TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

THINKING ABOUT THINKING: INSIGHTS FOR JUNIOR OFFICERS

IN THE

NEW ZEALAND DEFENCE FORCE

by

Roger Margetts

A business research report submitted to the Victoria University of Wellington in partial fulfilment of the requirements for the degree of Master of Business Administration Victoria University of Wellington 2016

Victoria University of Wellington
2016

ABSTRACT

As military thinkers our thinking is influenced by cognitive shortcuts or heuristics, and flawed by the associated predictable errors or biases. We are largely unaware of these effects and how they influence our decision outcomes. The current research seeks to create an approach that develops an awareness of heuristics and biases, and their effects on decision making. The aim is to answer two questions: (1) Have heuristics and biases important to the Military Appreciation Process (MAP) been identified? If so, have steps been formally taken to include heuristics and biases in the training and use of the MAP?; (2) Do instructors of junior officers believe that a heuristics and biases checklist could be developed to improve the use of the MAP by junior officers?

A review of the heuristics and biases literature revealed two relevant outcomes. One was that the body of original and updated academic research on heuristics and biases and the effects on decision making remain valid. The second is that other military organisations acknowledge these effects and discuss measures to address them. However they have not taken the next step and formally enacted these measures.

Exploratory qualitative research was undertaken to establish perspectives and understandings of the MAP by instructors and a key informant. Semi-structured interviews that incorporated a card sort exercise were conducted to identify which biases matched each step in the MAP. Participants strongly believe there is benefit and usefulness in developing a checklist that addresses the heuristics and biases associated with using the MAP.

The results of the card sort exercise were analysed against criteria in three reference models – consensus, theoretical (based on a synthesis of the literature), and best fit. Parameters of fit were analysed at four levels. The analysis is summarised in a deceptively simple model that forms the basis of a usable checklist.

The current research contributes to the heuristics and biases literature as it relates to military decision making processes. The mutual understanding of key heuristics and biases, and their match to individual steps of the MAP is seen as an important resource in the development of a checklist. Both instructors and a key informant believe that the checklist will assist them in improving the use of the MAP by junior officers.

ACKNOWLEDGEMENTS

I would like to acknowledge the support, guidance and encouragement I have received while conducting my MBA and this research report which is its culmination.

Firstly, Dr Jim Sheffield deserves particular mention and I include this email he posted to his students at the commencement of my MBA journey and which accurately describes the interaction between us:

"I'd like to believe that student engagement underpins the success of the MBA programmes at Harvard and Victoria. MBA programmes are inclusive - faculty and students are expected to present diverse points of view. Engagement and learning are facilitated when (1) faculty employ collaborative yet robust governance processes; (2). Students take responsibility for their own learning. *Motivation and time management are significant factors in student success (or lack of success).*"

(MMBA508: Problem Solving & Decision Making – Welcome 25 February 2015)

Secondly, I would like to thank my full-time MBA friends who started with me on this journey and the support we drew from each other. I also acknowledge the many other students and lecturers who I have had the pleasure to cooperate and learn from.

Thirdly, the participants involved in the research project who provided their time in a particularly busy period and my superiors who gave access and provided their support.

Fourthly, I would like to thank the New Zealand Army who awarded me a Kippenberger scholarship and for whom I hope this research project is of benefit and use.

Finally and most importantly I want to thank; my wife Kathy for her incredible support and having my back, my daughter Majken for her awesome editing skills and ideas and my son Jordan for his ability to make me *keep it real*.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

This first chapter presents the background and context of the research area as well as the problem that this research project seeks to address. It also presents the motivations behind the choice of this topic. Lastly, it details the structure of this report from the questions being investigated, to the findings and contribution to the research area.

1.1 Research Background

"Tell me what you know. Then tell me what you don't know, and only then can you tell me what you think. Always keep those three separated" (Colin Powell as cited in Lehrer, 2009, p. 236).

The quote from Colin Powell acknowledges the blind spots we have within our decision making. As decision makers we do not like gaps and so can find ourselves unwittingly involved in heuristics and biases. We do this as a means through which to take short cuts in thinking and manage the uncertainty such gaps create (Gilovich, Griffin, & Kahneman, 2002).

My interest in heuristics and biases came initially from an assignment I produced for an MBA course in managerial decision making which fostered critical and creative thinking. The assignment was a critical reflection of a decisive moment and later published under the title *'The Soldier: My Decisive Moment in Afghanistan'* (Sheffield & Margetts, 2016).

'The Soldier' made me think about thinking and to appreciate just how flawed our minds are, but that there are ways to overcome these (Lehrer, 2009). This is what I am seeking to do within the context of the Military Appreciation Process (MAP), which is the decision making process employed by the New Zealand Army.

1.2 Research Objectives

The aim of this research is to look at how the MAP can be better applied and used by junior officers through awareness of the heuristics and biases at play in the application of the MAP. As pointed out by Lehrer (2009), there is no secret recipe for decision making however, awareness and commitment to avoiding the errors we know about is a good place to start.

1.3 Research Questions

This report answers the two questions listed below in order to create an approach that develops awareness of heuristics, biases and their impact on the operational command decision processes employed by the NZ Army:

1. *Have heuristics and biases important to the Military Decision Making Process (MDMP) been identified? If so, have particular heuristics and biases been linked to specific steps in process models such as the Joint Military Appreciation Process (JMAP) employed by the Australian Defence Forces, or the Military Appreciation Process (MAP) employed by the NZ Army? Finally, have steps been taken to ensure awareness of heuristics and biases in the training and use of the JMAP and MAP?*

2. *Do instructors of junior officers in the NZ Army acknowledge that the use of the MAP is subject to bias? Do instructors tend to agree with an allocation (based on a theoretical reference model synthesised from the literature) of key heuristics and biases to specific steps of the MAP? Can the instructors devise a better allocation for the NZ Army? Do the instructors believe that a heuristics and biases checklist could be developed to improve the use of the MAP by junior officers?*

1.4 Outline of the Report

This report is structured to reflect the V-model adapted from Sheffield (2005), as shown in figure 1. The chapters conform to this model with research intentions shown on the left and research outcomes on the right. These are linked horizontally by; Why, What and How so that the report fits together in a coherent manner.

Chapter one describes the background to the research topic and why it was selected. It also contains the objectives, research questions and the structure of the report.

Chapter two reviews the literature. Key academic articles on heuristics and biases are discussed, along with military academic research papers that acknowledge that heuristics and biases are at play in Military Decision Making Processes (MDMP). The aim of this chapter is to highlight the gap in the research and develop a useful theoretical model to examine.

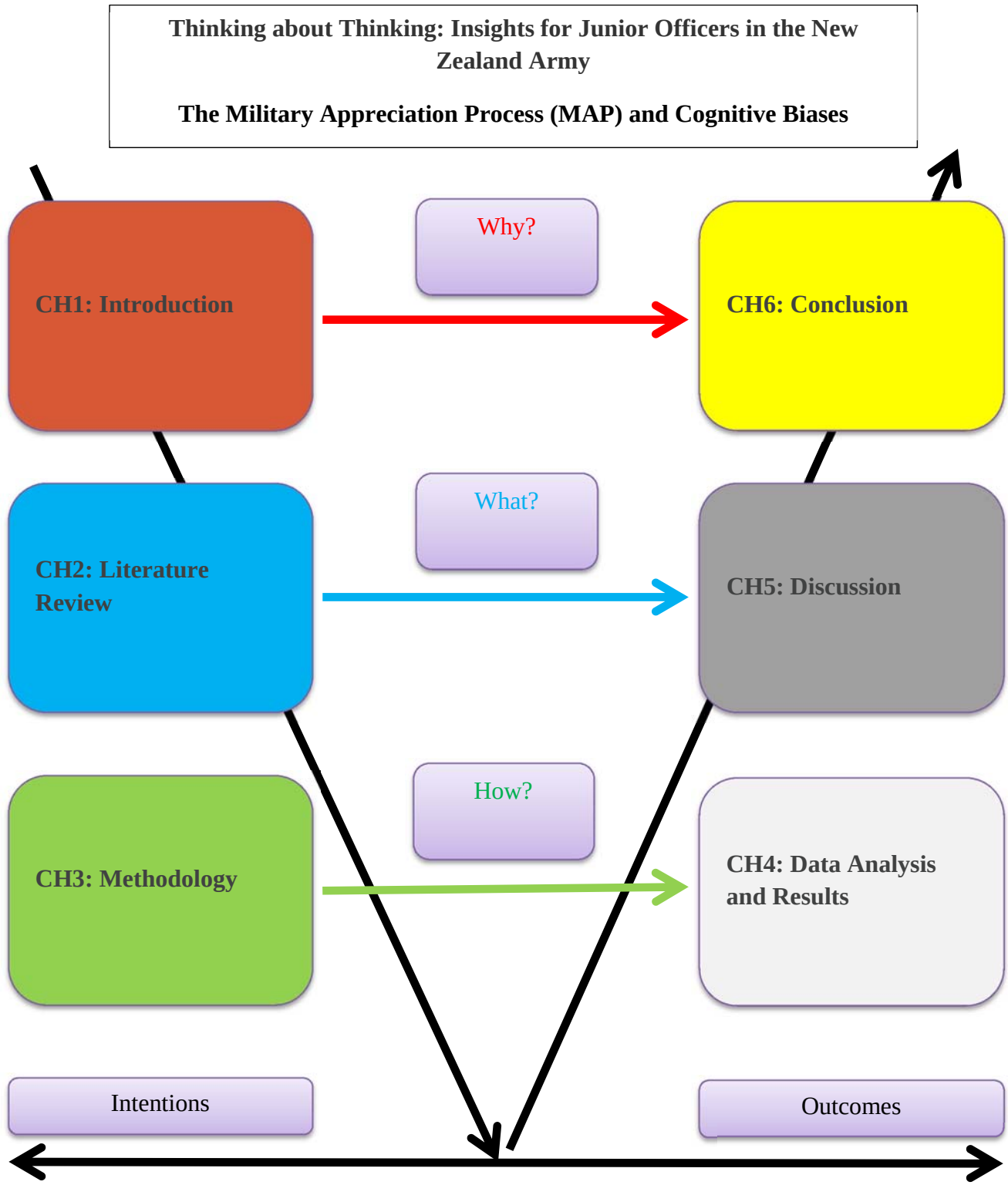
Chapter three (methodology) provides the research philosophy and methods employed to gather the evidence to test the model. This informs the basis for the data analysis in the following chapter.

