<tr>
<td>Autotelic experience</td>
<td>.447* [.096–.798]</td>
<td>.179</td>
<td>2.490</td>
<td></td>
</tr>
<tr>
<td>Positive affect</td>
<td></td>
<td>.051* [.000–.098]</td>
<td>.024</td>
<td>2.125</td>
</tr>
<tr>
<td>Mindfulness</td>
<td></td>
<td>.109** [.066–.152]</td>
<td>.022</td>
<td>5.002</td>
</tr>
</tbody>
</table>

*Note. SMC = squared multiple correlations; CI = confidence interval
*p<.05; **p<.001
A possible explanation for the weak effects is the issue of multicollinearity between the predictor variables. Some researchers claim that SEM is robust against multicollinearity (Maruyama, 1997). However, Grewal, Cote, and Baumgartner (2004) tested the SEM robustness theory using two Monte Carlo simulations. It was found that Type II error rates (failure to uncover a significant effect) are highly likely under a combination of circumstances related to low construct reliability, small sample size, and when explained variance ($R^2$) is low. In relation to the current study, correlations between constructs reached above .40 between components of flow, mindfulness and positive affect; with the highest correlation (.58) between mindfulness and positive affect. Grewal et al. (2004) suggested that multicollinearity between .4 and .5 has a low probability of Type II errors, except when scale reliability is weak (.7 or below), and when the $R^2$ is low (.25). The lowest reliability achieved was the DIS and DFS-2 with .73 and .77 respectively, and the $R^2$ were .16 (Model 1) and .19 (Model 2). As the sample size was relatively large ($n = 1,069$), this should have inoculated against the effects of multicollinearity.

The resulting global effect size calculated for the population (Cohen’s $f^2$), was found to be medium. As Cohen (1988) argued, when defining a small percentage of variance as a “medium” effect size it should be kept “in mind that we are defining population values—these are not subject to inflation (least squares overfitting), which requires correction of a sample $R^2$” (p. 413). Thus, it can be concluded that mindfulness and (components of) flow do have a significant effect on dispositional insight, albeit to a mild/moderate degree.

### 6.10 Discussion

The aim of the current study was to confirm that the traits positive affect, flow, and mindfulness have an effect on dispositional insight. Previous experimental studies
showed positive affect, but not negative affect, predicts insight experience in experimental (state) settings (Subramaniam et al., 2008). Therefore, it was hypothesised that positive affect, but not negative affect, would have an effect on dispositional insight. This was only partially supported. The correlation between positive affect and insight was small, and only showed a marginal effect on insight in the second model when the flow components were separated. As expected, negative affect showed no relationship to insight in any of the analyses. For the second hypothesis, it was expected that dispositional flow would have a positive effect on dispositional insight. The results of the correlations showed a strong positive relationship between flow and positive affect, and a weak negative relationship with negative affect. In the first model, flow showed a positive effect on insight as expected. In the second model the subcomponents of flow: merging of action and awareness, unambiguous feedback, and transformation of time had the strongest effect on insight, followed by autotelic experience. Interestingly, clear goals negatively predicted insight. Flow components that did not predict insight were challenge-skill balance, concentration on task, sense of control, and loss of self-consciousness. The third hypothesis expected that mindfulness would have a positive effect on dispositional insight. The results of the correlation showed that mindfulness related positively to positive affect and negatively to negative affect; this was supported by strong and weak relationships, respectively. As expected, mindfulness had a positive effect on insight in both SEMs, but the effect was only small.

Although positive affect showed a significant correlation with dispositional insight \( r = .24 \), it did not reveal an effect on insight when mindfulness and flow were entered into the first SEM, and showed only a small effect on insight in the second. It is argued that positive affect facilitates global thinking; however, Isen et al.’s (1985) research demonstrated that positive affect enhances a more flexible thinking style—that is, shifting between focused and global thinking where necessary. In a meta-analysis of
mood and creativity (experimental) studies, Baas et al. (2008) uncovered a relationship between positive affect and insight problem solving, although the effect size was small. The impact that positive affect has on facilitating insight appears to be evident in experimental research (i.e. state positive affect). At the trait level, the direct relationship between positive affect and insight is also evident; however, this relationship is negated when mindfulness and flow are taken into account for SEM.

There are several possible reasons for this outcome. The first is that positive affect may only show significant effects in experimental studies, which may have little ecological validity. This result may be due to the kinds of insight problems used in experimental research, and how well they reflect real-life insight problems. Second, real-life problems solved through insight often cause a great deal of frustration initially, such that resilience to negative emotions—not a high level of positive affect—is the key to dispositional insightfulness. Baumann and Kuhl (2002) argued that autotelic people are able to mitigate the negative emotions experienced when seeking out challenging situations. The results of the current research appear to support this hypothesis. Finally, mindfulness and autotelic personality may simply be better predictors of dispositional insight, particularly as they encompass trait-positive emotions, as well as additional cognitive benefits for insight. Mindfulness facilitates cognitive flexibility and global processing (Langer & Moldoveanu, 2000), possibly to a greater degree than positive affect as shown in the current results. If this is correct, future research should consider whether mindfulness—which encompasses positive emotions, resilience to negative experiences, and cognitive flexibility—has stronger effects on insight and other forms of creative problem solving. The direct relationship between mindfulness and insight ($r = .30$) was similar to the findings of Ostafin and Kassman’s (2012) experimental study ($r = .25$). Although the effect that mindfulness had on insight was only small,
even a small impact may have a significant effect on the tipping point of a sudden *Aha!* moment.

While flow as a disposition showed an effect on insight experience, an interesting finding was how the individual components of flow may affect insight. In order of effect size (positive) these were transformation of time, merging of action and awareness, unambiguous feedback, and autotelic experience, and clear goals (negative)—although the effect sizes were all small. For transformation of time, this suggests that insightful people become immersed in the problem-solving process, and lose track of time. Merging of action and awareness also represents the complete absorption in the activity, to the point of feeling “at one” with the task (Csikszentmihalyi, 1991). Unambiguous feedback reflects a cognitive state in which the prediction of a result from possible actions—in this case the result of possible answers to a problem—are acutely underlined (Csikszentmihalyi, 1991). Unambiguous feedback also reflects an absence of internal conflict and automaticity, where the results of a task appear to come about on their own. In neuroscience studies, activity in the ACC has been shown to predict subsequent problem solving through insight (Kounios et al., 2006). The ACC is involved in conflict monitoring, and detection of errors (Løvstad et al., 2012). However, it has been found that ACC activity during flow states is *reduced*, compared to that in boredom and overload conditions (Ulrich, Keller, Hoenig, Waller, & Grön, 2014), indicating the perception of no internal conflict during flow states. Autotelic experience reflects the enjoyment of solving problems (intrinsic reward) without the need for any kind of external reward (Csikszentmihalyi, 1991, 2014). It would be interesting to investigate whether intrinsic motivation—as opposed to extrinsic motivation—would also have an effect on insight experience.

Despite the fact that flow showed a positive effect on insight, its subcomponent—clear goals—resulted in a negative effect. This component of flow reflects more of an
analytical style of problem solving, in which there is a clear pathway to the goal (solution), and a conscious monitoring of movement towards the solution (Baumann, 2012). Warmth ratings (i.e. the feeling of moving closer towards a problem solution) used to compare insight and analysis have demonstrated that whereas warmth ratings climb gradually for analytical solutions, warmth ratings for insight stay low until immediately before the solution (Metcalfe & Wiebe, 1987). The current finding may suggest that insightful people do not always have a clear end goal, but rather prefer to search in an unknown problem space, open to what may arise. As shown by Martinsen (1993), explorers—people who prefer to seek novel pathways to a solution—are better at insight problem solving than assimilators who prefer to use analytical strategies. Similarly, mindful people are open to new possibilities and perspectives, and enjoy introducing ambiguity to problems (Ritchhart & Perkins, 2000). Highly insightful people appear to not have a clear goal, suggesting a more exploratory approach to problem solving. It may be the case that clear goals would have a positive effect on a disposition towards solving problems through analysis. Further research is needed to confirm this hypothesis.

While the two models only predicted between 16 and 19 per cent of the variance in dispositional insight, insight is a complex, multi-faceted construct. It is unlikely that any one trait (or state) will have a ‘large’ effect on insight. Furthermore, as Cortina and Landis (2009) argued, small effects can mean a great deal in certain contexts. For insight, even a small manipulation (of the predictor variables) may have a powerful impact on the solver.

### 6.11 Limitations of the study

There are limitations of the study that should be considered. First, limitations of self-report mindfulness measures have been raised. Bergomi, Tschacher, and Kupper (2013)
reviewed a number of mindfulness scales, including the FMI. It was suggested that some participants misinterpret items of the scale, due to ambiguity of wording (“to notice”, “to judge” etc.). Ratings of mindfulness may also be affected by social desirability and personal values—those who are low on mindfulness may perceive themselves as more mindful than they genuinely are. Second, as the short DFS-2 was used to assess dispositional flow, this meant that the nine factors of flow were measured using a single item. The shorter scale was used to reduce participant burden; however, the longer 36-item flow scale would provide greater fidelity (Jackson et al., 2008) in future studies.

6.12 Implications and future research

Previous experimental research has focused on the link between positive emotions and insight experience. The current findings suggest that positive emotions may be less important at the trait level (as opposed to state positive affect) for facilitating dispositional insight. Trait mindfulness, and trait flow experiences appear to show a greater effect on influencing insight experiences. To confirm these findings, future research may conduct diary studies on long-term meditators (i.e. those high on mindfulness), collecting their insight experiences. In addition, experimentally inducing a flow state prior to or during an insight problem-solving task may also provide additional support for the connection between flow and insight. Implications and future research will be discussed in more detail in the general discussion in Chapter 8.

6.13 Conclusion

Mindfulness, specific components of flow (merging action and awareness, unambiguous feedback, transformation of time, autotelic experience), and—to a lesser degree—positive affect, all have positive effects on a disposition towards insight, except clear
goals, which negatively affects insight. Although the current study measured these variables as a trait/disposition, like mindfulness, insight may also be considered a skill. As such, increasing mindfulness through practice will have positive effects on experiencing insight. It is less clear whether autotelic personality (dispositional flow) is modifiable through some kind of practice; the literature appears to suggest that some people simply tend to be this way. Thus, identifying people as autotelic suggests that they may tend to have more insights, unless having clear goals features prominently in their personality. In this case, they may be more analytical. This is purely speculative; further research is needed to confirm whether this is the case.

6.14 Summary of findings and implications for theory

The findings of the current study confirmed that flow and mindfulness have an effect on improving insightfulness. While the effect sizes were small, these qualities may have significant implications for increasing insightfulness in individuals. These dispositions are also considered skills that can be modified through practice; through their practice, insights may be improved. A reason for the small effect may be due to the fact that more stable traits—such as personality—are also involved in predicting insightfulness. The next chapter aims to empirically investigate personality—in particular, openness—as a predictor of insightfulness. To take the investigation further, the personality predictors of insight will be compared to aspects of personality that predict a more analytical problem-solving style, with the aim of revealing personality differences, if any, between insightful and analytical people. The following chapter will argue that the relationship between trait cortical arousal, personality, and creativity has an established base of empirical support, although the literature does not always agree on the dynamics of the relationship. Furthermore, no specific connection has been made with insight as a type of creative thinking. The next chapter aims to research this connection.
Chapter 7
Study 4: Insightful versus analytical people:
Do they differ in personality?
7.1 **Chapter overview**

The relationship between insight (a type of creative cognition), and the Big-Five personality, has not previously been investigated. However, in terms of the relationship between general creativity and the Big-Five personality, openness is the strongest predictor of creativity across different creative measures. Creative people also tend to be predisposed to high levels of arousal, except during the creative process when arousal levels are lower. The current study aimed to first investigate the Big-Five personality as a predictor of insight (creative cognition) versus analysis (non-creative cognition). The second was to investigate whether insightful people, like other creative types, are predisposed to high arousability. Findings showed that openness was the strongest positive predictor of insight, followed by conscientiousness. Of the two facets of openness measured—open to new experiences, complex; and unconventional, creative—the former was the strongest predictor of insight. For analysis, conscientiousness was the strongest positive predictor, followed by agreeableness. Openness was the strongest negative predictor of analysis, followed by extraversion. While openness only contains positive qualities of insight, conscientiousness shares qualities of both creative (insight) and non-creative (analysis) cognition. Those high on a disposition to arousability scored significantly higher on a disposition to insight than those low on arousability. The findings are discussed in the context of previous research on creativity in relation to personality and arousability.