Chapter four is data analysis and results. This contains the analysis of the collected data from the interviews and card sorting activities. These results and supporting tables form the basis for the following chapter.

Chapter five is the discussion and it is here that the interpretation and discussion of the data analysis is used to address the gap in the existing literature. Also the research model is critiqued and extended, and the implications of the findings are explained.

Chapter six is the conclusion which completes the report by concluding a summary of key findings and answering of the initial research questions. Limitations are acknowledged and recommendations for future research are made.

Figure 1: V-Model Decision Framework (Sheffield, 2005)



CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents a selective review of the heuristics and biases literature. The focus is on recent military papers that discuss the impact of heuristics and biases on military planning processes, and the suggested ways of addressing them. The review seeks to determine if the 44-year old heuristics and biases research programme remains relevant, and whether it has practical relevance to thinking more rationally about military planning processes. This chapter ends by identifying a research gap, and a MAP model in which each step is matched to relevant biases. It is expected that this model constitutes a valuable resource in developing a heuristics and biases checklist useful for improving the instruction and use of the MAP.

2.2 The Initial Research

2.2.1 Kahneman, Slovic, & Tversky (1982). *Judgment under uncertainty: Heuristics and biases.* Cambridge; New York: Cambridge University Press.

Kahneman, Slovic, & Tversky (1982) is cited in Google Scholar over 37,000 times and represents arguably the most significant work in this area (Google Scholar, 2016). Kahneman is an acknowledged leader in the field of heuristics and biases and was awarded a Nobel Prize in 2002. This was for his work which integrated insights from his psychological research into the field of economic science, particularly in the area of judgement and decision making under uncertainty (Nobel.org, 2014).

Kahneman, Slovic, & Tversky (1982) is comprised of journal articles from 39 authors that draw together a decade worth of results on research into how people make judgements under uncertainty. The book contains some of the more influential research by the editors: of the 35

papers presented in the book, 12 papers are by Kahneman and Tversky, and four by Slovic and his associates.

The exhaustive research in Kahneman, Slovic, & Tversky (1982) provides considerable evidence about the nature and importance of three heuristics that are commonly employed in decision making judgements under uncertainty (Kahneman et al. 1982):

1. *Representativeness*; which is used when people are asked to judge the probability that an object or event A belongs to (that is, is perceived as representative of) class or process B. For example, a reconnaissance patrol judges if the enemy group they are watching is part of a unit they are targeting, they ask themselves; *how similar this group is to their image of the target group?* This means the greater the similarity the greater the perceived probability.

2 *Availability;* of instances or scenarios, which is used when people are asked to assess the frequency of a class or plausibility of a particular development. For example, military personnel in battle may asses the risk of being wounded by thinking about how many people they know that have been wounded.

3. *Adjustment;* from an anchor, which is used in numerical prediction when a relevant value is available. For example you make estimates for values based on an initial value (from past events, random assignment, or whatever information is available) and typically make insufficient (poor) adjustments from that anchor when settling on the final value.

The cognitive shortcuts or heuristics, and the associated predictable errors or biases described at length in Kahneman, Slovic, & Tversky (1982) provide a cogent picture of the operation of the brain. (Table 1).

Table 1: Heuristics and Biases (adapted from Kahneman, Slovic, & Tversky, 1982)

Heuristic/Bias
Representativeness Heuristic
1. Insensitivity to prior probability of outcomes.
2. Insensitivity to sample size.
3. Misconceptions of chance.
4. Insensitivity to predictability.
5. The illusion of validity.
6. Misconceptions of regression.
Availability Heuristic
7. Retrievability instances.
8. Effectiveness of a search set.
9. Imaginability.
10. Illusory correlation.
Adjustment Heuristic
11. Insufficient adjustment.
12. Evaluation of conjunctive and disjunctive events.
13. Assessment of subjective probability distributions.

The relevance of Kahneman, Slovic, & Tversky (1982) can be seen in the work by Bazerman and Moore (2009) (see Table 2). Biases in bold are shared between both Table 1 and Table 2. The close correspondence is of particular note considering that Bazerman and Moore (2009) is a 9th edition of a book with the same name, which suggests that they had plenty of time to change their ideas and move away from Kahneman, Slovic, & Tversky (1982). This suggests that the conceptual and empirical evidence on the impact of heuristics and biases on judgment and decision making, accumulated over a period of 50 years, is of current theoretical and practical value (Fiedler & von Sydow as cited in Eysenck & Groome, 2015).

Table 2: Heuristics and Biases (adapted from Bazerman & Moore, 2009)

Heuristic/Bias	**Description**
Availability Heuristic	
1. **Ease of recall**	You judge things that are more easily recalled from memory, based on vividness or recency to be more numerous than events of equal frequency that are less easily recalled.
2. **Retrievability**	You are biased in your assessments of the frequency of events based on how your memory structures affect the search process.
Representativeness Heuristic	
3. **Insensitivity to base rates**	If assessing likelihood of outcomes, you tend to ignore base rates if any other descriptive information is provided, even if it is irrelevant.
4. **Insensitivity to sample size**	If assessing the reliability of sample information, individuals frequently fail to appreciate the role and sample size.
5. **Misconceptions of chance**	You expect that a sequence of data generated by a random process will look random, even when the sequence is too short for those expectations to be statistically valid.
6. **Regression to the mean**	You tend to ignore the fact that extreme events tend to regress to the mean on subsequent trials.
7. **Conjunction fallacy**	You falsely judge that two events co-occurring are more probable than a more global set of occurrences of which the occurrence is a subset.
Confirmation Heuristic	
8. The confirmation trap	You tend to seek confirmatory information for what you think is true and fail to search for contrary evidence.
9. **Anchoring**	You make estimates for values based on an initial value (from past events, random assignment, or whatever information is available) and typically make insufficient adjustments from that anchor when establishing a final value.
10. **Conjunctive and disjunctive events bias**	You show a bias towards overestimating the probability of conjunctive events and underestimate the probability of disjunctive events.
11. Overconfidence	You tend to be overconfident of the infallibility of your judgements when answering moderately to extremely difficult questions.
12. **Hindsight and the curse of knowledge**	After finding out whether or not an event happened, you tend to overcome the degree to which you would have predicted the correct outcome. Also you fail to ignore information you have that others don't when predicting others' behavior.

2.2.2 Summary

The conclusion from this work is that under conditions of uncertainty you will make decisions based on the use of decision making shortcuts. The impact of these shortcuts is detailed in the research on the heuristics and biases listed in Tables 1 and 2. Note that heuristics and biases both enable and constrain decision behaviour, and may to some extent be managed to mitigate less than optimal or flawed military decision making. However, given that the research is based on research that is nearly 50 years old, it is necessary to seek additional verification as to the validity of this work as a starting point for training and development of military personnel.

2.3 The Updated Research

2.3.1 Gilovich, Griffin, & Kahneman (2002). *Heuristics and biases: The psychology of intuitive judgment*. London, England: Cambridge University Press.

Published to coincide with the award of the Nobel Prize, Gilovich, Griffin, & Kahneman (2002) continues the research programme described in Kahneman, Slovic, & Tversky (1982). The book is divided into three parts. The papers in Part I build on classical themes to demonstrate that the original research programme continues to offer additional depth. The papers in Part II illustrate new theoretical approaches to heuristics and biases, again showing how the research builds conceptual and empirical depth. In contrast, the papers in Part III illustrate new practical approaches in applied settings. Heuristics are to be embraced, while the negative impacts of biases are to be mitigated.

Gilovich, Griffin, & Kahneman (2002) critique research on heuristics and biases in the face of four common arguments (Gilovich et al. 2002):

1. *We cannot be that dumb* as we get through life well enough. This blanket view is held to be overly pessimistic of the average person's ability to make sound and effective

judgements. Motor memory, employed while driving your usual route to work, is unthinking, as opposed to semantic memory, employed when recalling trigonometry from school, is more difficult. The researchers in Gilovich, Griffin, & Kahneman (2002) show just how context counts. When ecological validities are high, heuristics are generally useful, but common and profoundly important exceptions are still to be found. Also, the critique continues, those who make this argument seem often to advance the notion that people's judgements are hardly ever biased.

2. *It's all parlour games.* This view suggests that the experiments commonly employed in research on heuristics and biases do not address real world decision making. The controlled laboratory environments are claimed to be so far removed from the real world and that they are irrelevant. Worse, the impact of heuristics and biases is due to the artificiality of the laboratory environment. This view suggests that judgement outside the laboratory is likely to look far better. The researchers in Gilovich, Griffin, & Kahneman (2002) respond that the motivation for heuristic and bias research came in fact from the existence of biased judgements in the real world.

3. *It's not an error* argument. This charge suggests researchers are holding participants to a statistical standard of rationality that is inappropriate or too high. However, research by various authors in Gilovich, Griffin, & Kahneman (2002) show that meaningful probabilistic statements can be made about unique events and standards of rationality.

4. *Frequencies, good; probabilities, bad.* This is the argument between the normative status of frequency, and subjective probabilities. Proponents claim that assessments of single event probabilities are unnatural and that only a frequency format is consistent with how the mind works. However, the research in Gilovich, Griffin, & Kahneman (2002) shows there is more to biased judgement than an inability to handle probabilities.

It is therefore not enough to simply argue that heuristics and biases disappear if people are allowed to think in terms of frequencies rather than probabilities.

2.3.2 Summary

Kahneman, Slovic, & Tversky (1982), and Gilovich, Griffin, & Kahneman (2002) are part of a research programme dating back to the 1960's that appears sound and relevant today. The newer work acknowledges that perspectives have to some extent changed, and broadened. This leads into discussion on the systems thinking approach of fast and slow thinking where fast thinking is initial and reflexive, and slow thinking more considered and rational (Kahneman, 2011).

2.4 Kahneman and Gigerenzer

2.4.1 Kahneman, (2011). *Thinking, fast and slow.* New York, NY: Farrar, Straus and Giroux.

Gigerenzer, (2014). *Risk savvy: How to make good decisions*. London, England: Penguin Publishing Group.

Kahneman (2011), and the heuristics and bias research programme as a whole, may face its greatest critique from Gigerenzer (2014).

Kahneman (2011) models decision making using: System 1 thinking (thinking fast) where shortcuts using heuristics are open to bias due to emotion leading to poorer decisions; and System 2 thinking (thinking slow) which is more logical and provides better decisions. To make these better decisions he argues that people should use System 2 or use smart defaults to guide people in that direction (Kahneman, 2011).

Gigerenzer (2014) disagrees with Kahneman, advancing that System 1, in practice, is often correct when System 2 fails. He argues that System 2 is limited by our working memory and that many of our complex decisions in life go beyond what this working memory can deal with. This means that even though we cannot verbalise how we came to a System 1 decision they are sometimes better regardless (Gigerenzer, 2014). Further, Gigerenzer (2014) argues that many who use System 1 thinking inappropriately do so because they lack knowledge of statistics. He argues that through use of basic instructional techniques and learned responses that their decision making would be greatly improved (Gigerenzer, 2014).

2.4.2 Summary

In reviewing all of these stances it can be seen that there is a far more nuanced argument that accommodates both perspectives once the situation is addressed in context. A summary of the possibilities is provided in Lehrer, 2009, pages 232-239. Simple problems require reason (System 2) as anything more than four variables can overwhelm the rational brain. Novel problems also require reason, as we need our working memory to tackle a real dilemma if it really is unprecedented. However, we are blind to knowing what happens outside the Pre-Frontal Cortex. It is our emotions that give us a clue as to what's going on; giving us a visceral representation of the processes we can't see. From this it can be argued that Kahneman (2011) and Gigerenzer (2014), rather than opposing each other, actually complement each other's approach.

Lehrer (2009) is grounded in recent advances in neuroscience, the value of which is freely acknowledged by Kahneman and Gigerenzer. Neuroscience is currently employed in management education to assist decision makers to develop awareness of the strategic value of thinking and emotion, and to select an approach that matches the requirements of the situation (McDonald & Tang, 2014, Sheffield, 2015).

In the context of developing leadership and decision making in military officers, a less complex leader may react with lethal force while a complex leader understands negotiation may be better (Hannah, Balthazard, Waldman, Jennings, & Thatcher, 2013). This includes being able to use other related attributes, skills and self-control that foster the negotiation behaviours. Waldman, Balthazard, and Peterson (2011) also acknowledge both the limitations and possibilities of the brain's malleability and potential for being able to adapt to situations and to apply the appropriate thinking.

2.5 Military Papers

2.5.1 Janser (2007). *Cognitive Biases in Military Decision Making*. Carlisle, PA: U.S. Army War College.

Williams (2010). Heuristics and biases in military decision making. *Military Review, 90*(5), 40.

Dobson-Keeffe & Coaker (2015). *Thinking more rationally: Cognitive biases and the joint military appreciation process*. *Australian Defence Force Journal*, (197), 5-16.

Janser (2007), like Williams (2010) and Dobson-Keeffe and Coaker (2015), adopts the heuristics and biases approach of Kahneman, Slovic, & Tversky (1982). The author makes a strong argument for the impact of heuristics and biases on the MDMP, and on historical American military failures. Janser (2007) does not examine the relative importance of heuristics and biases, nor does he identify which steps in the operational command decision are likely to be greatly impacted by certain biases. While mitigating strategies are not devised or tested, Janser (2007) highlights the issues and possible solutions; and makes five specific recommendations for mitigating bias:

1. *Research*; where effort is made to identify which biases are held by commanders.
2. *Education*; on heuristics and biases are not currently addressed in training and that such education needs to be carried through the development continuum for military officers.
3. *Procedural*; where a checklist could be developed for those biases that are most relevant at each stage of the MDMP.
4. *Training*; where applied psychologists are used as objective observers in training to provide insight and comment on biases.
5. *Organisational*; where an officer on the staff is used as to coach the commander and provide decision support.

Williams (2010), makes a strong argument for the impact of heuristics and biases in the Military Decision Making Process (MDMP). He discusses three heuristics; *representativeness, availability* and *anchoring* and their related biases (see Table 3 below). While these heuristics are drawn directly from the heuristics and biases approach of Kahneman, Slovic, & Tversky (1982), Williams (2010) adds value by providing examples of their applicability to decisions by the US military up to the year 2001. Williams (2010) does not examine the relative importance of heuristics and biases, nor identify which steps in the operational command decision are likely to be greatly impacted by certain biases, nor design and implement training programmes to mitigate bias.

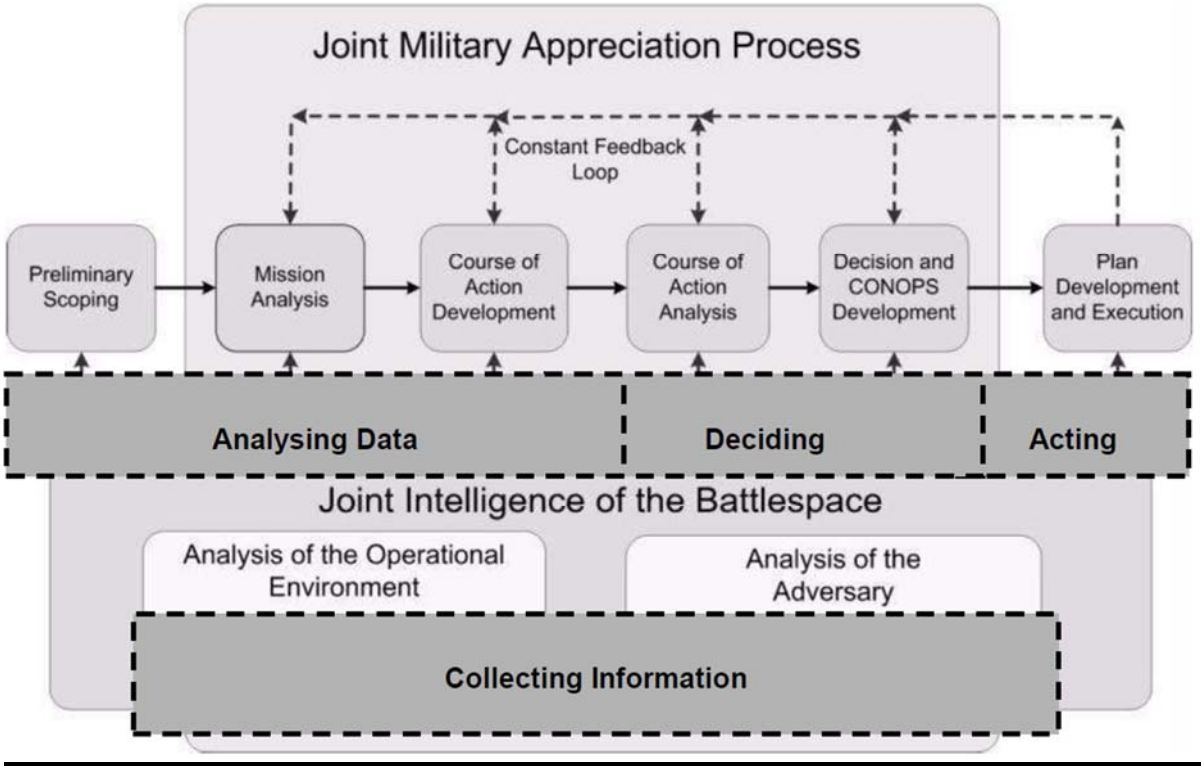
Table 3: Heuristics and Biases (adapted from Williams, 2010)

Heuristic/Bias
Representativeness Heuristic
1. Insensitivity to prior probability of outcomes.
2. Base-rate neglect.
3. Insensitivity to sample size.
4. Misconceptions of chance.
5. Misconceptions of regression.

Availability Heuristic
7. Retrievability instances.
8. Effectiveness of a search set.
9. Imaginability.
10. Illusory correlation.
Adjustment Heuristic
11. Insufficient adjustment.
12. Evaluation of conjunctive and disjunctive events.
13. Assessment of subjective probability distributions.

Dobson-Keeffe and Coaker (2015), examine the Joint Military Appreciation Process (JMAP) used by the Australian Defence Force (ADF) for operational level decision making. They assert that the JMAP is vulnerable to bias and provide a model (reproduced as Fig. 2 below) indicating four areas within the process that contain significant biases; *collecting information*, *analysing data*, *deciding*, *and acting*.

Figure 2: The JMAP (Dobson-Keeffe & Coaker, 2015, p.6)



Dobson-Keeffe and Coaker (2015) contends that:

1. *Collecting information;* is an iterative process conducted throughout the JMAP with error arising from ignoring some and/or too much emphasis on other information.

2. *Analysing data;* post collection, data is analysed with error arising from false associations and faulty problematic thinking.

3. *Deciding;* is central to the selection of the course of action for development into a plan in the JMAP. The error occurs in being able to select the best from a number of alternatives.

4. *Acting;* is the execution of the plan with the error arising in being able to adapt to realities and their impact on what was planned. Also errors can arise from the perception that you can control outcomes thus ignoring real threats or challenges.

Dobson-Keeffe and Coaker (2015) briefly describe each step in the JMAP and the biases thought to impact that step the most (Table 4).

Table 4: Heuristics and Biases (adapted from Dobson-Keeffe & Coaker, 2015)

Grouping/Bias	**Description**
Collecting Information	
1. **Information**	Tendency to gain more information than needed before decision making thus delaying or facing a paralysis brought on by excessive analysis.
2. **Availability**	Decision made relating to the likelihood of an event is moved away from what a normative process would indicate due to what is easily recalled from memory.
3. **Pattern Recognition**	You see patterns where there are none to fill in the gaps and make sense of what you are looking at.
Analysing Data	
4. **Confirmation**	You seek or evaluate information that supports your beliefs and expectations.
5. **My-side**	You assume others hold the same or similar thoughts, beliefs, values or positions as your own.
6. **Illusory Correlation**	You draw erroneous conclusions from the situation and previous experiences.
7. **Over-confidence**	You have a greater belief in abilities or outcomes than what is realistic.
Deciding	
8. **Groupthink**	You allow your thinking to be influenced by the group to which you belong.
9. **Framing**	You frame a problem in such a way that it conforms to how you want to perceive it as opposed to confronting the reality that is.
Acting	
10. **Sunk Cost Effect**	You continue to pursue a course of action once investment of time, money, effort or other resources have been committed.
11. **Illusion of Control**	Where there is an acceptance of uncertainty there is a tendency to believe the environment can be controlled by such actions as under-estimating risk and over-estimating success.