7.2 **Introduction**

The objective of this chapter is to further explore individual differences in insightful people by investigating the relationship between stable traits (i.e. FFP) and dispositional insight. Adding to this examination, predictors of insight (creative cognition) will also be compared with the predictors of analytical thinking (non-creative cognition). To date,
there has been no investigation of how personality predicts dispositional insight, or disposition to analysis. Lines of enquiry have previously been made, however, into the link between personality and other measures of creative cognition. This study therefore seeks to further unfold the individual differences in insight by investigating the FFP traits that describe insightful people, and whether these traits differ in comparison to analytical people.

Another stable trait—arousability—will also be investigated. Studies show that under conditions of low arousal, creativity increases (see Martindale, 1999). However, creative people tend to exhibit a higher dispositional arousability compared with their non-creative counterparts. When creative people lower their arousal, they tend to produce creative ideas. This theory will be extended to the investigation of the individual differences in insightfulness that are of interest to the current thesis.

7.3 An overview of the five-factor personality traits

The following section offers an overview of the FFP traits to provide a context for the kind of personality an insightful person may exhibit, compared to a more analytical person. The FFP model used in this chapter is based on the Big-Five personality model (Goldberg, 1990, 1992), which is widely used and accepted by personality researchers (Burger, 2007). The five personality factors include extraversion, agreeableness, conscientiousness, neuroticism, and openness.

Extraversion lies at the opposite end of the continuum to introversion, and refers to level of sociability (Costa & MacCrae, 1992). Extraverts are highly sociable, and display optimism, energy, and assertiveness; while introverts tend to be reserved, independent, and less energetic than extraverts (Costa & MacCrae, 1992).
Agreeableness refers to the level at which one is helpful, trusting, and sympathetic (McCrae & Costa, 1987). The other end of the continuum describes a person who is antagonistic, sceptical, and will argue for their beliefs.

Conscientiousness describes the level of self-discipline and control a person displays (George & Zhou, 2001). High scorers are organised, like to plan, and are determined. Conversely, low scorers are careless, distractible, and undependable.

Neuroticism refers to the level of emotional stability, with high scorers experiencing more emotional distress, mood swings, and reactivity to daily stressors (Clark, Watson, & Mineka, 1994). At the other end of the continuum, low scorers tend to be calm, well-adjusted, and more even-tempered. In the short TIPI, this dimension is labelled and scored as the more positive trait, “emotional stability” rather than neuroticism (Gosling et al., 2003).

Openness to experience refers to an active imagination, readiness to consider new ideas, divergent thinking, and intellectual curiosity (McCrae & Costa, 1987). High scorers are unconventional and independent in the way they think. Conversely, low scorers prefer the familiar rather than seeking out something new (McCrae, 1987). Openness has been shown to be high in innovative scientists and creative artists (Feist, 1998). As such, openness is of particular interest to insight, as argued below. Batey and Furnham (2006) proposed that openness consists of two sub-factors. The first is the attitudinal openness to new experiences for which it is commonly known. The second is perceptual openness, which refers to the inability to inhibit irrelevant information. Those who are open to new ideas are not able to filter information that is irrelevant. Seemingly irrelevant information may actually trigger a creative idea, including insight solutions.
7.4 Creativity and insight

The definition of creativity encompasses two aspects, originality and effectiveness (Runco & Jaeger, 2012). While originality is a necessary ingredient of creativity, it is not sufficient. As explored by Runco and Jaeger (2012), random acts are able to produce something original, but these products are not necessarily useful or appropriate. For originality to be creative, it must also be effective (have value). Insights in problem solving contain both these elements, in that they are original to the solver, and effective (they solve a problem). While insight is a type of creative cognition, it differs from other types of creative thought. Insights occur unexpectedly due to the unconscious nature of the process; thus, insight is creative problem solving that occurs outside conscious awareness (Finke et al., 1992). For example, the Harry Potter story came to J. K. Rowling as an insight: “the story […] simply fell into my head” (Rowling, n.d.). Conversely, other types of creative thinking processes occur through conscious channels. For example, a creative story may be written by collecting information and then analysing the information in such a way as to make it into an original, effective (creative) story. The RAT is a test of creative thinking (S. A. Mednick, 1962) that is also used in insight research, as the solutions can be arrived at through insight or analysis (Bowden & Jung-Beeman, 2003). Due to the hybrid nature of many creative measures, it is important to gather self-reported solution type: insight or no insight (Bowden, 1997). Most commonly, however, creative tasks are used to measure any type of creative cognition—including insight—without gathering self-report measures on solution type.

Although insight differs from other creative processes, researchers often focus more on their similarities as they both produce creative products, while ignoring their differences (their processes). Due to their assumed similarities, the following literature review will focus on the FFP variables and creative thinking. A couple of studies have
indirectly investigated the relationship between the FFP variables and insight (ability to solve insight problems). As the studies did not ascertain whether insights occurred, it is difficult to draw conclusions about their findings on insight and personality.

7.5 The Big-Five personality: Predictors of creativity

Several lines of enquiry have investigated personality as a predictor of creativity. McCrae (1987) investigated the connection between the Big-Five personality factors, divergent thinking (generating creative ideas through exploration of many possible solutions), and creative personality in a sample of 267 all-male participants. Openness was further broken down into six facets (related to fantasy, aesthetics, feelings, actions, ideas, and values). As a total score, openness correlated moderately with creative personality ($r = .44, p < .001$). The six facets of openness correlated weakly with openness to actions ($r = .17, p < .05$), to moderately with openness to new ideas ($r = .31, p < .001$). Creative personality correlated moderately with conscientiousness ($r = .30, p < .001$), extraversion ($r = .30, p < .001$), weakly with agreeableness ($r = .17, p < .05$), and negatively with neuroticism ($r = -.30, p < .001$). Overall, the strongest positive relationship to creative personality was with openness, followed by conscientiousness and extraversion. The positive relationship between conscientiousness and creative behaviour found by McCrae (1987), however, is not consistent with other research.

A study by King et al. (1996) investigated personality factors that predict verbal creativity and creative accomplishments—while controlling for academic ability—in a sample of 75 undergraduate psychology students. Verbal creativity was measured using two of the Torrance Tests of Creativity: “just suppose”, and “unusual uses” (Torrance, 1990). Creative accomplishments were taken from the participants’ self-reported creative achievements over the previous two years. They hypothesised that extraversion would relate to creativity based on Barron and Harrington’s (1981) suggestion that
extraversion characterises creative people, that is, the high energy and self-confidence of creative people is similar to that of extraverts. Extraversion only showed a small relationship to verbal creativity \( (r = .26, p < .05) \), however, while openness showed the strongest relationship to verbal creativity \( (r = .38, p < .01) \), and creative accomplishments \( (r = .47, p < .01) \). Agreeableness related negatively only to creative accomplishments \( (r = -.23, p < .05) \). Through regression analysis it was also found that openness was the strongest predictor of creativity \( (\beta = .34, p < .01) \). Conscientiousness predicted accomplishments that are low in creative talents \( (\beta = -.22, p < .05) \); however, the authors did find an interaction between conscientiousness and creative ability, in that when creative ability was low and conscientiousness high, there was a positive relationship with creative accomplishments. High creative ability in combination with conscientiousness, showed a negative relationship to accomplishments. Overall, the openness and creativity relationship was the most compelling, followed by extraversion. Conscientiousness was the strongest predictor of non-creative talents, although those with low creative ability were able to increase their accomplishments through higher levels of conscientiousness.

Openness has also emerged as a consistent predictor of creativity in a meta-analysis study. Feist (1998) compared the five personality traits of creative versus non-creative scientists (28 studies), and artists versus non-artists (29 studies). Creative scientists were higher on extraversion \( (d = .09) \), and openness \( (d = 0.31) \); and lower on conscientiousness \( (d = 0.30) \) than non-creative scientists. Artists were higher than non-artists on openness \( (d = 0.47) \), and lower on conscientiousness \( (d = 0.49) \). Extraversion showed only a weak median effect size for artists \( (d = 0.17) \). Together, creative people were consistently higher on openness and lower on conscientiousness.

Similar findings have been found with creative personality (using the NEO Five-Factor Inventory; Costa & McCrae, 1992), story writing, and creative hobbies. In a
study of 204 art and design students, Wolfradt and Pretz (2001) reported that openness was the only personality factor that significantly (positively) predicted creative personality (β = .26, p < .001), creative hobbies (β = .22, p < .05), and story writing (β = .19, p < .05). Conscientiousness negatively predicted creative story telling (β = -.22, p < .05).

Another study focusing on the connection between personality (openness and conscientiousness only), and creative behaviour took a more nuanced approach. George and Zhou (2001) recruited 149 office employees to investigate creative behaviour in the work setting. They argued that the degree to which openness and conscientiousness predict creativity will depend on particular moderating variables. Moderators included feedback valence (the degree of positive feedback given regarding job performance), close monitoring (closeness of supervision by a superior), unclear ends (the clarity of understanding of job goals), unclear means (the clarity of understanding regarding how to reach job goals), accuracy of communication, and relationship with co-workers, among other measures. Openness to experience predicted creative behaviours only when feedback valence, unclear ends, and unclear means were all high. If any of these variables were low, it had a negative impact on creative behaviours. Therefore, open people behave more creatively in the work place with positive feedback and a certain lack of clarity of means and ends to the job goal. On the other hand, highly conscientious workers were more creative in the work environment when communication was accurate, co-workers were helpful, there was a high level of close monitoring, and the work environment was positive.

Related interactions between personality (openness and conscientiousness) and creative measures have been noted in other studies. Furnham, Zhang, and Chamorro-Premuzic (2005) sampled 64 undergraduate psychology students. The Big-Five personality variables were measured along with a self-report measure of creativity: self-
estimates of creativity (SEC) (Furnham, 2000) and the Barron-Welsh Art Scale (Barron & Welsh, 1952). The latter scale purports to be a measure of creativity through presenting a series of black and white pictures which the participants rate as like or dislike. Creativity is measured by the figures that were liked by artists but disliked by the general population through the scale’s construction process. Furnham et al. (2005) found a moderate positive relationship between conscientiousness and self-reported creativity ($r = .30, p < .05$), and a negative relationship to the Barron-Welsh Art Scale ($r = -.28, p < .05$). Openness and self-reported creativity did not reach significance; however openness was related to the Barron-Welsh Art Scale ($r = .31, p < .05$), and in a multiple regression analysis (MRA), openness was the only predictor of the creativity measure ($\beta = .32, p < .01$).

Studies investigating creativity often measure more than one type of creativity and examine them separately. Batey et al. (2010) measured four creative abilities (two divergent thinking measures, achievements, and attributes) and summed z-scores to create a total creativity score. The independent variables consisted of fluid intelligence, general knowledge, and the Big-Five personality measure (as measured by the TIPI). Openness was the only personality variable to correlate with creativity ($r = .46, p < .01$). In an MRA, openness ($B = 0.38, p < .01$) was the only personality factor to predict creativity scores.

A more recent study by Beaty, Nusbaum, and Silvia (2014) examined whether ability to solve verbal insight problems (the ladder, basketball, marriage, and light problems) predicts real-world creative ability over two studies. Creative achievements were measured with the creative achievement questionnaire (CAQ) (Carson, Peterson, & Higgins, 2005). The CAQ measures creative achievements in 10 domains. The scores for each are added to obtain a global creative achievement score. Both studies used a sample of undergraduate psychology students with $n = 133$ in the first, and $n = 173$ in
the second. The five personality variables were included as a control, particularly to control for openness. Analysis was conducted using SEM. They found that openness to experience was the strongest predictor of creative achievement ($\beta = .358, p < .001$), followed by a moderate effect for extraversion (only in the first $[\beta = .270, p = .001]$ of two studies), and a small negative effect for agreeableness ($\beta = -.162, p = .048$). There was no support for insight problem-solving ability as a predictor of global creative achievement. Of the 10 domains, insight only predicted drama ($\beta = .235, p = .046$).

However, the authors were testing whether the ability to solve verbal insight problems is a valid measure of creativity.

As discussed in Chapter 1, so-called insight problems may be solved either through an insight process or through an analytical process (Bowden et al., 2005). Therefore, it is questionable whether Beaty et al.’s (2014) findings accurately reflect the relationship between insight processes and creativity. Of the four insight problems, only 20–25 per cent on average (Study 2 and Study 1 respectively) were able to find the correct solution in the eight minutes of allocated time. Two minutes per problem is not an ideal amount of time to solve ambiguous problems. A better study design would be to administer several RAT problems, along with self-reported solution type (insight or no insight). This would improve the probability of obtaining a greater number of correct answers, and hence, improving the reliability of the creativity measure. Across different measures of creativity, openness is the only personality factor to consistently predict creative ability. Conscientiousness has shown mixed findings due to moderating variables or the type of measure used.