Dobson-Keeffe & Coaker (2015) provide a nuanced description of the difficulties associated with mitigating bias ("de-biasing"). Four strategies are described:

1. *Understanding and recognising bias*; e.g., through the use of checklists.

2. *Promoting lateral and creative thinking*; e.g., through critical thinking techniques.

3. *Ensure critical thinking*; through the use of structured analysis techniques.

4. *Enhance diversity*; through the use of blended teams drawn outside of single specialist disciplines.

In summary, Dobson-Keeffe & Coaker (2015) argue for the need to think more rationally about the JMAP, and discuss biases selected for their importance to each step. This is particularly useful for the current research in that there is considerable overlap between the use of the JMAP by the Australian Defence Forces, and the use of the MAP by the NZ Army.

While the Dobson-Keeffe & Coaker (2015) assignment of heuristics and biases to the JMAP is an excellent start, it needs to be adapted and tested in the context of the MAP. For example, it is important to note that the JMAP is an Army, Navy, and Air Force operational level group process and the training includes group-specific biases (such as group think) and mitigating techniques. These do not apply as readily to the MAP which is largely seen as an individual Army planning process.

Dobson-Keeffe & Coaker (2015) do not design and implement training programmes to mitigate bias. What remains to be addressed is the design and implementation of the above four strategies so as to address the most relevant biases within each step of the decision making process.

This review of military decision making processes failed to find other papers on the application of heuristics and biases. Further, no papers were encountered on the application of heuristics and biases to the decision processes, or MAP, employed by the NZ Army.

2.6 Checklist

2.6.1 Gawande, A. (2009). *The Checklist Manifesto: How to Get Things Right.* New York, NY: Henry Holt and Company.

Gawande (2009) argues that memory and attention are particularly fallible under time pressures; that simple checklists greatly aid memory recall. Gawande (2009) argues that this significantly improves performance in complex situations where memory and following the correct sequence in a process are essential (Gawande, 2009).

Gawande (2009) cites examples in aviation and construction engineering, to argue that the some of the limitations of the human mind in coping with complexity can be overcome.

The essence of his argument is that under conditions of complexity checklists are more than aids and that they are a requirement for success. He further acknowledges that while there must always be room for judgement, such judgement is aided and enhanced by appropriate procedure (Gawande, 2009).

Gawande (2009) proposes that checklists must be;

1. *simple and to the point*,
2. *not too big or overly complex*, and
3. *presented in a simple, usable, systematic form*.

2.7 Synthesis

Whereas the JMAP process model in Figure 2 has six steps, there are eight steps in the Tactical School Guide [TSG], (2015) *Military Appreciation Process* developed for the NZ Army:

1. Mission Receipt.
2. Mission Analysis.
3. Intelligence Preparation of the Battlespace (IPB).
4. Course of Action (COA).

5. COA Test.
6. COA Development.
7. COA Analysis.
8. Decision and Implementation.

A theoretical model based on our synthesis of the military papers on heuristics and biases is shown in Table 5. The groupings described by Dobson-Keeffe and Coaker (2015) are employed to organise biases common to Janser (2007), Williams (2010), and Dobson-Keeffe and Coaker (2015), into each of the eight steps of the operational control processes of the MAP employed by the NZ Army.

Table 5: Synthesized allocation of heuristics & biases to each of the 8 steps of the MAP

Military Appreciation Process	Synthesis of Cognitive Bias from Military Papers
1. Mission Receipt The received mission step frames the situation to focus on the key elements of the problem. It also allows the capture of initial thoughts to aid subsequent analysis. The determination of start-state, including administration control dependencies occurs in this step.	**Collecting Information:** • Information Bias • Availability Bias • Pattern Recognition
2. Mission Analysis Mission analysis is the process of determining what must be done, including evaluating the available guidance on how it should be done in order to meet the commander's requirements.	**Analysing Data:** • Confirmation Bias • My-side Bias • Illusory Correlation • Over Confidence
3. IPB IPB[1] is the process of analysing the battlespace threats, environment and stakeholders (groups, including the adversary). It determines the effects on own and others plan of the physical and	**Collecting Information:** • Information Bias • Availability Bias • Pattern Recognition

[1] Intelligence Preparation of the Battlespace.

non-physical environment, and the range of actions likely to be undertaken by stakeholders (including the adversary).	
4. COA Design COA[2] design is the process of creating different concepts that can achieve the mission, including the acheivement of tasks required by the higher commander and tasks to defeat of the adversary.	**Analysing Data:** • Confirmation Bias • My-side Bias • Illusory Correlation • Over Confidence
5. COA Test COA test is the first combination of friendly and adversary actions, to determine possible reactions and decision by both sides. It helps refine which COA concepts are sound, and ensures orchestration in the COA.	**Analysing Data:** • Bias • My-side Bias • Illusory Correlation • Over Confidence
6. COA Development COA development is the process of adding the detail of supporting LOF[3] actions to the COA concept to cover all areas of planning. At this point the FF[4] COG[5] can also be confirmed.	**Analysing Data:** • Confirmation Bias • My-side Bias • Illusory Correlation • Over Confidence
7. COA Analysis COA analysis confirms the synchronisation of a plan, and highlights areas of risk. It also identifies potential CONPLAN's[6] that may be required and C2[7] arrangements needed to coordinate the plan.	**Analysing Data:** • Confirmation Bias • My-side Bias • Illusory Correlation • Over Confidence
8. Decision & Implementation Decision and implementation is the backbrief for approval by higher commander, the inclusion of required detail identified in the previous step(s), and the preparation of orders.	**Deciding:** • Framing Bias **Acting:** • Sunk Cost Effect • Illusion of Control

2.8 Conclusion

The literature review is sufficient answer the first research question posed in Chapter 1:

[2] Course of Action (COA).
[3] Land Operating Functions (LOF) such as protection and sustainment.
[4] Friendly Force (FF).
[5] Centre of Gravity (COG) the essential construct that they draw strength from.
[6] Contingency Plans (CONPLANS).
[7] Command and Control (C2).

1. *Yes, heuristics and biases important to the Military Decision Making Process (MDMP) that have been identified by Janser (2007), Williams (2010), and Dobson-Keeffe and Coaker (2015). Yes, as illustrated in Tables 1 and 2, Dobson-Keeffe and Coaker (2015) link particular heuristics and biases to specific steps in the Joint Military Appreciation Process (JMAP) process model used by the Australian Defence Force (ADF). No, particular heuristics and biases have not been linked to specific steps in the Military Appreciation Process (MAP) employed by the NZ Army. Finally, no steps appear to have been taken to ensure awareness of heuristics and biases in the training and use of the JMAP and MAP.*

The fact that particular heuristics and biases have not been linked to specific steps in the Military Appreciation Process (MAP) employed by the NZ Army confirms the gap that motivates the current research. The synthesis advanced above will be employed as the starting point for an empirical study with instructors of officers in the NZ Army. These officers may, or may not agree with the synthesised model. Either way, a combination of the synthesised model and the consensus of instructors of junior officers in the NZ Army is expected to assist in answering the second research question:

2. *Do instructors of junior officers in the NZ Army acknowledge that the use of the MAP is subject to bias? Do they agree with an allocation (based on a synthesis of the literature) of key heuristics and biases to specific steps of the MAP? Can the instructors devise a better allocation for the NZ Army? Do the instructors believe that a heuristics and biases checklist could be developed to improve the use of the MAP by junior officers?*

CHAPTER 3: METHODOLOGY

This chapter commences with an explanation of the philosophy adopted (American Pragmatism) which informs the focus of the current research on usefulness rather than truth. It then presents the research methodology used to gather qualitative data to test the synthesised model. It also explains the rationale and techniques for data collection. Lastly; credibility, limitations and planning issues are addressed.

3.1 Research Philosophy

3.1.1 Informing Research

The researcher has adopted the philosophy of American Pragmatism (Barnes, 2008). This paper discusses how beliefs are a collective product and response to given conditions and human needs in a given social environment. Truth is therefore seen as a makeshift construct that needs to be refashioned for new situations. To this end processes do not necessarily neatly fit like *Russian dolls* nesting within each other. While Bryman and Bell (2015) allude to this possibility under the title *Competing Paradigms,* they do not address the need to shift from a fixed perspectives, and to include discussions on all relevant perspectives.

Stanley Deetz's article titled *Describing Differences in Approaches to Organization Science: Rethinking Burrell and Morgan and their Legacy* (Deetz, 1996) covers this area well. It treats the claim of objectivity or subjectivity, not as a useful descriptive label, but as a rhetorical move for justifying a research system. Deetz argues that "as language replaces consciousness as central, theories of discourse and representational practices replace philosophies of science based on subject-object, idealist-realist, rationalist-empiricist, or similar contrasts" (Deetz, 1996, p.194). Deetz argues that methodological considerations should address "how organisational science is practiced – how research representations are produced, disseminated, and used rather than their truth or reconstructed justification" (Deetz, 1996, p. 193).

3.1.2 Usefulness vs Truth

"…ideas do not develop according to some inner logic of their own, but are entirely dependent, like germs on their human carriers and the environment" (Menand, 2001 cited in Barnes, 2008, p.1545). Ideas are pliable and adaptable with the interaction between the participants and researcher needing the group to get the ideas (Barnes, 2008). These ideas are "bets about the future" (Barnes, 2008, p. 1546) which guess at what the future would look like most of the time. These concepts are well aligned with the idea of engaging with instructors of the MAP in order to improve use of the MAP by junior officers. This approach is grounded in the beliefs and values of the instructors and the benefit they see in the awareness of heuristics and biases and their effects on decision making within the MAP.

Pragmatism is an "idea about ideas" and therefore becomes a "means for thinking about thinking" (Barnes, 2008, p.1551). Barnes (2008, p.1544) quotes from William James (1907, p.77) as follows: "..truth happens to an idea. It *becomes* true, it is *made* true by events." Barnes (2008, p.1551) invokes a passage from Menand (2001) to remind the researcher that the ideas informing research should be understood:

1. As tools for achieving a particular research purpose.
2. As gaining legitimacy from the larger community in which they are presented, and thus dependent upon their context of use.
3. As always provisional, never certain, and subject to change.
4. As opportunities for experimentation, and the hope of a better outcome.
5. As messy and incomplete, unable to capture the issues coherently *and* completely.

The tools used in the current research are semi-structured interviews during part of which participants sort concepts on cards (biases) into categories in a process model (steps of the MAP). This creative and critically reflective exercise in card sorting is seen as pragmatism in

action. Truth is what happens when cards are in the hands of acknowledged experts, who engage in discourse around experience with the bias, and the purpose of the MAP, its strengths and weaknesses, and whether or not it could be improved via a heuristics and biases checklist.

Legitimacy is claimed on the basis that the participants constitute the entire instructional staff responsible for training junior officers in the MAP. The context of the use of the card sort tool is directly related to the nature of the improvement sought.

The idea is provisional. The allocation of biases to steps in the MAP, and the instruction around the MAP, are seen as experiments towards a better outcome.

Finally, dealing directly with the key stakeholders, MAP instructors, and their beliefs, values and experiences is accepted as messy and incomplete, and that issues will not be captured coherently *and* completely. However it will hold a truth for them and equally a value (usefulness) in how they believe the idea will provide benefit and possible improvement.

In summary, Deetz (1996) and Barnes (2008) support the claims of the current research to benefit and usefulness as opposed to a truth. This approach shapes the research perspective adopted.

3.2 Research Perspective

3.2.1 Perspective/Approach Adopted

Bryman and Bell (2015) compare and contrast a large number of methodologies, and the purposes they serve. A qualitative method was adopted to answer research question 2, the key last sentence of which is: *Do the instructors believe that a heuristics and biases checklist could be developed to improve the use of the MAP by junior officers?*

The answer to research question 2 requires qualitative evidence based on people's reflections, and mutual understanding between researcher and participants about participants orientation towards, and experiences of, the MAP. The participants were MAP instructors who are asked to express their views and communicate how they apply their knowledge (Bryman & Bell, 2015, p. 28). The focus was on understanding the instructor's appreciation of their social world by looking at their interpretation of that world (Bryman & Bell, 2015, p. 30). The world in this context was their understanding and experience with the application and use of the MAP.

The qualitative approach can be epistemologically defined further by the research perspective of phenomenology (Bryman & Bell, 2015, p. 29). Phenomenology describes the study of phenomena as it presents itself through the medium of direct experiences which in turn aligns with methods of engagement such as interviews where the experiences can be acknowledged (Bryman & Bell, 2015, p. 30). It is asserted that through this approach; insight, reflection and understanding from sense making can be created from personal experiences and what people believe (Bryman & Bell, 2015, p. 30).

The literature review provided a degree of informed knowledge that allowed for the creation of Table 5. However this needed to be confirmed through engagement with relevant participants. Therefore the approach proposed was to employ the key informant interview method (Bryman & Bell, 2015, p. 455). As discussed below, a semi-structured format was adopted to support both participant's spontaneous expressions and their privileged and expert knowledge (DiCicco-Bloom & Crabtree, 2006, p. 314; Bryman & Bell, 2015, p. 456).

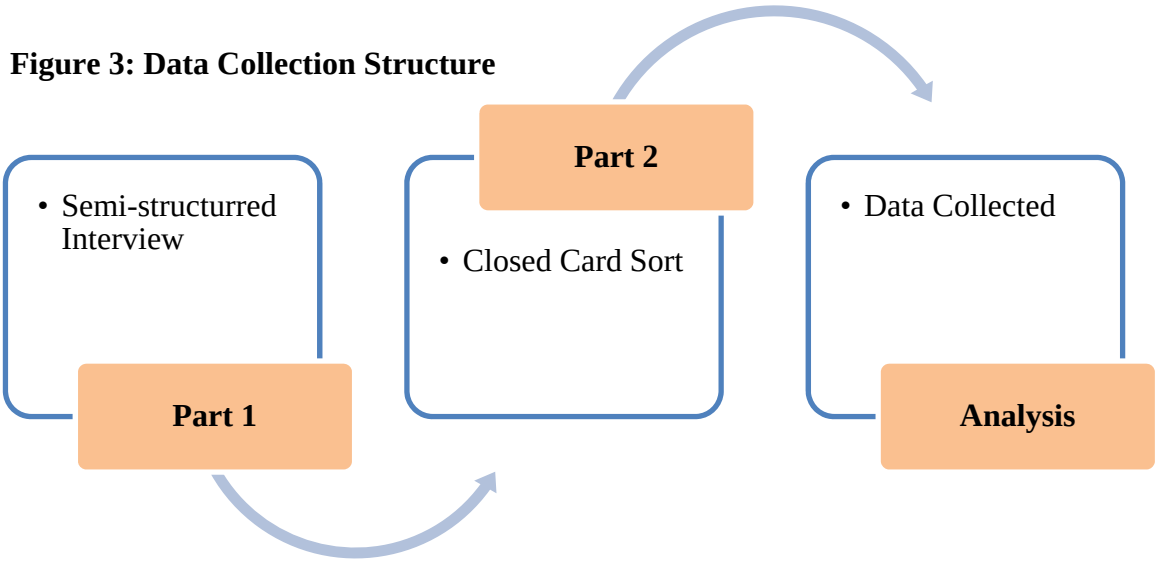
3.3 Research Method

The research method focuses on gaining insight and perspectives from experienced MAP instructors so as to answer the following part of research question 2: "*Do they agree with an allocation (based on a synthesis of the literature) of key heuristics and biases to specific steps of the MAP? Can the instructors devise a better allocation for the NZ Army?*"

3.3.1 Semi-structured Interviews

The semi-structured interview process is diagrammed in Figure 3. Part 1 involved a predefined series of open-ended questions. This was a practical approach as the researcher commenced the research with a fairly clear focus allowing more specific aspects to be addressed (Bryman & Bell, 2015, p. 483).

Figure 3: Data Collection Structure



3.3.2 Closed Card Sort

Part 2 involved the use of a card sorting technique in which all cards were predefined ("closed card sort"). Participants were not permitted to create additional cards to explore issues beyond those planned by the experimenter. A closed card sort method was preferred as it included only those cards containing biases from the synthesis of the literature, and it simplified comparisons between participants (Roth et al. 2011, p. 91; Faiks & Hyland, 2000, p. 350).

Participant's sense making faculties were harnessed as they created order both from various pieces of information and their own mental models (Roth et al. 2011, p. 89; Faiks & Hyland, 2000, p. 350). The various pieces of information took the form of cards marked with biases, and a large sheet showing the steps of the MAP. The participant allocated biases to each step as they believed to be relevant. Figure 4 shows the design of the cards with the actual cards used listed in Appendix C. Each card showed a bias with the name of the bias on the front and a military example on the reverse (Faiks & Hyland, 2000, p. 350). This reinforced the intent behind gaining knowledge from key informants in a semi-structured and ordered manner that limited researcher bias (Roth et al. 2011, p. 89; Faiks & Hyland, 2000, p. 350; Santos, G. 2006, p. 291).

The data created in the semi-structured interviews included the results of the card sort, the experimenter's notes based on participants verbal answers to the open-ended questions, and 20 hours of voice recordings. Additionally notes were made after each interview in order to deepen the depth of analysis on the collected data (Bryman & Bell, 2015, p. 220). Based on the research questions and participant's reflections, emergent themes were identified with the data coded to reflect common themes (Bryman & Bell, 2015, p. 212). A recognised limitation to this method is bias in how data is interpreted and grouped into themes by the researcher (Bryman & Bell, 2015, p. 213). However this was balanced by the literature review and use of the steps (but not the biases) in the synthesised model in Table 5 as a target for the card sort. It is noted that the experimenter at no stage offered any interpretations, and that participants may, or may not allocate biases as indicated in Table 5.

Figure 4: Example 'Bias to MAP Step Card.'

FRONT	Bias name followed by a description	**REVERSE**	Statement of a Military example.

3.4 Research Credibility

3.4.1 Credibility

Credibility as discussed by Bryman and Bell (2015, p. 401) features two key aspects; *trustworthiness* and *authenticity*. Within each of these a number of key components exist (Bryman & Bell, 2015, p. 402-403):

1. *Trustworthiness;* credibility, transferability, dependability and confirmability.
2. *Authenticity;* fairness, ontological, educative, catalytic and tactical.

This research anchored itself on the validation achieved through adherence to the methods and techniques prescribed for the research methods adopted. For example, the open-ended questions were formally committed to an A4 sheet (Table 6). The interview process and data collection processes were tested through an exhaustive interview simulation involving subject matter experts from Victoria University of Wellington and the New Zealand Army (Bryman & Bell, 2015, p. 489). On the basis of intendedly objective feedback from the experts, adjustments were made before the formal research data collection effort commenced. In order to reduce misunderstanding the research employed triangulation with data from each interview compared against direct observations (Bryman & Bell, 2015, p. 402). Also the data collected formed an unbroken thread through retention of interview recordings, documentation of participant's card sorting activity, and analysis of the coded data (Bryman & Bell, 2015, p. 258).

Table 6: Interview Structure

Interview Guide, Part One – Open Questions	**Interview #**
Introduction: overview of business research topic and structure of this interview	
Warm up questions: 1. What is the purpose of the MAP & how useful is it to make decisions using the MAP in critical situations? 2. What do you think are the MAPs greatest strengths and why? 3. What are its greatest's weaknesses and why? 4. What are the difficulties those new to using it find? 5. Do you see any pattern to these problems? 6. Are these problems persistent? 7. Would a checklist be useful?	
Card Sort Guide, Part Two of the Interview	**Interview #**
A. Sort bias cards onto the MAP steps that you feel align with your experience of where they fit. B. You can sort the cards across more than one step.	

3.4.2 Limitations

The focused literature review, the synthesised model in Table 5, the semi-structured interviews and closed card sort exercise with the entire instructional staff of the NZ Army mitigates the (general-purpose, context-free) limitations on qualitative research that are noted in Bryman and Bell (2015):

1. *Qualitative research is too subjective*: Techniques were adhered to that assisted in remaining grounded in the objective frame. The data collection process was validated

through an interview simulation involving subject matter experts from Victoria University of Wellington and the New Zealand Army.

2. *Difficult to replicate:* Standardised questions were employed and the processes applied were documented in detail.

3. *Problems of generalisation:* This is acknowledged and the research was intended for a very specific profession. All members of the key population to which the results are intended to generalise participated. As indicated in sections 3.1 and 3.2 generalisation is conceptually based on usefulness, not statistical based sampling. Truth as fitness for purpose will emerge as the MAP instructors engage in a future exercise around developing a checklist. Tests of generalisation may emerge as soon as experience in using the checklist is obtained.