### 7.6 Extraversion and creative insight

Of the studies reviewed so far, only a few have shown a relationship between extraversion and creativity. One study that has directly examined the connection
between personality and insight was by Fink and Neubauer (2008). More specifically, they hypothesised that extraverts would exhibit more insightful ideas (i.e. they did not directly measure insight). Their hypothesis was based on the theory that extraverts generally exhibit lower cortical arousal compared to introverts—low arousal has been shown to relate to more original ideas (Martindale, 1999). In the experiment, two verbal insight tasks were administered (utopian situation and alternative uses test) with three minutes to provide as many original ideas as possible. During the task, alpha power was measured as a test for cortical arousal. Alpha waves are thought to correspond with lower cortical activity; thus, greater alpha activity, as measured by EEG, corresponds with lower cortical arousal. In support of their theory, extraverts showed lower cortical arousal and more original ideas than introverts.

Concerns about the methodology of the study were raised in the literature review (Chapter 2). To recap, time constraints for introverts (under five minutes) are known to affect performance, because they tend to think more deeply and take more time than extraverts to formulate an idea before expressing it (Gorla et al., 2012). As Fink and Neubauer (2008) provided only three minutes to perform the task, extraverts would be expected to perform better than introverts under these time constraints. Had at least five minutes (rather than three minutes) been given to perform the task, introverts would likely have produced a greater number of original ideas. This may have resulted in insignificant differences between extraverts and introverts in terms of task completion. This raises an issue for experimental research when designing studies with introverts in mind. In order to avoid stifling their creative performance, enough time must be given to enable reportable answers to be generated. Overall, the connection between extraversion and creativity/insight is currently unclear.
7.7 Arousability and insight

A further issue with the Fink and Neubauer (2008) study is the over-simplification of Martindale’s arousal and creativity theory. Martindale’s (1990) theory relates only to ‘state’ measures of arousal during creative tasks, not “trait” arousability. In a review of seven creativity studies measuring arousal with EEG, it was revealed that highly creative people showed higher basal levels of cortical arousal, suggesting “that creativity is associated with a high resting level of arousal” (Martindale, 1999, p. 141).

It is during creative tasks that creative individuals are able to lower their cortical arousal, compared with non-creative individuals (Martindale, 1999). In one study, Martindale, Anderson, Moore, and West (1996) found that creative people show a greater physiological response to stimuli and habituate to the stimuli more slowly that those low on creativity. As Martindale suggested, this may explain why creative individuals place themselves in situations of almost extreme sensory deprivation (i.e. complete isolation) to do their creative work. It appears to be the shift from a general high arousal to a state of low arousal that facilitates creativity—not a consistently low level of arousability. The causal mechanism may also be in reverse—rather than actively seeking low arousal environments to be creative, the creative process itself may cause a lowering of arousability, in part by experiencing flow states (see, Csikszentmihalyi, 1996). At the dispositional level, it appears that insightful people may actually exhibit a higher cortical arousal than those low on insightfulness.

7.8 Personality of the analytical person

Analytical problem solving is described as sustained directed attention towards the problem elements (Ansburg & Hill, 2003). Studies have found that analytical problem-solving strategies rely on a conscious, focused attention throughout the solution process (Ansburg & Hill, 2003; Martindale, 1995; Metcalfe & Wiebe, 1987). Consequently,
only narrow or steep associative hierarchies are triggered, making the solutions less creative (Martindale, 1995). Stated another way, uncreative thinkers tend to have access to only learned solutions, as novel solutions depend on a wider or flatter associative hierarchy (Martindale, 1995). Defocused attention triggers a flatter associative hierarchy, allowing for a more distant search for answers that are novel to the solver. Those who rely predominantly on what they know (i.e. analytical people) are characterised as being low on openness to new experiences (Burger, 2007; McCrae & Costa, 1987).

The ability to focus attention would suggest that analytical people are rated highly on conscientiousness (Komarraju, Karau, Schmeck, & Avdic, 2011). As reviewed earlier, however, King et al. (1996) found those who were low on conscientiousness performed superiorly on non-creative tasks compared with their highly conscientious counterparts. In contrast, Feist (1998) showed that creative scientists and artists were low on conscientiousness in a meta-analysis; while the more recent study by Komarraju et al. (2011) of 308 undergraduate college students that evaluated personality, learning style, and academic achievement, reported that conscientiousness was the strongest predictor of a methodical style of study ($\beta = .58, p < .001$). This style of study is organised and systematic, whereas creative people tend to be more impulsive (Feist, 1998). Taken together, the findings from the literature suggest that analytical problem solvers are likely to be low on openness and high on conscientiousness.

### 7.9 Aims and hypotheses

Research on the link between personality and creativity is reasonably well established; however, the connection between personality and insight, specifically, is currently lacking. In terms of the general arousability of creative people, it has been established that creative people tend towards a high resting-state arousability (e.g. Martindale,
1990); however, the question must be asked whether this also extends to those who are highly insightful. The aim of the current study was two-fold: first, to investigate the Big-Five personality variables as a predictor of dispositional insight and compare this with personality as a predictor of dispositional analysis; and second, to compare low versus high arousability and disposition towards insight. The following hypotheses were tested:

**H₁:** Based on the review of the literature it is evident that openness to new experiences is the most consistent positive predictor of creativity across a variety of creative measures. It is therefore hypothesised that openness will be the strongest positive predictor of insight. No other predictions were made for impact of personality on insight. Conscientiousness and extraversion have not been shown to consistently predict creativity across different measures and types of creativity. Effects for agreeableness are weak at best. Moreover, these studies have not found any relationship between neuroticism and creativity.

**H₂:** As analysis is the use of pre-existing knowledge rather than the search for novel answers, it is expected that:

**H₂a:** Openness will negatively predict analysis.

**H₂b:** Conscientiousness will positively predict analysis.

No other predictions for analysis were made as this part of the study is predominantly exploratory.

**H₃:** Based on Martindale’s (1989, 1999) theory that creative thinkers exhibit high arousal in general, it is expected that those high in a disposition towards insight (highly novel thinkers) will have higher arousability than those low on a disposition towards insight.
7.10 Method

7.10.1 Participants and procedure

The participants and procedure were described in Chapter 3, Sections 3.6 and 3.8.

7.10.2 Materials

Scales used in the analysis were the DIS (Ovington et al., 2016); and the CSI) (Allinson & Hayes, 1996). Cognitive style is an individual trait that represents the way we tend to organise and process information (Messick, 1984). The CSI measures two bipolar styles of thinking, intuition and analytic. High scorers are considered to show a greater analytical cognitive style and low scorers are more intuitive. For the purpose of this study, only the analytical items were utilised, in order to obtain a more “pure” analytical measure. Also used was the TIPI (Gosling et al., 2003), which measures openness, conscientiousness, extraversion, agreeableness, and emotional stability (rather than neuroticism); and the APS (Coren, 1990) for measuring dispositional arousability (Coren, 1990; Coren & Mah, 1993). See Chapter 3, Section 3.4 for details on the psychometric properties of these scales.

7.10.3 Data analysis

All analyses were conducted using SPSS version 22.0. As significance levels are inflated in a large sample size—and to avoid a Type I error—significance levels were set at .01. A Pearson’s correlation was initially performed to examine the direct relationships among the variables. This was followed by three regression analyses: one for the FFP variables predicting dispositional insight; the second for the two openness facets predicting dispositional insight; and the third predicting a disposition to analysis, with the Big-Five personality variables as the predictors. To test the arousability hypothesis, an independent t-test was performed to compare the difference between low versus high arousability and dispositional insight.
7.11 Results

Means, standard deviations, and alpha reliabilities for each scale are reported in Table 7.1. As the TIPI factors contain only two items per factor, a Pearson’s correlation was used to test reliability. While a high reliability is not expected for only two items, it was noted that reliabilities were quite low, particularly for agreeableness and openness. A Pearson’s correlation was initially conducted to examine the direct relationship between the variables of interest. As shown in Table 7.1, the DIS shows a small positive relationship to CSI analytical, APS, extraversion, agreeableness, and conscientiousness; and a moderate relationship to openness. The CSI analytical scores show small negative relationships to extraversion and openness; and small positive relationships with agreeableness, and conscientiousness. There was no relationship between analysis and the APS. The APS shows mostly small negative relationships with all the measures of personality, although its relationship with conscientiousness was medium, and as expected showed a strong negative relationship with emotional stability. Note that although there was a significant negative correlation between arousability and extraversion as expected, the strength of the relationship was weak.

Table 7.1
Correlations among disposition to insight, analysis, arousability, and personality

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>α</th>
<th>DIS</th>
<th>CSI: Analytical</th>
<th>APS</th>
<th>Extraversion</th>
<th>Agreeableness</th>
<th>Conscientiousness</th>
<th>Emotional stability</th>
<th>Openness</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIS</td>
<td>27.00</td>
<td>3.80</td>
<td>.74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSI: Analytical</td>
<td>30.19</td>
<td>5.22</td>
<td>.70</td>
<td>.09**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>APS</td>
<td>32.99</td>
<td>7.42</td>
<td>.86</td>
<td>.13**</td>
<td>- .03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extraversion</td>
<td>7.80</td>
<td>2.86</td>
<td>.46</td>
<td>.13**</td>
<td>- .13**</td>
<td>- .07*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agreeableness</td>
<td>9.91</td>
<td>2.24</td>
<td>.23</td>
<td>.14**</td>
<td>.14**</td>
<td>- .18**</td>
<td>.07*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>10.85</td>
<td>2.35</td>
<td>.46</td>
<td>.16**</td>
<td>.27**</td>
<td>- .30**</td>
<td>.08*</td>
<td>.29**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional stability</td>
<td>9.20</td>
<td>2.69</td>
<td>.48</td>
<td>.09**</td>
<td>.03</td>
<td>-.59**</td>
<td>.18**</td>
<td>.33**</td>
<td>.35**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Openness</td>
<td>9.97</td>
<td>2.26</td>
<td>.32</td>
<td>.32**</td>
<td>-.12**</td>
<td>-.13**</td>
<td>.26**</td>
<td>.20**</td>
<td>.22**</td>
<td>.23**</td>
<td></td>
</tr>
</tbody>
</table>

Note. DIS = Dispositional Insight Scale; CSI = cognitive style index; APS = arousability predisposition scale
*p <.01; **p <.001
Reliabilities for the ten-item personality inventory scales were obtained through Pearson’s correlation

7.11.1 Predicting insight and analytic problem-solving type

To estimate the proportion of variance in insight and analysis that can be accounted for by the Big-Five personality, two standard MRAs were conducted. A third MRA was also performed on the two facets of openness, and insightfulness. The results for the MRA are reported separately as follows.

7.11.2 Personality and insight

In combination, the five personality variables accounted for a significant 12 per cent of the variability in insightfulness, $R^2 = .12$, adjusted $R^2 = .11$, $F(5, 1,102) = 29.05, p < .001$. This resulted in a medium global effect size, $f^2 = 0.15$ (Cohen, 1988). Table 7.2 reports the unstandardised ($B$), and standardised ($\beta$) regression weights for each predictor in the regression model. As expected, openness was the strongest predictor. Conscientiousness also positively predicted insightfulness. Agreeableness, extraversion, and emotional stability did not significantly predict insightfulness.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$ [Confidence interval]</th>
<th>$\beta$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraversion</td>
<td>0.079 [0.001–0.158]</td>
<td>.060</td>
<td>.47</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>0.125 [0.021–0.229]</td>
<td>.074</td>
<td>.019</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>0.151 [0.053–0.250]</td>
<td>.094</td>
<td>.003</td>
</tr>
<tr>
<td>Emotional stability</td>
<td>-0.064 [-0.153–0.025]</td>
<td>-0.045</td>
<td>.157</td>
</tr>
<tr>
<td>Openness</td>
<td>0.466 [0.365–0.566]</td>
<td>.277</td>
<td>.000</td>
</tr>
</tbody>
</table>

In order to investigate the relationship between openness and insight further, openness was separated into two facets: open to new experiences, complex; and unconventional, creative. These were entered into a separate regression analysis in order to uncover which facet made the strongest predictor of insight. In combination, the two openness facets accounted for a significant nine per cent of the variability in
insightfulness, $R^2 = .09$, adjusted $R^2 = .088$, $F (2, 830) = 52.71, p < .001$. This global effect size was small, $f^2 = 0.10$ (Cohen, 1988). Table 7.3 reports the unstandardised ($B$), and standardised ($\beta$) regression weights for each predictor in the regression model. [I see myself as] open to new experiences, complex; predicted dispositional insight to a greater degree than did unconventional, creative. While this result is expected, given the nature of insight, a cautionary note is that each facet was only measured by one item on the subscale.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$ [Confidence interval]</th>
<th>$\beta$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open to new experiences, complex</td>
<td>0.698 [0.497–0.900]</td>
<td>.208</td>
<td>.000</td>
</tr>
<tr>
<td>Unconventional, creative</td>
<td>0.443 [0.280–0.607]</td>
<td>.163</td>
<td>.000</td>
</tr>
</tbody>
</table>