4. *Lack of transparency:* Validation was sought from participants on their interview data and they were able to comment on the final report before it was submitted.

3.4.3 Bias

Given that the researcher is a member of the NZDF and has been an instructor of the MAP himself, it must be acknowledged that bias is a factor that needs to be addressed. Bias in this regard was addressed through the use of a semi-structured interview method as it provided the participant's views and not those of the researchers (Bryman & Bell, 2015). Use of standardised and peer-reviewed questions and the use of an interview simulation refined the interview method and sought to avoid potential influence from the researcher's own experience and attitude (Bryman & Bell, 2015). Researcher bias is further discussed in the use of the closed card sort method used in part two of the interview structure.

3.5 Planning

3.5.1 Participants

Nine participants were interviewed representing the instructor staff group at the NZ Army Command School (ACS). This provided a significant population for testing the synthesised data in Table 5. In the course of the interviews demographic details of each participant were noted providing the average experience and expertise in the use of and instruction of the MAP (Table 7).

Table 7: Demographic Questions

Number of years in the military.	
Number of deployments.	
Number of development exercises.	
Number of professional courses.	

3.5.2 Access

Access was granted to participants and the organisation through liaison between the researcher and key commanders within the New Zealand Army and the New Zealand Defence Force (NZDF) Office of Organisational Research. Permissions were granted from:

1. Chief of Army – Major General Peter Kelly, MNZM as principle sponsor.
2. Commander of Training and Doctrine Command (TRADOC) - Colonel Jim Bliss.
3. Commandant of the Army Command Centre - Lieutenant Colonel Andrew Fox.
4. NZDF Office of Organisational Research.

3.5.3 Resources

The resources required in order to complete this research included the use of interview facilities in Waiouru and access to the instructor group as participants in the interviews. This was secured as was accommodation and travel which the researcher arranged.

3.5.4 Schedule

The schedule was conducted over the period 12 to 14 September, 2016 (Table 8) and was conducted at the ACS located at the Waiouru Army Camp. The schedule involved eight participants being interviewed representing the instructional staff at ACS. The interview simulation was conducted on the 5th of September allowing refinements to be made.

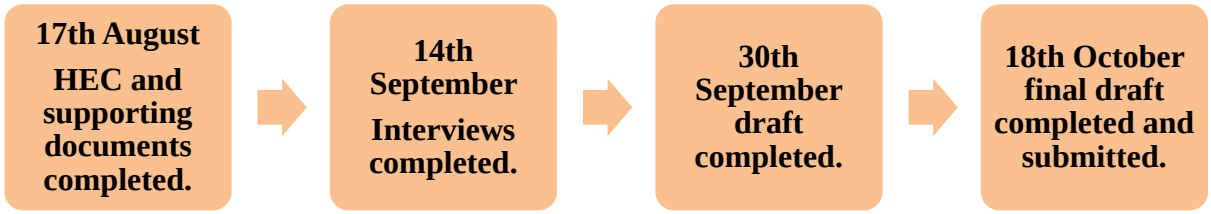
Table 8: Interview Schedule

Interview Schedule 12 -14 September			
Participants:	**Monday**	**Tuesday**	**Wednesday**
1	**X**		
2	**X**		
3	**X**		
4		**X**	
5		**X**	
6		**X**	
7			**X**
8			**X**

3.5.5 Time-line

A timetable with achieved milestones is shown at Figure 5. This conformed to the provisional discussions held between the researcher and the NZDF and conformed to the Victoria University of Wellingtons deadline.

Figure 5: Indicative Milestones



3.6 Conclusion

The literature review in Chapter 2 provided sufficient conceptual understanding to answer research question 1. This chapter has argued for the choice (for the purposes of this research only) of research philosophy, perspective, methodology, credibility, and planning associated with answering question 2:

> 2. *Do instructors of junior officers in the NZ Army acknowledge that the use of the MAP is subject to bias? Do instructors tend to agree with an allocation (based on a theoretical reference model synthesised from the literature) of key heuristics and biases to specific steps of the MAP? Can the instructors devise a better allocation for the NZ Army? Do the instructors believe that a heuristics and biases checklist could be developed to improve the use of the MAP by junior officers?*

In the limitations section it was noted that Truth as fitness for purpose will emerge as the MAP instructors engage in a future exercise around developing a checklist. Tests of generalisation may emerge as soon as experience in using the checklist is obtained. This note is extended below to identify the broader context of the research.

Over time, evidence will emerge about the applicability of the results to other Army officers within the New Zealand Defence Force (NZDF) that use the MAP. Additionally the current research is considered a primer for further study, and application to other decision makers, through the Institute of Leadership Development (ILD) in the NZDF.

CHAPTER 4: DATA ANALYSIS AND RESULTS

The fourth chapter applies the research techniques described in chapter 3 to generate evidence about research question 2. Section 1 analyses the data gathered through the semi-structured interviews about decision making in the MAP. Section 2 analyses the results of the card sort exercise in which participants tested the MAP model synthesised in chapter two. Finally, section 3 briefly acknowledges the limitations of the techniques used, and summarises the key findings.

4.1 Analysis of Interview Data

4.1.1 Profile of the Participants

Nine participants were involved in the interviews and card sort activity. Demographic data is reported in Table 9. This data confirms that the beliefs and opinions are drawn from people who are well qualified to understand and use the MAP.

Significantly a key informant interview was conducted with a participant central in the development of the MAP. This participant has over three decades of military experience from which to reflect and offer insight and opinions. These were captured in a full transcript from an interview session lasting seven hours with an additional 12 hours of interview material then added from other participant interviews. Summaries of responses are presented in this chapter and discussed further in chapter five. Responses from the key informant are presented first as they proved to be central to the responses of the remaining 8 participants in each area discussed. Coded reference is made to participants where Participant A is (PA). This code goes from PA to PI and can be seen in Table 10.

Table 9: Participant Demographics

Number of participants	**9**
Average Number of years in the military.	**15**
Average Number of deployments.	**2**
Average Number of development exercises.	**22**
Average Number of professional courses.	**13**

4.1.2 Purpose and usefulness of the MAP

Key Informant: *"So the purpose of the MAP is simply to assist individuals in groups to plan and make decisions in a variety of demanding situations ranging from simple to complex, low stress to high stress and non-conflict right through to high end conflict. It achieves this by aiding commanders and staff to think through what may happen and thereby be better prepared to effectively mitigate risks or exploit opportunities as they occur. So the MAP is kind of doing two things; it's assisting planning and it's assisting decision making in the execution of the plan. Whether the critical situation is time sensitive or not, whether it's simple or complex, or whether you feel your life is threatened or not, it's a tool with great utility."* **(PI)**

A strong theme was that the MAP provided structure and focus when dealing with complexity. Comments such as; *"provides structure to the decision making process"* **(PH)** and *"breaks down complexity to get at what you need to use - then do"* **(PC)** were common.

Using a scale between 1 and 5, where 1 was least useful and 5 most useful when dealing with complexity in critical situations, usefulness was assessed at 4. The comments; *"a method of interpreting complexity"* and *"making sense of all the complexity"* **(PG)** recurred consistently in responses to this question. The majority of participants describing it this way were from the 44% who scored it a 5 and 11% who scored it a 4.

The other 44% who scored it a 3 made comments such as; *"leads people down rabbit holes"* **(PA)** and "not packaged user friendly." **(PE)** Such people expressed; reservations over the *"time compression issues"* and preferences for *"simpler tools like the 7 questions combat estimate."* **(PE)**

4.1.3 Strengths and Weaknesses of the MAP

Key Informant: *"In the Military context we are often faced with a complex and dynamic situation, that ideally requires slow thinking to solve, but in reality we have to react to using fast thinking. In these circumstances the MAP is very good at focussing a Commander and staff on determining when a decision has to be made by, and what type of planning approach is to be used. The MAP enables you to balance in the time available, the use of slow thinking analysis against fast thinking intuition. If you've got plenty of time you can run the full deliberate process and weight analysis over intuition – thereby avoiding the pit fall of using bias prone fast thinking to solve complex problems when you don't have to. This exposes a real weakness in military culture – because we are so used to using short term fast thinking in conflict situations we tend to automatically apply this style of decision making to all situations. From my own experience I have observed Commanders and staff faced with long term complex problems instinctively adopt an intuitive decision making style better suited to simple short term problems. I've probably not explained this very well but my point is the MAP tool can be used either in a smart or dumb way for planning and decision making. Used dumbly you get locked into one particular style of planning and decision making, and do not or are unable to, appropriately adapt your planning and decision making style to the needs of the situation."* **(PI)**

The MAP appears to draw its greatest strength from the fact that it is a structured process for ordering complexity as seen in this comment; *"thorough and breaks down the details."* **(PG)**

Another comment captures the temporal and cognitive component where it is seen as *"time sensitive – balancing fast and slow thinking."* **(PI)** The individual and group aspects of planning are also acknowledged in; *"harnessing the brilliance of the individual and power of the group"* **(PI)** where the MAP is applied in larger staff planning situations. The most common theme was the ordering and sifting power where it; *"lays out a logical order for understanding the problem."* **(PB)**

An emergent theme around weaknesses was seen in these comments; *"at worst is inflexible and less responsive"* **(PI)**, and *"not supportive of quick – instinctive decision making."* **(PF)** It seems the deliberate nature of the process and the discipline it provides is also a drawback as it; *"limits divergent thinking as we are all brought up with the same training which can produce similar solutions."* **(PH)** Another theme centered on the frustration shared by students and instructors where comments such as; *"hard to teach – overwhelming for them and how to get into the detail they don't understand"* **(PA)** were common.