7.11.3 Personality and analysis

In combination, the five personality variables accounted for a significant 13 per cent of the variability in analytical, $R^2 = .13$, adjusted $R^2 = .122$, $F (5, 1,102) = 31.66, p < .001$. The global effect size was small, $f^2 = 0.14$ (Cohen, 1988). Table 7.4 reports the unstandardised ($B$), and standardised ($\beta$) regression weights for each predictor in the regression model. Conscientiousness was the strongest positive predictor of an analytical disposition, followed by agreeableness. The strongest negative predictor was openness followed by extraversion, an opposite pattern to insightfulness. Emotional stability did not predict analysis.
Table 7.4
Predictors of Disposition to Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$ [Confidence interval]</th>
<th>$\beta$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraversion</td>
<td>0.250 [-0.401--0.098]</td>
<td>-.097</td>
<td>.001</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>0.287 [0.085--0.488]</td>
<td>.087</td>
<td>.005</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>0.955 [0.765--1.145]</td>
<td>.305</td>
<td>.000</td>
</tr>
<tr>
<td>Emotional stability</td>
<td>0.121 [-0.291--0.050]</td>
<td>-.044</td>
<td>.165</td>
</tr>
<tr>
<td>Openness</td>
<td>0.550 [-0.744--0.356]</td>
<td>-.169</td>
<td>.000</td>
</tr>
</tbody>
</table>

7.11.4 Comparing low versus high arousability on disposition to insight

An independent samples $t$-test was performed to compare dispositional insight on those low on arousability with those high on arousability. High arousability is a score of $> 40$ and low arousability is a score $< 30$ (Hicks et al., 1992). High arousability ($n = 198$) included 18.5 per cent of participants, and low arousability ($n = 419$) included 39.2 per cent of participants. The Levene’s test was not significant, thus equal variances can be assumed. The $t$-test was statistically significant, with the low arousability group ($M = 23.94$, $SD = 4.09$) scoring lower on a disposition to insight than the high arousability group ($M = 25.91$, $SD = 3.93$), $t (615) = -5.68$, $p < .001$, two-tailed, $d = -0.46$. As expected, those who are higher on a disposition to insight also have a higher arousability predisposition, with a medium effect size (Cohen, 1988).

7.12 Discussion

The aim of the current study was first to investigate the personality traits that predict insightfulness in comparison to analytical individuals. The second aim was to test the arousability hypothesis of creative people by comparing low versus high predisposition to arousability on disposition to insight. As anticipated, openness was the strongest positive predictor of insight (a measure of creative cognition). Openness to new experience, the complex facet of openness, was a stronger predictor of insight than the unconventional, creative facet of openness. Conscientiousness also positively predicted
insight. As expected, openness was the strongest negative predictor of analysis, and extraversion also negatively predicted analysis; while the strongest positive predictor of analysis was conscientiousness, followed by agreeableness. As with previous creativity research, emotional stability (usually measured as neuroticism) did not predict insight, nor did it predict analysis. The hypothesis that those predisposed to high arousability would score higher on disposition to insight compared with those low on arousability was also supported.

7.13 Comparing personality traits: Insightful versus analytical people

The greatest contrast in personality between insightful and analytical people was on openness. Openness positively predicted insightfulness and negatively predicted analysis. In particular, the complex facet of openness [I see myself as] open to new experiences, complex; strongly predicted insightfulness. This finding confirms the idea that insightful people have a readiness to consider new ideas, are divergent thinkers, and an intellectual curiosity (McCrae, 1987). The second facet of openness [I see myself as] unconventional, also significantly predicted insightfulness, indicating that insightful people are creative and independent in the way they think. This finding is consistent with other research across various creative measures (Beaty et al., 2014; Feist, 1998; Furnham et al., 2005; George & Zhou, 2001; King et al., 1996; McCrae, 1987; Wolfradt & Pretz, 2001). Conversely, openness negatively predicted analysis, indicating that analytical people prefer the familiar rather than seeking out new ideas. This aligns with the theory that less creative thinkers have steeper associative hierarchies than highly creative thinkers (Martindale, 1995). Steep associative hierarchies trigger well-known (closely related) solutions, and are thus less creative than information retrieved by
processes using flatter associative hierarchies. The latter process allows for solution searches that are more weakly associated (thus more creative).

Conscientiousness was by far the strongest positive predictor of analysis. The two facets of conscientiousness measured in the current study were: dependable, self-disciplined; and organised, careful. The outcomes of research between conscientiousness and creative thinking are mixed. Some have found a negative relationship (Feist, 1998; Furnham et al., 2005; Wolfradt & Pretz, 2001), indicating the use of fewer creative abilities and cognitive processes. However, others have found a positive relationship between conscientiousness and creativity, particularly when moderating variables are included (Furnham et al., 2005; King et al., 1996; McCrae, 1987). The current results support these findings, with conscientiousness also positively predicting insightfulness—although to a lesser degree. This suggests that conscientiousness has qualities of both creative and non-creative cognition, depending on where it is channelled. As King et al. argued, conscientiousness is related to perseverance in the face of difficulty. Many scientific insights occur due to the perseverance of breaking through an impasse. Problems using analytical processes such as mathematical problem solving also require perseverance.

Agreeableness also positively predicted an analytical cognitive style. The two facets measured in the present study included: sympathetic, warm; and low in qualities of critical, quarrelsome. Agreeableness, in a few creative studies, has been shown to negatively predict creative ability (Beaty et al., 2014; King et al., 1996). The argument for this finding is that creative people tend to be argumentative and sceptical (King et al., 1996). However, in the current study, agreeableness approached significance ($p = .02$) as a positive predictor of insightfulness. A limitation of these results is that agreeableness—as measured by the TIPI—had a low reliability (alpha = .23).
Extraversion also showed similar results to previous research on creativity. The direct relationship between extraversion and insight was significant ($r = .13$), but as with some other studies, the relationship was small (King et al., 1996); although other authors have found a moderate relationship (McCrae, 1987). When extraversion was entered into a MRA it did not significantly predict insight ($\beta = .06$), which is also consistent with the reviewed literature (Batey et al., 2010; Beaty et al., 2014 [Study 2]; King et al., 1996). This finding suggests that when other personality factors are controlled for in a multiple regression, extraversion no longer shows a relationship with creative measures, including dispositional insight. For analysis, however, the relationship reversed. The direct relationship showed a weak negative correlation ($r = -.13$), and in the MRA the negative relationship remained significant ($\beta = -.10$). It is likely that extraverts and introverts alike can be insightful people. However, analytical people are likely to be more introverted.

### 7.14 Insight and dispositional arousability

Consistent with Martindale’s (1999) theory of creative people, it was shown that insightful people reported significantly higher dispositional arousability than those lower on insightfulness; the effect size for this difference was medium. Martindale et al. (1996) argued that greater fluctuations in arousal for creative people could mean that they take longer to create an internal model of the problem, and remain alert to new information—even after a mental model is constructed. This suggestion can plausibly translate to insightful people, as insights are often triggered by noticing new information, and how it fits in with the current problem (Davidson & Sternberg, 1984).

The findings of the current study are not consistent with those of Fink and Neubauer (2008), in that extraversion did not predict insight. The methodology used could be responsible, however, as although Fink and Neubauer used a creative thinking
measure often used in insight research, they did not gather data on solution type (insight or no insight), compared with the current study, which did measure self-report insightfulness. In terms of other findings; while the inverse relationship between extraversion and dispositional arousability was similar to Fink and Neubauer’s results, the strength of the relationship was only small ($r = -.07$). Another inconsistency was that although the current study found arousability was positively associated with insightfulness, Fink and Neubauer found an inverse relationship between these constructs. However, they did measure ‘state’ cortical arousal, whereas this study was interested in comparing ‘trait’ level of arousal and insight. Both studies therefore support Martindale’s (1999) theory of arousability and creative thinking. At the dispositional level, arousability is positively associated with insightfulness (creative cognition), while it is negatively associated with creativity at the state (experimental) level. Fink and Neubauer’s study was more in line with creativity research, as they measured ability to solve insight problems, not whether participants experienced an insight solution. As argued previously, these tasks can be solved analytically if the solver has previous experience with similar problems. In future, in experimental studies on insight it would be of benefit to measure both state and trait levels of arousability, with the aim of comparing any differences.

In regard to Fink and Neubauer’s (2008) finding that extraverts produce a greater number of novel answers within three minutes, this could also be explained within the context of the research by Matthews and Amelang (1993). These authors found that extraverts performed more quickly and accurately than introverts under conditions of low cortical arousal. On the other hand, introverts performed more accurately under moderate levels of arousability and more quickly under high cortical arousability than extraverts. Investigating extraversion/introversion and arousability in terms of creativity requires the consideration of the time given to participants to complete the task (more
than five minutes for introverts) and the conditions that affect arousability (other than the task itself).

### 7.15 Limitations of the study

The limitations of the study should also be noted. The first is that a short 10-item measure of personality was used. While the TIPI has been well validated against other measures of the Big-Five (Gosling et al., 2003), the current study showed reliabilities ranged from only .23 to .48. Low reliabilities may explain why the results were not significant, particularly for extraversion. Although this limitation is noted, the results for openness and insight revealed the expected outcome.

A second limitation is that hypotheses were derived from the connection between insight and creativity based on assumptions in the literature, and the similarity between insight and other creative thinking. Their important difference is the nature of the process; that is, insight processes are implicit, whereas other types of creative thinking rely on conscious processes. These differences make them similar yet distinct, however the degree to which they are similar and different is not well understood.

### 7.16 Implications and future research

Future research seeking to replicate the current study should utilise a full personality scale to test these findings. If future studies continue to find similar results to the current study, then a stronger conclusion can be drawn. Future research should also include other creative cognition measures to verify the relationship with insightfulness. A common measure for assessing creative cognition is a divergent thinking task (Silvia et al., 2008). In this task participants are asked to generate unusual uses for an item, such as a brick. Another well utilised creative self-report scale is the CAQ (Carson et al.,
which measures creativity across 10 domains. Further research is discussed in more detail in the Chapter 8.

7.17 Conclusion

In summary, the current study revealed important personality predictors of insightfulness in comparison to the personality predictors of analytical people. The strongest positive predictor of insightfulness was openness, with the same construct being a strong negative predictor of analysis. Conscientiousness was the strongest positive predictor of analysis, but also positively predicted insightfulness. Analytical people were shown to be low on extraversion and high on agreeableness. These results demonstrate that insightful people are open and conscientious, in contrast to analytical people who are highly conscientious and agreeable, and low on openness and extraversion. The current study also found that highly insightful people possess a higher predisposition to arousability, in comparison to those low on insightfulness. The implications and future studies that can extend on the current findings will be discussed in Chapter 8.

7.18 Summary of findings and implications for theory

This chapter aimed to further understand the individual differences of insightful people by first, measuring and comparing their personalities with those who are more analytical, and second, measuring the arousability of the insightful person. The current study made a significant contribution to the literature, with findings as follows:

- Openness by far revealed the strongest contrast between these two groups, with insightful people being high on openness (positive relationship) and analytical people being low on openness (negative relationship).
- High conscientiousness strongly predicted analysis, followed by agreeableness.
• Conscientiousness also positively predicted insight, but to a much lesser degree. It is probable that conscientiousness contains qualities that facilitate both creative and non-creative processes.

• Extraversion did not predict insightfulness; however, it negatively predicted analysis.

• Emotional stability did not predict either disposition.

• In terms of a predisposition to arousability, as with creative types, those higher on insight were moderately higher on arousability compared to those lower on insight.

These findings offer further understanding of the dispositions that separate insightful from non-insightful people, and in particular, how they compare to analytical people.
Chapter 8
General discussion and conclusion
8.1 Chapter overview

This chapter summarises the aims and findings of each study; drawing together a cohesive theme that emerged from the four studies. A discussion of the results in connection with previous research will then follow, with a particular focus on how the current thesis answers the issues identified in Chapter 1 (the gap in the research).

Implications for the findings are also discussed in relation to how these can be utilised by researchers, industry, and individuals. Limitations of the study are raised and how future research may avoid these. Further studies that will assist in deepening the enquiry initiated in this thesis are also considered, followed by concluding comments.