4.1.4 Problems with Initial Use and Common Issues

Key Informant: *"Experienced Military people who are new to the process have an advantage that they are already attuned to military language and have operational and work experience that enables them to simply focus on learning the new process. But even for them they need to be drilled in the process so it becomes second nature. Then they're free to think creatively and innovatively about the situation they face. In my experience that is about a six week process and that comes from Command Staff College where I put 180 students through that over two years. So it takes about six weeks for experienced Military people to get up to speed on the process and then be able to intelligently focus on the situation. This includes preparing units to use the MAP before being deployed on operations. The next category though is new users who are inexperienced in Military. So they have three challenges really. Not only are they*

challenged to learn a new process, but they have to understand this new Military culture they're in with its associated unique language. Because they've got no Military experience they're also challenged with trying to understand Military effects on the ground in terms of all the complexities of conflict etc. that we dump on them. So they've got massive challenges hitting them all at once. Having said that I think there's an opportunity for new users [militarily inexperienced] to learn the process as long as they are given enough time and a simplified military problem and situation to consider. Learning or rather absorbing military culture, jargon and the lessons from operational experience is a socialisation process that you can't speed up and takes between two to four years, in my opinion." **(PI)**

Key Informant: *"There's a danger, in the military we do this all the time, of always starting the clock and putting people under pressure, particularly in the Army - it's endemic to our culture. So with the clock ticking people naturally want to get through the process steps as fast as they can to get an answer, any answer on time. Because we value decisiveness, particularly in the Army, in fact if you can't make a decision that becomes one of the reasons we deselect you as an officer; I think there's a real danger of reinforcing only fast thinking as our default planning and decision making style. I think initially when you're learning the process we need to take the time sensitivity out so that people have the opportunity to practise slow thinking. This is difficult in the Army because we also instinctively try to compress 10 activities into one activity all the time. So not only do we do everything fast we also always try to do too much. There's a real tension here, under pressure people just whip out the first answer that comes to mind which makes people even more prone to their bias. We could be inadvertently conditioning our officers to being decisive, unimaginative and bias prone decision makers."* **(PI)**

For those new to the army and lacking experience the MAP is confounding as seen in this comment; *"the new and inexperienced face a military culture (they are now learning), a*

language they don't understand (military terms) and no experience of military capability." **(PI)** This adds up to being a *"bridge too far."* **(PI)** Others capture a theme where the MAP; *"requires significant practice to master – until which time they struggle to use"* it **(PH)** and again with this comment; *"complexity and no prior experience (can) only be remedied by repetition of use."* **(PC)**

Another theme was around instructor observations that some seemed better enabled than others where; *"university graduates and ex-soldiers have greater discipline of thought and organisation"* **(PA)** while those straight from school or without university experience *"struggle with formal ways to think."* **(PB)** A comment of; *"they get two weeks in the program for drill and a matter of days devoted to the MAP in detail"* **(PD)** captures a common theme that more time is needed for instruction and use. Also the comment; *"need to over train in this error"* **(PI)** was a common theme as students otherwise came to; *"see things how they want (in order) to conform to their ideas."* **(PF)**

4.1.5 Usefulness of a Checklist

Key Informant: *"When using the MAP as an individual challenging yourself to be a little bit creative in each of those steps that I talked about, and being aware of your own bias is critical. Having some sort of mini process to be creative and avoiding being prone to bias or whatever your frame of reference is, will be helpful when an individual is applying the MAP. At those points we should use some sort of tool or process that prompts us to think outside the box and avoid our instinctive and normal way of viewing things. That would help offset the danger of bias and lack of creativity. Those critical points of the process that challenge your thinking become even more critical. So a smart checklist that mitigated bias at those critical points in the MAP requiring assumptions and deductive reasoning would be very useful. I think the MAP nicely folds into three generic packages or clusters (see Table 10). I put mission receipt,*

mission analysis and IPB together into a cluster which we could term problem definition. Then a second cluster which is around course of action, design and development and testing. Let's call this second cluster design. The third cluster includes decision implementation and course of action analysis – let's call that implementation. I think there is clear value in understanding the effects of bias within the steps of the MAP and designing a checklist to help mitigate the negative effects of bias potentially at work within these three MAP cluster groups." **(PI)**

A strong theme was that a checklist would in the view of the participants be of significant benefit in being able to improve the use of the MAP by junior officers. Participants believe improvement could be achieved by there being; a common awareness of the existence and effect of relevant biases by instructors and junior officers and knowing where these were likely to occur. A comment that represented this common view was; in order to avoid *"reacting thoughtlessly and (just) stepping through the process (a checklist would be) incredibly helpful (given we are) prone to bias, especially initially (in the use of the MAP)"* **(PI)**. Participants saw it as; *"definitely beneficial as an instructor"* **(PA)** as it gave *"instructors (their) own understanding of bias"* **(PA)**.

Using a scale between 1 and 5, where 1 was least useful to 5 most useful, usefulness was assessed at 4 in being assessed as beneficial to both instructors and students. The comment; *"both ways – good for the student and instructors"* **(PC)** recurred as a theme consistently in responses. The majority of participants describing it this way were from the 33% who scored it a 5 and 67% who scored it a 4.

No one scored the checklist lower than 4 and some revised it upwards post the card sorting activity where they came to reflect on the biases and how they influenced decision making.

Comments after the card sorting activity typically were; *"biases exist and seeing how they affect decision making processes is advantageous"* **(PD)**. Instructors commonly agreed a checklist could provide a focus when debriefing or correcting student performance allowing them to; *"better hone into the issues"* **(PE)** and *"big fan of that and good way to operate"* as it allows students to *"look, think and act"* **(PF)**. This appeared to recognise that instructors and students would be able to; share a common description and presentation of a bias, where it was likely to occur, and to address it systematically.

4.1.6 Conclusion

The MAP is a useful means through which to deal with complexity and develop useful solutions. Its greatest strength is it lays out an effective way to understand and solve complex problems; while its key weakness is it can be initially complex and needing experience and practice that is often missing in order to unlock its strengths. Common and recurring problems appear to be its complexity to the uninitiated and insufficient time allocated to reinforce effective understanding and use. Instructors strongly believe that a checklist holds positive benefit for both themselves and students and that a better decision awareness and use of the MAP could result.

4.2 Analysis of the Card Sort Data

4.2.1 Reference models

The second part of the engagement strategy with participants was the use of a card sort activity in which participants sorted the cards shown in Appendix C into the steps of the MAP process model (the left side of Table 5). During this process participants were encouraged to speak

briefly about their military experiences with the biases. Observations were noted about participant's verbalisations, and their deliberations as they assigned biases to steps.

Tables 10 and 11 and Appendix D and E analyse the match of participant bias assignments by triangulating the raw data against the criteria in three holistic reference models:

1. An empirically derived card sort consensus model (at least 5 out of the 9 participants constitute a consensus)
2. A theoretical best practice model (Table 5) based on a synthesis of the literature
3. A best-fit model, based on an opportunistic choice of either the empirical or theoretical models

4.2.2 Parameters

In order to compare and contrast the match of the data to each reference model, 10 parameters were evaluated based on the number of assignments meeting the criteria for:

1. **B**oth the empirical and the theoretical **M**odels (BM),
2. **E**mpirical Model **O**nly (EO); in Tables 10 and 11 assignments that meet consensus requirements have an asterisk,
3. **T**heoretical Model **O**nly (TO); in Tables 10 and 11 assignments that match those in the right side of Table 5 have an underline,
4. **N**either **M**odel (NM),
5. **W**orst **F**it **M**odel (WFM), i.e., BM plus MIN (EO, TO),
6. **M**odel **I**mprovement (MI), calculated as the positive or negative value of TO-EO
7. **M**odel **D**ifference (MD), i.e., EO+TO, and more importantly,
8. **E**mpirical **M**odel (EM); assignments meeting the requirements of the empirical card sort consensus model (BM+EO)

9. **T**heoretical **M**odel (TM); assignments meeting the requirements of the theoretical model (BM+TO)
10. **B**est **F**it **M**odel (BFM), i.e., BM plus MAX (EO, TO).

4.2.3 Levels

The parameters were evaluated at four levels

1. STEP. Each step in a cluster is evaluated separately. Per Table 5 different criteria may be applied to each step in a cluster. Match at the cluster level requires a match at each step in the cluster ("AND" logic). Provides maximum rigour in evaluating match to reference models. (Appendix D)
2. STEP OR CLUSTER. There are no longer separate criteria for steps in a cluster. If the assignment matches the criteria for one step in a cluster, it matches the criteria for all steps in the cluster. Match at the cluster level requires a match to the criteria of any step in the cluster ("OR" logic). Provides a balance between rigour and relevance in evaluating match to reference models. (Appendix E)
3. CLUSTER. The assignment of biases employing "OR" logic are reported without reference to the steps in the cluster. Provides maximum relevance in evaluating match to reference models. (Appendix E)
4. MAP. An overall assessment of the shape of the MAP seen in the light of the reference models.

4.2.4 Analysis at the step level (Table 10 and Appendix D)

In Table 10, Participant A (PA) has assigned biases (3) and (5) to MAP step 1. The (5) bias is underlined because the theoretical model (Table 5 and left side of Table 10) identifies it as one of three relevant biases - (5), (6), & (7). The (5) bias is asterisked because a consensus (5 out of 9 participants) judged it to be relevant to step 1.

For step 1 a total of 5 out of 7 assignments (71%) matched the requirements of the consensus model, and 6 out of 7 (86%) met the requirements of the theoretical model. Five assignments (5, 5, 5, 5, and 5) met the requirements of both models (BM=5), no assignment met only the requirement of the empirical consensus model (EO=0), one assignment (6) met only the requirements of the theoretical model (TO=1), and one assignment (3) met the requirements of neither model (NM=1). Five assignments were captured in the worst fitting model (i.e., the empirical consensus model) (WFM=5), and the additional match in moving from the empirical model to the theoretical model is one (6-5) (MI=1). The difference between the number of assignments matching the empirical and theoretical models evaluated strictly at the level of each step is one (6) (MD=1). More importantly, five assignments were captured in the empirical card sort consensus model (EM=5), six assignments were captured in the theoretical model (TM=6), and six assignments were captured in the best fitting model (i.e., the theoretical model in Table 5) (BFM=6). The parameters for all eight steps of the MAP are reported in Appendix D.

For cluster 1, evaluated strictly at the level of each step a total of 57 out of 81 assignments (70%) matched the requirements of the consensus model, 41 assignments (51%) met the requirements of the theoretical model, and 58 (72%) met the requirements of the best fit model (i.e., the empirical card sort consensus model). The remaining parameters are reported in Appendix D. For the MAP as a whole, out of 182 assignments 85 (47%) matched the consensus model, 91 assignments (50%) matched the theoretical model, and 108 (59%) matched the best-fit model (Table 10).