8.2 Introduction

Through experimental studies, researchers have begun to understand the neural and cognitive differences between insight and non-insight problem solving. However, it is still not fully understood what states are conducive to producing an insight, or traits that are associated with insightful people; nor is there a self-report tool to identify them. The aim of this thesis was threefold. The first aim was to identify the proportion of the population that experiences insights, to qualitatively investigate the general contexts (time and place) in which people tend to experience their insights, and to understand how the general population perceives the phenomena of insight. The second aim of the thesis was to construct a self-report scale—the DIS. This scale was then used to identify the degree to which an individual is insightful. The final aim was to investigate other traits (positive affect, flow, mindfulness, the Big-Five personality, and arousability) that would theoretically predict a disposition towards insight.
8.3 Overview of the thesis and findings

The first study utilised both closed- and open-ended questions in the questionnaire. Participants were first asked if they had ever experienced an insight (yes or no); with 20 per cent of the sample selecting no (they had never had an insight). This result suggests that not only is there a degree to which individuals differ in their insight experiences, but that it is also a dichotomous trait; with approximately 80 per cent of the population experiencing insights at least occasionally, while 20 per cent do not experience insights at all. If some people do not have insights, then this also supports the theory that insight is a “special” form of problem solving. While analytical problem solving is a cognitive ability that all people use, the cognitive abilities involved in insight are employed for particular types of problems, work better under particular (internal and external) conditions, and are not universal abilities. The most common places and times that insights purportedly occur, in order of popularity were: night (before, during and after sleep), in the shower, at work, at home, when it is quiet, during exercise, in nature, and on transport (bus, train, and driving). The demographics related to people who experience insights were: gender (female), younger, and highly educated. These results are summarised in Figure 8.1, along with other characteristics of the insightful person established by the current thesis.

The next part of the study aimed to investigate dispositions related to insightfulness. As no measure currently exists, a scale was constructed in the second study to meet this requirement. The result was a brief five-item scale assessing a single factor of a disposition towards insight experience (the DIS). Normative data for the scale were also reported, with separate data for males and females. Future studies could utilise the scale to characterise trait insight as a continuous variable, and to compare other variables with insight, without needing to collect experimental data.
Once the DIS was constructed, it was possible to confirm other traits that predict a disposition to insight. The third study sought to determine whether the positive affect/insight connection is consistent at the dispositional level using SEM. This study also looked to investigate whether dispositional mindfulness has an effect on trait insight. While positive affect showed an effect on dispositional insight, mindfulness had a stronger effect—although the effect was small (Model 1, 0.18, and Model 2, 0.19). The correlation between mindfulness and insight was moderate. An additional hypothesis was tested in the third study that has not been investigated in previous
research. This was the effect that dispositional flow (autotelic personality) would have on insightfulness. Autotelic people enjoy challenging tasks and their propensity to flow states mean that they have the cognitive capacity to search more broadly for weaker associations in memory (Baumann, 2012). Dispositional flow was also added to the SEM along with positive affect and mindfulness in two models. Model 1 included a composite score of dispositional flow, and Model 2 included the nine factors of flow separately, as measured by the DFS-2. As a composite-score flow had a positive effect on insight (.16), its specific facets showed a slightly stronger effect (.19) when combined with positive affect and mindfulness. This finding is likely to be related to the fact that one of the facets—clear goals—had a negative effect on insight experience. The negative relationship between clear goals and insight is not surprising given that analytical problem solving (and likely, the analytical person) starts with a clear goal, while insight problem solving begins with a lack of clarity about the goal (Mayer, 1995). In Model 2, only four of the nine facets of flow had a positive effect on insightfulness: merging of action awareness, unambiguous feedback, transformation of time, and autotelic experience. The correlation between flow and insight was similar to mindfulness ($r = .31$), suggesting a moderate relationship.

The final study first investigated the Big-Five personality variables as a predictor of insight versus analysis as a disposition. Hypotheses were drawn from the creativity literature, as insight as a creative measure has not previously been directly investigated in terms of personality. It was anticipated that openness would positively predict insight. Through MRA it was found that openness was the strongest predictor of insightfulness; however, this was followed by conscientiousness, which is commonly associated with non-creative abilities (King et al., 1996). Others have found a positive association between creativity and conscientiousness (e.g. McCrae, 1987). No other personality variables predicted insight. Conscientiousness positively predicted analysis,
as expected, followed by agreeableness. Openness and extraversion negatively predicted analysis. Based on the results, it was concluded that the qualities of openness show the strongest contrast between insight and analysis traits. The qualities of conscientiousness, however, were found in both insightful and analytical people—particularly in the latter. The second part of the final study compared high versus low dispositional arousability and insightfulness. Those high on arousability were moderately more insightful than those low on arousability. This finding is consistent with the research connecting arousability and creativity (see Martindale, 1999, for a review). At the dispositional level, creative types show higher cortical arousal. During the creative process, however, their cortical arousal tends to be lowered.

### 8.4 Measuring individual differences in insight

A tacit assumption in the literature is that everybody solves problems in one of two ways. If the problem is clearly defined and the solver has some experience with the issue at hand, then it can be solved through analytical strategies (Mayer, 1995). Alternatively, if the problem is ambiguous, and the solver has no experience with it, then they will likely form an incorrect representation of the problem and initially fail to find a solution (Davidson, 2003). The failure to find a solution may lead to an impasse, followed by an incubation period (S. M. Smith, 1995b). During the incubation phase, the faulty representation may undergo a restructuring process of the problem elements (i.e. forming a correct representation of the problem leading to the correct solution path), or through an unconscious search for alternative solutions. After the unconscious process has been completed, the solution pops suddenly into conscious awareness—the *Aha!* moment.

In this thesis it has been argued that it is possible that not all people will experience insights, even when solving ambiguous problems with which they have no experience.
This was supported by the findings in the first study, which showed that only about 80 per cent of the sample population reported having insights. From this finding, it is advised that researchers should identify or control for people who do not have insights. It would also be of importance to understand why some people do not have them. It was suggested in the introductory chapters that whereas some individuals may give up on a complex problem entirely, others may have developed tactics to break the problem down into smaller problems, allowing the use of analytical strategies to solve the problem. Further research is needed to confirm this. A small number of researchers use self-report questions (was it an insight or no insight?) to confirm that the experimental data they collect represents actual insights (e.g. Bowden & Beeman, 2003). This type of self-report data is useful for experimental research, particularly investigating neural correlates of insight. However, the results may not necessarily gauge the degree to which people are generally insightful, particularly if only a few problems are used. A greater number of hybrid problems (e.g. RAT problems) may indicate a trend in the data—that some tend to have insights, while others do not.

In taking this further, the short five-item self-report DIS was constructed to measure the degree to which participants are generally insightful. This will add a further measure for uncovering individual differences in problem solving. The DIS also takes the insight research out of the laboratory. It can be placed in a questionnaire along with other measures of interest, and can be used with other methodologies for investigating insight. The DIS will be helpful in future studies to identify how insightful people are in their daily life, and to what degree.

8.5 States: Places and times that insight occur

Drawing from the results of the first study, for those who do experience Aha! moments, it is likely that certain conditions will be more conducive to facilitating a state that leads
to them. States such as positive emotions (Subramaniam et al., 2008), and after a period of meditation practice (Ostafin & Kassman, 2012) have been shown to increase insight solutions. The qualitative findings from the current study strongly suggest that activities that lead to a quiet, restful state are also important. In particular, insights most often occur at night, and after waking (before, during sleep, and after waking), followed by during showering.

The finding about night time insights supports a series of studies on how sleep improves the ability to solve insight problems (Stickgold & Walker, 2004; Wagner et al., 2004; Walker et al., 2002; Walker & Stickgold, 2010; Yordanova, Kolev, Wagner, & Verleger, 2010). The theory posits that slow-wave sleep facilitates consolidation of new memories, and increases functional connectivity of the right hemisphere (Yordanova et al., 2010). Activity in the right hemisphere is also associated with insight solutions (Bowden & Beeman, 2003). REM sleep is thought to strengthen the connection between more remote associations in memory (Walker et al., 2002). It would be interesting to gather further information on whether more insights occur in morning or evening showers. Morning showers may serve as an insight trigger from the consolidation that occurs during sleep. How this could occur is worthy of future investigations.

Many of the other activities found to be associated with insights in the first study suggest that mind-wandering might be happening at the time of the sudden solution (e.g. at work, at home, during exercise, and using transport). In a related study, it was found that engaging in mind-wandering was helpful during an incubation phase between encountering a novel problem and producing creative solutions (Baird et al., 2012). Neuroscience studies have discovered that a network of regions in the brain become active during restful states, which were subsequently labelled the default mode network (DMN) (Raichle, 2015). The DMN is also active during mind-wandering and
daydreaming (Domhoff & Fox, 2015), but even more so during REM sleep (Chow et al., 2013). Kounios and Beeman (2014) hypothesised that activation of the DMN in those who have insights reflects a broader attention focus to the environment during resting-state, and then an inward-directed focus during preparation and problem solving. Analytical solvers are thought to have the opposite cognitive pattern—during resting-state they are less outwardly focused; while during the preparation and solving phase, they become more outwardly focused. The inward focus of insightful people is said to reduce distractions from the environment (Kounios & Beeman, 2014). The qualitative results from the current study appear to support this hypothesis. It has also been hypothesised that activity in the DMN of the brain is likely to vary between individuals; research is yet to determine this (Buckner & Vincent, 2007). Given the connection between insightful people and the DMN activity during resting-state, if there are individual differences in the way that the DMN functions, then this may also explain the individual differences in insight ability.

It is interesting to note that both mind-wandering (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009) and meditation (Ostafin & Kassman, 2012) are conducive to the insight experience. These constructs sit at opposite ends of the present moment awareness continuum—from being unaware (mind-wandering) to fully focusing on the current moment (mindfulness) (Mrazek, Smallwood, & Schooler, 2012). While it has been revealed that the DMN is active during mind-wandering, it has been shown that activity in the default network is substantially lower in experienced meditators compared to non-meditators (Brewer et al., 2011; Mrazek et al., 2012). Whether both constructs have a key commonality that facilitates more insights, or whether they facilitate in different ways is a worthy avenue for further research. The key commonality is likely to be a state of defocused attention. Experienced meditators have
the ability to switch from focusing attention, to a state of defocused attention, depending on what is required (Ricard, Lutz, & Davidson, 2014).

A limitation of the current study is the reliance on participants’ recall of where and when their insights usually occur. Future studies should gather more contextual information: where subjects were, exactly, at the time of the insight; what emotional and cognitive state they were in during the activities when the insight occurred; and so on. A better method to confirm the place, time, mental state, and the context of the insight is to collect data through ESM (Csikszentmihalyi & Larson, 1987). ESM is a well-established instrument designed to collect data at the time the event is occurring. This method reduces the need for relying on memory, and increases ecological validity. Gathering as much data as possible at the time of the event will uncover more nuances of the insight experience. This will be discussed further under Section 8.8.4.

### 8.6 Traits associated with insightfulness

#### 8.6.1 Demographics

While the current thesis found that gender (female) predicted insight, previous research has not reported gender differences. Either gender differences were never the aim of these studies, or the results were not reported. Gender differences in general creativity have been investigated, with the relationship between gender and creativity being complex. Matud, Rodríguez, and Grande (2007) compared men and women on creative tests including figural originality, figural creativity, and verbal fluency. Men with the lowest education (primary and secondary schooling) outperformed women with the same level of education on visual tests (figural originality and figural creativity). Women with university degrees outperformed men with the same level of education on verbal tests (verbal fluency). He and Wong (2011) showed that for creative drawing tasks, girls tend to provide more detail than boys; however, boys tended to break outside
the boundaries of convention more than girls. In a review, Baer and Kaufman (2008) reported that even though the gender and creativity relationship is complex, on average girls and women scored higher on creative tasks than boys and men. The current results on insight support the findings of these studies. However, further research is needed to confirm the link between gender and insight. The results of the current study warrant further investigation.

Age and insight experiences showed mixed findings. While more of the younger participants reported experiencing insights, some of the older participants reported that their insights improved with age. Although the percentages showed age differences, this was not supported by statistical analysis. Like gender, the differences may be complex, requiring further research to uncover the nuanced variances. It may be that younger people are less likely to experience fixation and mental ruts, as they have less experience to draw on than older people. It is argued that insights can occur without fixation (S.M. Smith & Blankenship, 1991). Insight may occur as a result of fixation, or the fixation may persist indefinitely and the insight may never arise. Ageing differences may be mediated by specific individual differences including personality (e.g. degree of openness) and cognition. The cognition hypothesis has some research support. Ageing has been associated with distractibility, which helps in the detection of new information that may be relevant to the problem (Kim et al., 2007). A future study could confirm this by measuring insight capacity in older participants, and comparing this with their level of distractibility.

More of the higher-educated participants reported experiencing insights than their lower-educated counterparts. Statistically, this was non-significant. There does not appear to be any research prior to this study that has focused on education. However, there is some research to suggest a connection between insight and intelligence. Sternberg and Davidson (1983) defined insight ability as the capacity to selectively
encode (irrelevant information is discarded, with only relevant information encoded into memory), selectively combine (the relevant information is combined in a novel way), and selectively compare (new and old information are related in a novel way). Preliminary results in children showed that performance on measures that test these abilities were positively associated with intelligence (Davidson & Sternberg, 1984). There does not appear to be any follow-up research to confirm this finding.

Research linking education achievement and intelligence could provide a hint as to why insights may occur in more highly educated people. A five-year longitudinal study of more than 70,000 children found a correlation of .81 between general intelligence and educational achievement (Deary, Strand, Smith, & Fernandes, 2007). While knowledge is believed to be a cause of fixation (S. M. Smith, 1995a), greater flexible knowledge (openness to new experiences) may provide a greater repository of knowledge to draw on. The cognitive search for alternative solutions beyond current assumptions may be successful due to alternative relevant knowledge laid down in memory. Openness has been shown to be a predictor of intelligence (Laidra, Pullmann, & Allik, 2007). The longitudinal study previously mentioned also found that while females were not superior in general intelligence, they did perform better in all subjects, except physics (Deary et al., 2007). It has also been found that particular schooling experiences can lead to improvements in cognitive ability (Gustafsson, 2008). Openness coupled with higher education may explain why younger females are more likely to experience Aha! moments. Further research focusing on the link between education, intelligence, and insight is needed to confirm whether there is a true relationship. The statistics in this study did not definitively support this, but it did suggest there may be a connection.
8.6.2 Intuition

An intuitive cognitive style showed a relationship with the DIS in Study 2. Many of the qualitative responses stated there is a “need for the details first”. Solving problems that result in insight solutions start out with an analytical approach—trying what one knows first. When this fails after a period of thinking about the problem carefully, the problem is often left to “incubate” where—at least for those who have insights—the unconscious mind takes over (Gilhooly et al., 2013). During this phase, connections are likely to begin forming “intuitively”; as other participants stated, “the answer was staring me in the face”. Intuitive cognitive style is purported to be at the opposite end of the spectrum to analysis (Allinson & Hayes, 1996). Much like insight, intuitive decisions are made without consciously knowing how they occurred (Baumann & Kuhl, 2002). One participant expressed insight as: “Not controllable but often very valuable. Although similar, it is quite different to intuition,” and another wrote, “[insights] tell me to trust my intuition”.

While intuition comes from well-learned patterns, insight is discovering new patterns (Klein, 2013); however, both these qualities form part of the System 1 aspect of cognition (i.e. fast, automatic, outside conscious awareness, and not constrained by the limits of WM), as opposed to analysis or System 2 which is slow, effortful, conscious, and sequential (Gilhooly & Fioratou, 2009). The insight/intuition relationship suggests that insightful people automatically employ System 1 for solving problems, after analytical strategies fail (Macchi & Bagassi, 2012). It is the familiar story of setting the problem aside to let the idea incubate, which, when returning to it, allows the solution to pop into the solver’s mind. This is comparable with the phase proposed by Kounios and Beeman (2014), whereby insightful people focus inward just prior to finding the solution. It has been shown that insight solutions are often formed prior to the solution becoming conscious (Durso et al., 1994; Sadler-Smith, 2015); the act of turning inward
may trigger the solution. In sum, the DIS showed convergent validity with an intuitive cognitive style. This also demonstrates that those who experience insights are likely to rely on a more intuitive cognitive style, rather than an analytical one.

8.6.3 Need for cognition

NFC or enjoyment in challenging cognitive activities, also related positively to the DIS suggesting that System 2 (i.e. rational thought) is also utilised in the solving process. While this is likely to occur in the course of understanding the problem, those high on NFC also depend on their intuition, emotions, and images, but in more thoughtful ways than their low NFC counterparts (Petty, Briñol, Loersch, & McCaslin, 2009). Those high in NFC have a tendency to evaluate their assumptions for validity (self-validity). As argued by Wallas (1926), validation of the solution is the stage after the insight occurs; thus it may be automatic for insightful people to check the accuracy of the solution. It has been claimed that NFC is a stable individual difference that reflects the intrinsic motivation—which develops over time—to focus on the process rather than the outcome of thinking (Cacioppo & Petty, 1982). In terms of a dual system process, it has been shown that both System 1 and System 2 interact during the insight problem-solving process (Hélie & Sun, 2008, 2010).

8.6.4 Mindfulness

Long-term meditators (i.e. a high level of trait mindfulness) have been shown to exhibit neural activity similar to that found in the Aha! moment, during—and even after—meditation practice (Begley, 2007). Mindfulness reduces habitual thinking and increases cognitive flexibility (Ostafin & Kassman, 2012), minimising the effects of functional fixedness. The current thesis found that mindfulness has a small but significant effect on dispositional insight, even when controlling for positive affect. This was also demonstrated by Ostafin and Kassman (2012), although they did not collect self-report
data on solution type (insight/no insight). While state positive affect has been shown to positively predict insight (Subramaniam et al., 2008), the current study suggests that mindfulness has a greater effect.

Positive affect and mindfulness share similar facilitative effects on the brain—including greater cognitive flexibility and global processing—explaining why they both predict insight (Baumann et al., 2005). Mindfulness, however, appears to have additional benefits that are not shared with positive affect; for example, mindfulness practice has been shown to increase perceptual sensitivity (Brown et al., 1984a; 1984b). Increases in perception—or noticing new information from the environment that would otherwise go unnoticed—is one possible explanation for these benefits. For real-world insight problems, many people may not always be aware of new information to which they have been exposed, let alone how it fits with a current issue. By increasing their abilities to perceive new information in their environment—and how it fits in with a current problem—they are more likely to experience the perceptual shift that leads to insight.

As discussed earlier, Sternberg and Davidson (1983) proposed that insight ability requires selective encoding, selective combination, and selective comparison. They argue that intelligence is what allows some people to do this better than others; hinting that these abilities may not be modifiable, given the heritability of intelligence (Bouchard & McGue, 1981). If mindfulness can modify the brain in such a way as to increase perceptual sensitivity, then it may also increase these three abilities. This is certainly the case for selective comparison, when new information is detected along with a sudden understanding of how it fits into current knowledge, triggering the Aha! moment. Stated another way, an unsolved problem stays active beneath the level of awareness; the mindful person is exposed to new information (e.g. a statement made by colleague, to which they are paying attention); and in an instant this new information is
seen as the missing piece of the puzzle (Aha!). For a person low on mindfulness, or not paying attention, this information may go unnoticed or ignored (opportunity is lost). Another benefit of mindfulness is its ability to increase flow states (Aherne, Moran, & Lonsdale, 2011), a condition that has additional benefits for triggering insights, as shown in the current thesis.

8.6.5 Autotelic personality/dispositional flow

The enjoyment of cognitively challenging tasks also applies to autotelic personality/dispositional flow. Research examining how this applies to the insight experience has been absent to date. To put the following discussion on the flow findings into context, the questionnaire asked participants to: *think of a time when you were working on a difficult problem for which you had to find a solution*. This aimed to place the DFS-2 questions into the context of the problem-solving process. An important finding from the current thesis is that although dispositional flow has an effect on insightfulness, not all of its nine facets apply. First, *clear goals* had a negative effect on insight, which is unsurprising given that clarity of the problem and the end goal is more applicable to analytical problem solving. Insight problems begin with a lack of clarity in regard to where to begin, and how to consciously represent the problem. Flow is likely to operate in analytical abilities too, which may be a reason for the small effect size found in Study 3 (see Chapter 6). The importance here is that autotelic people have the ability to flexibly switch between conscious and unconscious processing where needed, and to resist the frustration of dealing with ambiguous problems (Baumann, 2012). The four factors of autotelic personality that had a positive effect on insightfulness—merging of action and awareness, unambiguous feedback, transformation of time, and autotelic experience—will be discussed in turn.
Merging of action and awareness

Merging of action and awareness reflects the experience that when completely involved in an activity, actions become automatic and indistinct (Csikszentmihalyi, 1991). However, another related element of flow—loss of self-consciousness—did not show an effect on insight. These two factors were considered separately, as merging of action and awareness can sometimes heighten the sense of self as a product of the action (Csikszentmihalyi, 1996). In the case of insight, neuroscience studies have illustrated that insightful people tend to turn their attention inwards just prior to the solution, whereas analytical people turn their attention outwards (Kounios & Beeman, 2014). Turning inward is almost certain to increase the sense of self, as the problem becomes a part of the solver.

Unambiguous feedback

Unambiguous feedback was the second facet of flow to positively affect insightfulness. This construct reflects the ability to be aware of outcomes of possible actions, and to reduce any conflict that may arise from the activity. Conflict monitoring is associated with activity in the ACC, an area of the brain that is active just prior to the insight occurrence (Subramaniam et al., 2008). A characteristic feature of the Aha! moment is the feeling of confidence that the solution is correct (Bowden et al., 2005). This strong certainty regarding the correctness of the solution produces the feeling of elation that the goal has finally been achieved. Conviction that one has succeeded in achieving the goal is the main feature of unambiguous feedback (Csikszentmihalyi, 1991). Thus, the problem-solving process starts with an unclear goal, but ends with clear feedback that the goal (solution) has been achieved.

Transformation of time

The third facet of flow to positively affect insightfulness was transformation of time. During the flow experience, time appears to stand still, while afterwards it seems that
time has passed very quickly (Csikszentmihalyi, 1991). As the qualitative results showed, people are engaging in activities where mind-wandering occurs. During mind-wandering, people are lost in their thoughts to the extent that after their thoughts return to the present moment, time has passed without awareness. Transformation of time may also reflect how people become absorbed in the problem itself (merging action and awareness), and lose track of time. An ESM study could reveal exactly what is occurring during the problem understanding, and/or impasse/incubation phase.

**Autotelic experience**

The principal feature of the “optimal experience”—that is, autotelic experience—was the fourth facet of flow to effect insightfulness. Autotelic experience refers to an activity that is done simply for the enjoyment of the experience, not for some future reward (Csikszentmihalyi, 1991). Autotelic experience—coupled with a high need for cognition—suggests that insightful people enjoy difficult problem solving simply for the sake of it. Of course, this may also be the case for highly analytical people. Future research should consider exploring why autotelic experience positively predicts insightfulness, as opposed to non-insightfulness.

Autotelic personality or dispositional flow encompasses a disposition towards positive affect, and a resilience to negative affect (Baumann, 2012); however, dispositional flow showed a stronger effect on insightfulness than dispositional positive affect. To date, focus has been on experimental manipulation of positive affect, and how this facilitates global processing (Gasper & Clore, 2002), and therefore, insight (Subramaniam et al., 2008). The relationship between positive affect and insight solutions in Subramaniam et al.’s (2008) study was reported as medium ($r = .40, p < .005$), compared to the small relationship in Study 3 ($r = .26, p < .01$) in this thesis. However, the relationship between dispositional flow and insight was strong ($r = .53, p < .01$), with the findings of this thesis suggesting that dispositional flow has additional
benefits to increasing insights over and above positive affect. Being in a state of flow has other cognitive qualities that are conducive to the search for more obscure solutions, as discussed previously.

It is also important to discuss the aspects of flow that did not show an effect on dispositional insight. Loss of self-consciousness has already been discussed; however, three other facets—challenge-skill balance, concentration on task, and sense of control—also did not predict insight. The theory of flow personality states that challenge-skill balance refers to a belief that one’s skills can meet the challenge of the problem or task at hand (Csikszentmihalyi, 1991). To obtain skills, a person must gain a degree of experience with the relevant task. With experience, the solver could solve the problem analytically. Recall that insights occur with problems where there is a lack of experience—solvers do not have the skills to meet the challenge (i.e. the sense of confusion elicited by the ambiguous problem). It is plausible to assume that insightful people experience insights with problems where their skills do not meet the challenge, as opposed to non-insightful people who may give up on the problem; or they may be adept at using analytical strategies. These people can be contrasted by the way they solve ambiguous problems; in that insightful people automatically employ unconscious processing strategies, while non-insightful people may avoid these problems or employ conscious analytical processes. Further research on analytical people and the strategies they use to solve ambiguous problems could help to verify this hypothesis. The other two flow facets that did not predict insightfulness—concentration on task, and sense of control—both also rely on conscious, controlled cognitive processes, and thus relate to analytical problem solving rather than insight.

8.6.6 Big-Five personality

The comparison between insightful and analytical people in regard to personality revealed both differences and similarities. The largest contrast was on the openness
construct. Insightful people reflected high openness and analytical people were low on openness. One of its two facets—openness to new experiences and seeing oneself as being “complex”—predicted insight to a greater degree than the second facet of openness, being unconventional and creative, although the latter also moderately predicted insight. Openness to new experiences reiterates the idea that insightful people are searching for new creative ways of thinking, understanding, and solving problems. Openness also encompasses an inability to ignore irrelevant information (Batey & Furnham, 2006), which has been shown to positively relate to insight (Knoblich et al., 2001; Sternberg & Lubart, 1995). Noticing seemingly irrelevant information and implicitly seeing how it fits into an existing problem is the hallmark of many insightful discoveries. Davidson (1995) termed this selective encoding, when the problem solver notices something important to solving the problem that was not previously noticed. Selective encoding can contribute to insight by restructuring one’s mental representation, so that information that was previously seen as irrelevant is now seen as relevant to the problem. Or in reverse, what was thought to be relevant becomes irrelevant.

A similarity in personality between insight and analysis was conscientiousness. It was the strongest positive predictor of analysis, but also significantly predicted insight. Conscientiousness is likely to be a trait that can be applied and adapted to an individual’s specific abilities—qualities of self-discipline, determination, and organisation (McCrae & Costa, 1987)—that benefit both the philosopher, who analytically studies an argument; and the creative scientist who formulates a creative response to a scientific problem.

While extraversion did not predict insightfulness, it did negatively predict analysis. The findings of this thesis suggest the extraversion/introversion dimension is not important to insight ability. Its negative relationship to analysis needs further
investigation in order to make any conclusions. However, the combination of low extraversion (introversion) and low openness suggests that analytical people prefer their habitual thinking, avoid new experiences, and are low on sociability and sensation seeking (McCrae & Costa, 1987). Agreeableness showed no relationship to insight, but it did positively predict analysis, suggesting that analytical people also prefer to comply with others over being disagreeable.

Emotional stability did not predict insight or analysis. As with activities that lead to flow states (Baumann, 2012), solving difficult problems leads to mood fluctuations; from frustration (not able to solve the problem) to elation (problem is suddenly solved). It is the resilience to the negative emotions elicited by the frustration of solving ambiguous or complicated problems that is important. It is not that people will stay calm, it is the resilience and ability needed to continue moving through frustrations until the problem can be solved. This is also likely to involve a high level of intrinsic motivation, an aspect of autotelic personality (Baumann & Scheffer, 2010). One caution to making conclusions about personality is that the TIPI scale was used in the current thesis. The TIPI measures only two facets of each of the five personality variables. A future study seeking to replicate this one, should use the full BFI personality scale (Costa & MacCrae, 1992).

8.6.7 Arousability disposition

Those high on arousability showed more insightfulness than those low on arousability. Arousal predisposition related negatively to emotional stability (i.e. positively to neuroticism). Highly sensitive people exhibit greater awareness of internal sensations compared to less sensitive types (Benham, 2006). This could possibly support the hypothesis that those who report not having insights are actually not aware of them. Insights create a level of surprise of which one is immediately aware; however, the level of surprise and awareness may vary between people. Those high on arousability will be
sensitive to this sensation. Those at the extreme end of low arousability may not experience the Aha! sensation.

Arousability is also associated with highly creative individuals (Martindale, 1999). Such people exhibit a generally high arousal level, and during the creative process arousal levels are significantly lowered. The ebb and flow of arousal levels may relate to insight triggers. As the qualitative results showed, many people experienced insights at night, or in a quiet place. They also occurred while relaxing on a bus or train, and while driving—this movement appears to produce the right kind of relaxation. If an individual has a cognitively demanding day and then, for example, travels on a train—the shift from high arousal to low may trigger the insight.

8.7 Strengths and limitations

The majority of the research into insight has come from cognitive and neuroscience research, based mostly on experimental methods. These methods have the strength of controlling for extraneous variables and investigating causation. Two main limitations are evident. The first is that the sample sizes tend to be small, and the second is that they are predominantly composed of university students (particularly first-year psychology students). While the current study was not experimental, the questionnaire design made it possible to use a large sample size. The sample—taken from a market research company—was balanced across demographics to make it as representative of the Australian population as possible. Comparisons across demographics (gender, age, education, and occupation) were possible. In saying this, self-report data does have its limitations. When participants are completing the questionnaire, they are required to make judgments relatively quickly; some more than others may make snap decisions. Retrospective data may also be less accurate (Bernard, Killworth, Kronenfeld, & Sailer,
Qualitative data is generally derived from small sample sizes, so while new insights emerge from interviews and focus groups, these generally need to be followed up with a more extensive study—such as a quantitative study—if generalisations about the topic are required. Themes that emerged from the current study allowed for a relative confidence in and generalisability of these findings, although the qualitative results lacked the context in which the insights occurred. For example, the second most popular theme for place of insight was “at work”. What was not uncovered was the context of the insight—what was happening at the time—whether they were focusing on the problem, or engaged in mind-wandering. A means of addressing this problem is discussed in Section 8.8.4.

8.8 Implications and future research

The results of these studies have several implications—not only for the research, but for industry, and for individuals. Each will be addressed separately.

8.8.1 Insight and creativity research

From the findings of the current thesis, a number of important recommendations for improving the research can be made, including the need to collect self-report data on solution type. Although this method is currently being utilised by a few researchers, this study underlines the importance of incorporating self-report data on solution type into all insight research. Another suggestion is to filter out people who tend not to have insights (rarely, or not aware they have them) from experimental research. Investigators can achieve this through using the brief self-report scale (DIS) that was developed in the course of this thesis. The DIS can easily be incorporated into studies, whether they are experimental, questionnaires, or other designs. This will allow researchers to extend the
kind of data they collect. It can also be used by creative researchers investigating the link between different types of creativity, including insight.

8.8.2 Industry

A crucial outcome of research is the application of the findings to industry practice. Concepts obtained from insight research have much to offer industry across all sectors, given the pre-eminence now accorded to innovation in business. The shift from a labour-based workforce to creating new and innovative ideas to survive, means innovation is now important to businesses, corporations, and governments alike for extending and improving technologies and policies. As argued in the introduction to this thesis, relying on analytical thinking limits the creative process. Analytical thinking draws on close associative memories that are already laid down in memory; in other words, these are timeworn ideas. Insight is the ability to creatively move beyond old associations into new ways of thinking and problem solving. Insights are likely to be a more creative way of solving problems, and therefore contribute significantly to innovative ideas. This study has done preliminary work on identifying insightful people. This information can be used to recruit innovative people into positions that require them to pioneer new ideas.

Ideally, future research should investigate whether it is possible to train people to have (more) insights. The understandings that this study has generated show that developing mindfulness and flow states can help with this. Furthermore, through the qualitative findings, it was found that people need time and space to relax in order to have insights. Identifiable traits that are less malleable include those who score highly on openness, and are conscientious, to a degree. In contrast, if analytical people are important to the job role, these people can be identified as highly conscientious and introverted.
8.8.3 Individuals

The results of the study can also be applied to individuals. The qualitative results revealed that insights occur most commonly at night-time (before bed, during sleep, after waking). As a result, it is recommended that people find a method of recording these insights—such as in a journal or notebook, or on a smartphone that they keep beside their bed. Some may find that other times of the day are better for producing insights; consciously being aware of when insights happen will allow people to predict when they are likely to occur. Awareness of insights may also encourage more or greater awareness of them.

Mindfulness and flow both predicted insight; and while they were not mutually exclusive, the relationship between these two constructs was strong. It is possible that practising mindfulness—for example, through meditation—will lead to a quieter mind by reducing inner chatter. This achievement could help in increasing flow experiences, leading to further insights. The flow process circumvents conscious analytical thoughts and allows access to more automatic unconscious thoughts—or extension memory, as described by Baumann and Kuhl (2002). Insights come from the unconscious (Bowden et al., 2005), so it makes sense that practices or experiences that allow direct access should also lead to an increase in insights. Again, this needs further validation, although preliminary results from the current study suggest that this will help.

8.8.4 Future research

The current study has emphasised the importance of individual differences in insight experiences. Through answering the question on individual differences, it has also forged a new avenue of research into insight.

Further work needs to be completed on both state and traits associated with insight. One way to confirm the current qualitative “state” findings without relying on recall is by employing ESM (Csikszentmihalyi, Larson, & Prescott, 1977). ESM is a
methodology used to gather data on people’s experiences while interacting with their environment. This method has the strength of ecological validity (Csikszentmihalyi & Larson, 1987), and does not require reliance on memory, as experiences are recorded in-situ (Hormuth, 1986). Traditionally, the participant was supplied with a pager that emitted a signal at a random schedule, alerting them to record current events (Csikszentmihalyi & Larson, 1987). These events may include mood, symptoms of illness, or heightened concentration levels (e.g. flow states) at work. The data is recorded on an experience-sampling form that is designed to be quickly and easily completed. Nowadays, ESM data can be recorded on purpose-made apps for iPhones and Android devices.

The ESM method could be modified to capture insight experiences as they happen. This could be achieved by using a participant experience-driven method—when the insight occurs, the participant opens the app and records their insight, as opposed to being signalled to record an experience. Additional information could include the time, place, emotions before and after the insight, the magnitude of the insight (i.e. range from small Aha! moment to an epiphany), did it solve the problem, and other information pertinent to the experience. The results from such a study would be valuable in terms of confirming the results of the current study, and for providing further information on the contexts in which insights occur.

Future research on the DIS could include an extension of the scale to include a multi-factorial design. The scale could also be designed to be flexible in its use as not only a trait measure, but also a state measure. Like mindfulness which is approached as a construct that is a state, a trait, and a skill, insight is likely to also fit into the skill domain. The DIS may additionally measure whether this skill increases over time. However, further research is required to investigate whether insight is a skill that can be
trained or increased. A suggestion offered by the current research is that mindfulness practice may increase the frequency and/or intensity (i.e. epiphanies) of insights.

Future studies should also investigate other dispositions that may predict insight. Important to complex problem solving is having the motivation to stay with the problem until a solution is found. Although motivation is a factor in disposition to flow, isolating the type of motivational orientation would be of interest. Individual differences in motivation relate to extrinsic and intrinsic orientations (Amabile, Hill, Hennessey, & Tighe, 1994). Extrinsic motivation comes with competitiveness, recognition, money, evaluation, and other external incentives. Intrinsic motivational factors, such as competence, self-determination, task involvement, interest, curiosity, and enjoyment are likely to be most important to insight problem solving. Motivation can also be situational, in which the task itself brings about motivation (Guay, Vallerand, & Blanchard, 2000), is related to flow (Keller & Bless, 2008), and is also likely to be a predictor of insight problem solving.

It is also important to acknowledge that while all people have the capacity to work through problems analytically, not all people are able to have insights. Although it was suggested that these people should be controlled for, they could also be the focus of further research. Lack of insight ability may be related to motivation or other skills used to solve complex problems that lead to non-insight solutions.

A final important topic for future research is how insight skills can be improved. It was suggested that mindfulness may lead to flow states that increase insights—whether the frequency or the depth of insights (i.e. profound epiphanies). The current results were not able to conclusively support this theory, but they do lend support for further investigation.
8.9 Conclusion

The process of insight is an unconscious restructuring of currently held assumptions that result in the answer or solution popping suddenly into the conscious awareness of the solver, leaving a subjective feeling of *Aha!* This thesis was concerned with understanding the characteristics and beginning to develop a profile of the insightful person. Based on the findings, insightful people enjoy effortful thinking, but also rely on their intuition. They tend to orient their attention to the present moment; and when solving a difficult problem, they begin without a clear goal, become absorbed by the activity, enjoy it for the sake of the challenge, lose track of time, and become completely absorbed. They have the ability to see the results of possible actions and to deal with internal cognitive conflicts. Insightful people are open to new experiences and are conscientious. Although they tend to have a higher predisposition to arousability, particular activities and environments that lower cortical arousal (e.g. night time, relaxation, quietness, in the shower, and travelling) can possibly trigger an insight. It appears that not all people are capable of having insights, which is why this is an avenue for future research. This is the first study to reveal a comprehensive profile of the insightful person, and to show that not all people experience this phenomenon.
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Appendix A

Participant Information

Who are we?

Charles Sturt University (CSU) was established in 1989 as a multi-campus institution and has grown into a dynamic and progressive university that is well-known for its innovative approach to education and applied research. Through our network of campuses, and in close association with industry, professions and government, CSU is committed to maintaining a course and research profile that meets the needs and supports the aspirations of our communities, and contributes to the enrichment of our regions.

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Why are we doing this?

My name is Linda Ovington; I am conducting research as part of my PhD in Psychology at Charles Sturt University in Wagga Wagga, New South Wales. This study is concerned with how individuals solve problems. More specifically, how the solution arises in the mind. Some people work through a particular problem until they eventually arrive at a solution. Others may tackle a problem with no solution in sight and then, often at a time when the problem is not on their mind, the solution suddenly appears without warning. The former solution type is often termed ‘analytical’ problem solving, whereas the latter type of solution is often termed as an ‘insight’. Most people will often find solutions to problems both ways; however some individuals may be more prone to one of these styles. What I am interested in is the style that you solve problems and how this may relate to your personality and other abilities you poses.

What are we asking of you?

This research involves the completion of an anonymous questionnaire. The questions are in regards to the way in which solutions to problems appear to you (gradually or
suddenly) not on how you go about solving problems specifically. The remainder of the questions are in regards to your personality and your general ways of thinking. The questionnaire takes approximately 20 – 30 minutes to complete. Since the task and questions are mild in nature, it is not anticipated that you will experience any adverse effects arising from the activity. If you nevertheless find that some questions elicit thoughts that bring distress, please end the task immediately. In such instances, you might also want to call Lifeline on 13 11 14.

Who can participate?

We are seeking participants who fulfil the following criteria:
• Over 18 years of age.

Confidentiality/Privacy:

The questionnaire is completely anonymous. All data collected will be stored on a password protected computer or the duration of the study. Information that identifies individual participants will not be published. All data will be kept for five years (as required by research protocols), after which it will be deleted. The data collected will be used for the purpose of my PhD and could possibly form the basis of a journal article.

Participation:

Your participation in this research is voluntary. Thus, you can withdraw from the questionnaire at any time without being subject to any penalty or discriminatory treatment. However, responses cannot be withdrawn once the survey has been submitted due to the anonymous nature of the questionnaire.

NOTE: The School of Psychology Ethics Committee at Charles Sturt University has approved this project. If you have any complaints or reservations about the ethical conduct of this project, you may contact the Committee through the Secretary: The Secretary School of Psychology Ethics Committee Charles Sturt University Panorama Avenue Bathurst NSW 2795 PH: 02 63384580 Email psychethics@csu.edu.au

Any issues you raise will be treated in confidence and investigated fully and you will be informed of the outcome. Approval Code: 113/2012/65

Your involvement in the research is entirely voluntary. You are free to withdraw from the research at anytime without penalty.
Appendix B

Scales in order of appearance in the questionnaire

Part A:

1. What is your gender?
   - Female
   - Male

2. What is your age?
   - 18 to 24
   - 25 to 34
   - 35 to 44
   - 45 to 54
   - 55 to 64
   - 65 to 74
   - 75 or older

3. What is the highest level of education you have completed?
   - High School
   - TAFE certificate/diploma
   - Bachelor’s degree
   - Master’s degree
   - Doctoral
   - Other (please specify)

4. Which of the following best describes your current occupation?
   - Management Occupations
   - Business and Financial Operations Occupations
   - Computer and Mathematical Occupations
   - Architecture and Engineering Occupations
   - Life, Physical, and Social Science Occupations
   - Community and Social Service Occupations
   - Legal Occupations
   - Education, Training, and Library Occupations
   - Arts, Design, Entertainment, Sports, and Media Occupations
   - Healthcare Practitioners and Technical Occupations
   - Healthcare Support Occupations
   - Protective Service Occupations
   - Food Preparation and Serving Related Occupations
   - Building and Grounds Cleaning and Maintenance Occupations
   - Personal Care and Service Occupations
   - Sales and Related Occupations
   - Office and Administrative Support Occupations
   - Farming, Fishing, and Forestry Occupations
• Construction and Extraction Occupations
• Installation, Maintenance, and Repair Occupations
• Production Occupations
• Transportation and Materials Moving Occupations
• Other (please specify)

5. In which state is your permanent residence?
• NSW
• VIC
• QLD
• SA
• WA
• NT
• TAS
• ACT

Part B:

For the purpose of this study, an ‘insight’ is the moment in which an idea or a solution to a problem arises suddenly and unexpectedly. Insights often occur when working on a problem for a long period of time without a solution being found and then without any warning the solution comes unexpectedly. An insight may occur while working on the problem or when not thinking about the problem at all (i.e. while attending to something different entirely). The purpose of this part of the survey is to explore experiences of insights you may have had.

6. First of all, have you ever had an insight (a solution or idea which came unexpectedly)?
   • No
   • Yes

7. Do they generally occur at a particular place?
   • No
   • Yes
   • If yes, where?

8. Do you consider your ‘insights’ to be more or different to the explanation given above?
   • No
   • Yes
   • I consider my insights to be
9. **Dispositional Insight Scale (full questionnaire)**

Scale: 1 = Strongly disagree to 7 = Strongly agree

1. When solving a problem, the solution is often not what I expected
2. When solving a problem, I often find solutions come when I don’t think about it (i.e. unexpectedly)
3. I find solutions to problems come when I sleep on it
4. I tend to solve problems unconsciously
5. Thinking about problems just gets in the way of finding answers
6. Ideas pop into my mind when I’m doing mundane activities (e.g. Housework)
7. Often when I’m trying to solve a difficult problem the answer comes when I wake up in the morning
8. Focusing on a problem restricts my ability to find a new solution
9. When ideas don’t come I do something else
10. When a solution pops into my mind, I feel a sense of excitement
11. I’m someone who experiences A-ha! moments
12. I find problem solving is all or none, the solution either comes all at once or not at all
13. In my experience problems tend to work themselves out
14. I have awoken in the night after finding a solution to a problem in my sleep
15. I find solutions to problems while going on a relaxing walk or a similar activity

10. **Cognitive Style Index**

Scale: 1 = very strong disagreement to 9 = very strong agreement

1. I would prefer complex to simple problems
2. I like to have the responsibility of handling a situation that requires a lot of thinking

3. Thinking is not my idea of fun

4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities

5. I try to anticipate and avoid situations where there is likely chance I will have to think in depth about something

6. I find satisfaction in deliberating hard and for long hours

7. I only think as hard as I have to

8. I prefer to think about, small daily projects to long-term ones

9. I like tasks that require little thought once I’ve learned them

10. The idea of relying on thought to make my way to the top appeals to

11. I really enjoy a task that involves coming up with new solutions to problems

12. Learning new ways to think doesn’t excite me very much

13. I prefer my life to be filled with puzzles that I must solve

14. The notion of thinking abstractly is appealing to me

15. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought

16. I feel relief rather than satisfaction after completing a task that required a lot of mental effort It’s enough for me that something gets the job done; I don’t care how or why it works

17. I usually end up deliberating about issues even when they do not affect me personally

18. My philosophy is that it is better to be safe than risk being sorry

19. When making a decision, I take my time and thoroughly consider all relevant factors
20. I get on best with quiet, thoughtful people
21. I would rather that my life was unpredictable than that it followed a regular pattern
22. Most people regard me as a logical thinker
23. To fully understand the facts I need a good theory
24. I work best with people who are spontaneous
25. I find detailed, methodical work satisfying
26. My approach to solving a problem is to focus on one part at a time
27. I am constantly on the lookout for new experiences
28. In meetings, I have more to say than most
29. My ‘gut feeling’ is just as good a basis for decision making as careful analysis
30. I am the kind of person who casts caution to the wind
31. I make decisions and get on with things rather than analyse every last detail
32. I am always prepared to take a gamble
33. Formal plans are more of a hindrance than a help in my work
34. I am more at home with ideas rather than facts and figures
35. I find that ‘too much analysis results in paralysis’

11. Freiberg Mindfulness Inventory

The purpose of this inventory is to characterise your experiences of mindfulness. Please use the last 30 days as the time-frame to consider each item. Provide an answer for every statement as best you can. Please answer as honestly and spontaneously as possible. There are neither ‘right’ nor ‘wrong’ responses. What is important to us is your own personal experience.

Scale: 1 = Rarely; 2 = Occasionally; 3 = Fairly often; 4 = Almost always

1. I am open to experience of the present moment
2. I sense my body, whether eating, cooking, cleaning or talking
3. When I notice an absence of mind, I gently return to the experience of the here and now

4. I aim to appreciate myself

5. I pay attention to what’s behind my actions

6. I see my mistakes and difficulties without judging them

7. I feel connected to my experience in the here-and-now

8. I accept unpleasant experiences

9. I am friendly to myself when things go wrong

10. I watch my feelings without getting lost in them

11. In difficult situations, I can pause without immediately reacting

12. I experience moments of inner peace and ease, even when things get hectic and stressful

13. I am impatient with myself and others

14. I am able to smile when I notice how I sometimes make life difficult

12. Ten-Item Personality Inventory

Here are a number of personality traits that may or may not apply to you. Please indicate the extent to which you agree or disagree with the statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

1 = Strongly disagree to 7 = Strongly agree

1. I see myself as:
   2. Extraverted, enthusiastic
   3. Critical, quarrelsome
   4. Dependable, self-disciplined
   5. Anxious, easily upset
   6. Open to new experiences, complex
   7. Reserved, quiet
   8. Sympathetic, warm
   9. Disorganized, careless
   10. Calm, emotionally stable
   11. Conventional, uncreative
13. Positive and Negative Affect Scale

This scale consists of a number of words and emotions. Read each item and then mark the appropriate answer. Indicate to what extent you generally feel this way, that is, how you feel on the average. Use the following scale to record your answers:

Scale: 1 = Very slightly or not at all; 2 = A little; 3 = Moderately; 4 = Quite a bit; 5 = Extremely

1. Interested
2. Irritable
3. Distressed
4. Alert
5. Excited
6. Ashamed
7. Upset
8. Inspired
9. Strong
10. Nervous
11. Guilty
12. Determined
13. Scared
14. Attentive
15. Hostile
16. Jittery
17. Enthusiastic
18. Active
19. Proud
20. Afraid
14. **Arousability Predisposition Scale**

This questionnaire deals with a number of common behaviours and self-perceptions. For each question you should select the response which best describes you and your behaviours. You can select from among the following response alternatives: 1 = Never (or almost never); 2 = Seldom; 3 = Occasionally; 4 = Frequently; 5 = Always (or almost always)

1. I am a calm person
2. I get flustered if I have several things to do at once
3. Sudden changes of any kind produce an immediate emotional effect on me
4. Strong emotions carry over for one or two hours after I leave the situation which caused them
5. I am restless and fidgety
6. My mood is quickly influenced by entering new places
7. I get excited easily
8. I find that my heart keeps beating fast for a while after I have been “stirred up”
9. I can be emotionally moved by what other people consider to be simple things
10. I startle easily
11. I am easily frustrated
12. I tend to remain excited or moved for a long period of time after seeing a good movie

15. **Final open-ended question:**

Are there any concluding remarks you would like to make on your experiences of insight?
### Appendix C

**Table A.1**

*Correlations Amongst all Variables in the Studies*

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<thead>
<tr>
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*Note.* DIS = Dispositional Insight Scale; CSI = cognitive style index; APS = arousability predisposition scale; FMI = Freiburg Mindfulness Inventory; NFC = Need for Cognition.  
*p < .01; **p < .001
## Appendix D

Table A. 2

*Insight Solution Scale Exploratory Factor Loadings for the Original 15 items*

<table>
<thead>
<tr>
<th>Item</th>
<th>EFA factor loadings</th>
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<tbody>
<tr>
<td>1. When solving a problem, the solution is often not what I expected</td>
<td>.42</td>
</tr>
<tr>
<td>2. When solving a problem, I often find solutions come when I don’t think about it (i.e. unexpectedly) *</td>
<td>.68</td>
</tr>
<tr>
<td>3. I tend to solve problems unconsciously *</td>
<td>.67</td>
</tr>
<tr>
<td>4. Thinking about problems just gets in the way of finding answers</td>
<td>.48</td>
</tr>
<tr>
<td>5. Ideas pop into my mind when I’m doing mundane activities (e.g. Housework) *</td>
<td>.65</td>
</tr>
<tr>
<td>6. Often when I’m trying to solve a difficult problem the answer comes when I wake up in the morning</td>
<td>.41</td>
</tr>
<tr>
<td>7. Focusing on a problem restricts my ability to find a new solution</td>
<td>.48</td>
</tr>
<tr>
<td>8. When ideas don’t come I do something else</td>
<td>.41</td>
</tr>
<tr>
<td>9. I find solutions to problems come when I sleep on it</td>
<td>.42</td>
</tr>
<tr>
<td>10. When a solution pops into my mind, I feel a sense of excitement</td>
<td>.43</td>
</tr>
<tr>
<td>11. I’m someone who experiences A-ha! Moments *</td>
<td>.54</td>
</tr>
<tr>
<td>12. I find problem solving is all or none, the solution either comes all at once or not at all</td>
<td>.23</td>
</tr>
<tr>
<td>13. In my experience problems tend to work themselves out</td>
<td>.32</td>
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<tr>
<td>14. I have awoken in the night after finding a solution to a problem in my sleep</td>
<td>.39</td>
</tr>
<tr>
<td>15. I find solutions to problems while going on a relaxing walk or a similar activity*</td>
<td>.59</td>
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</table>

* Item retained