Table 10: Analysis at the step level

THEORETICAL MODEL (TABLE 5)		PER ANALYSIS IN APPENDIX D: <> Match based on card sort consensus model: 47% <> Match based on theoretical model: 50% <> Match to the "best fit model": 59%									CONSENSUS MODEL	ALL THREE CLUSTERS 182 ASSIGNMENTS
		PA 44 %	PB 60 %	PC 59 %	PD 63 %	PE 41 %	PF 61 %	PG 38 %	PH 53 %	PI 44 %		
1	86% Group 2 - Collecting Information: 5, 6, 7	3, 5*	5*	5*	5*		5*, 6				70%* 5*	CLUSTER 1: PROBLEM DEFINITION 81 ASSIGNMENTS
2	62% Group 1 - Analysing Data: 1, 2, 3, 4		2*, 3, 4*, 5*	2*, 3, 4*, 5*, 7	2*, 3, 4*	2*, 5*	2*, 4*, 5*, 8	4*, 5*	1, 8, 9	1, 2*, 6	62%* 2*, 4*, 5*	
3	40% Group 2 - Collecting Information: 5, 6, 7	2*, 4, 6*, 7*, 10*	1*, 2*, 6*, 7*, 10*	1*, 2*, 6*, 7*	1*, 2*, 5, 6*, 7*, 10*	1*, 2*, 4, 6*, 7*, 9, 10*	1*, 3, 7*	1*, 2*, 3, 4, 5, 7*, 10*	2*, 3, 5, 7*, 10	1*, 2*, 5, 6*, 7*, 9	75*% 1*, 2*, 6*, 7*, 10*	
4	65% Group 1 - Analysing Data: 1, 2, 3, 4	3*, 4*, 6	2, 3*, 6, 10	3*, 4*, 6, 9	3*, 7, 8	3*	3*, 4*	1, 4*	2, 3*, 4*	7	52%* 3*, 4*	CLUSTER 2: DESIGN 59 ASSIGNMENTS
5	50% Group 1 - Analysing Data: 1, 2, 3, 4	2, 4*, 8	8	4*	1, 4*, 6	4*, 8, 10		3, 7, 9, 10	1, 4*, 6,10	1, 2, 4*, 8, 9	25%* 4*	
6	33% Group 1 - Analysing Data: 1, 2, 3, 4	1, 10	4, 7	1, 2		9	6, 10	6, 8	5		0%*	
7	30% Group 1 - Analysing Data: 1, 2, 3, 4	8, 9*		8, 9*, 10	9*	1, 4	1, 4, 6, 9*	2, , 8, 9*	3, 8, 10	5	25%* 9*	CLUSTER 3: IMPLEMENATION 42 ASSIGNMENTS
8	59% Group 3 – Deciding: 8 Group 4 - Acting: 9, 10	5	8*, 9, 10	1, 8*, 10	8*, 10	3	8*, 9	9		1, 2, 3, 4, 6, 7, 8*,9, 10	23% 8*	

4.2.5 Analysis at the step OR cluster level (Table 11 and Appendix E)

In Table 11, there are no longer separate criteria for steps in a cluster. “OR” logic is applied. In step 1 assignments that match the (previously different) theoretical criteria for step 2 are included (red font, including red underline). In step 1, assignments that are part of a consensus in steps 2 and 3 are included in the empirical consensus (red asterisk).

For step 1 a total of 6 out of 7 assignments (86%) matched the requirements of the consensus model, and 7 out of 7 (100%) met the requirements of the theoretical model. Six assignments (5, 5, 5, 5, 5, and 6) met the requirements of both models (BM=6), no assignment met only the requirement of the empirical consensus model (EO=0), one assignment (3) met only the requirements of the theoretical model (TO=1), and no assignment met the requirements of neither model (NM=0). Six assignments were captured in the worst fitting model (i.e., the empirical consensus model) (WFM=6), and the additional match in moving from the empirical model to the theoretical model is one (7-6) (MI=1). The difference between the number of assignments matching the empirical and theoretical models evaluated using “OR” logic is one (3) (MD=1). More importantly, six assignments were captured in the empirical card sort consensus model (EM=6), seven assignments were captured in the theoretical model (TM=7), and seven assignments were captured in the best fitting model (i.e., the theoretical model in Table 5) (BFM=7). The parameters for all eight steps of the MAP are reported in Appendix E.

For cluster 1, evaluated using “OR” logic a total of 69 out of 81 assignments (85%) matched the requirements of the consensus model, 70 assignments (86%) met the requirements of the theoretical model, and 73 (90%) met the requirements of the best fit model (i.e., the theoretical model in Table 5). The remaining parameters are reported in Appendix E. For the MAP as a whole, out of 182 assignments 107 (59%) matched the consensus model, 137 assignments (75%) matched the theoretical model, and 140 (77%) matched the best-fit model. (Table 11).

Table 11: Analysis at the step OR cluster level

THEORETICAL MODEL (TABLE 5)		PER ANALYSIS IN APPENDIX E: <> Match based on card sort consensus model: 59% <> Match based on theoretical model: 75% <> Match to the "best fit model": 77%									CONSENSUS MODEL	ALL THREE CLUSTERS 182 ASSIGNMENTS
		PA 72 %	PB 79 %	PC 86 %	PD 79 %	PE 71 %	PF 79 %	PG 71 %	PH 65 %	PI 72 %		
1	100% Gps 1&2 - 1, 2, 3, 4: 5, 6, 7	3, 5*	5*	5*	5*		5*, 6*				86%* 1*, 2*, 4*, 5*, 6*, 7*, 10*	CLUSTER 1: PROBLEM DEFINITION 81 ASSIGNMENTS
2	88% Groups 1&2 - 1, 2, 3, 4: 5, 6, 7		2*, 3, 4*, 5*	2*, 3, 4*, 5*, 7*	2*, 3, 4*	2*, 5*	2*, 4*, 5*, 8	4*, 5*	1*, 8, 9	1, 2*, 6*	77%* 1*, 2*, 4*, 5*, 6*, 7*, 10*	
3	83% Groups 1&2 - 1, 2, 3, 4: 5, 6, 7	2*, 4*, 6*, 7*, 10*	1*, 2*, 6*, 7*, 10*	1*, 2*, 6*, 7*	1*, 2*, 5*, 6*, 7*, 10*	1*, 2*, 4*, 6*, 7*,9, 10*	1*, 3, 7*	1*, 2*,3, 4*, 5*, 7*, 10*	2*, 3, 5*, 7*, 10	1*, 2*, 5*, 6*, 7*, 9	90*% 1*, 2*, 4*, 5*, 6*, 7*, 10*	
4	65% Group 1 - Analysing Data: 1, 2, 3, 4	3*, 4*, 6	2, 3*, 6, 10	3*, 4*, 6, 9	3*, 7, 8	3*	3*, 4*	1, 4*	2, 3*, 4*	7	52%* 3*, 4*	CLUSTER 2: DESIGN 59 ASSIGNMENTS
5	50% Group 1 - Analysing Data: 1, 2, 3, 4	2, 4*, 8	8	4*	1, 4*, 6	4*, 8, 10		3*, 7, 9, 10	1, 4*, 6,10	1, 2, 4*, 8, 9	29%* 3*, 4*	
6	33% Group 1 - Analysing Data: 1, 2, 3, 4	1, 10	4*,7	1, 2		9	6, 10	6, 8	5		8%* 3*, 4*	
7	30% Gps 1, 3&4 - 1, 2, 3, 4, 8, 9, 10	8*, 9*		8*, 9*, 10	9*	1, 4	1, 4, 6, 9*	2, 8*, 9*	3, 8*, 10	5	45%* 8*, 9*	CLUSTER 3: IMPLEMENTATION 42 ASSIGNMENTS
8	86% Gps 1, 3&4 - 1, 2, 3, 4, 8, 9, 10	5	8, 9*, 10	1, 8, 10	8, 10	3	8, 9*	9*		1, 2, 3, 4, 6, 7, 8, 9*, 10	41% 8*, 9*	

4.2.6 Analysis at the cluster level

The first participant in the key informant interview was a principle architect of the MAP. As part of this interview, the participant opined that the 8 MAP steps were but perspectives on a single underlying complexity, and could usefully be visualized as 3 key clusters: Problem Definition, Design, and Implementation. It was this insight that enabled an integrative approach to the assignment of biases to steps by participants (Faiks & Hyland, 2000, p. 353), and the more holistic use of all three reference models and in Table 11 and Appendix E. The analysis of reference models, parameter values, and levels of analysis can be summarized in a deceptively simple model that forms the basis of a usable checklist (Table 12).

In cluster 1 (81 assignments), the consensus and theoretical models (7 relevant biases) provided a similar match with 85% for the consensus model and 86% for the theoretical model. These values are halfway between what could have been expected by chance (7 out of 10 biases would by chance attract 7 out of 10, or 70% of the assignments) and the maximum (100%).

In cluster 2 (59 assignments), the consensus and theoretical models (4 relevant biases) provided different degrees of match with 34% for the consensus model and 53% for the theoretical model. These values are only modestly greater than what could have been expected by chance (4 out of 10 biases would by chance attract 4 out of 10, or 40% of the assignments).

In cluster 3 (42 assignments), the consensus and theoretical models (7 relevant biases) provided very different degrees of match with 43% for the consensus model and 86% for the theoretical model.

Table 12: Analysis at the cluster level

MAP steps	Applicable biases	Fit to models	CLUSTERS
1 2 3	1. Confirmation. 2. My-Side. 3. Illusory Correlation. 4. Over-Confidence. 5. Information. 6. Availability. 7. Pattern Recognition.	**81 assignments** **85% consensus** **86% theoretical** **90% best fit**	**CLUSTER 1: PROBLEM DEFINITION**
4 5 6	1. Confirmation. 2. My-Side. 3. Illusory Correlation. 4. Over-Confidence.	**59 assignments** **34% consensus** **53% theoretical** **53% best fit**	**CLUSTER 2: DESIGN**
7 8	1. Confirmation. 2. My-Side. 3. Illusory Correlation. 4. Over-Confidence. 8. Framing (Gain vs Loss). 9. Sunk Cost Effect. 10. Illusion of Control.	**42 assignments** **43% consensus** **86% theoretical** **86% best fit**	**CLUSTER 3: IMPLEMENTATION**

4.3 Conclusion

The analysis of interview and card sort data surfaced many perspectives on the MAP. The analysis also showed that there is significant belief in the benefit and usefulness of a checklist that could improve the use and application of the MAP by junior officers. This research while exploratory does set the foundation for the development of a checklist on the basis of the holistic data in Table 12. These findings are interpreted and discussed further in the next chapter.

CHAPTER 5: DISCUSSION

The fifth chapter interprets and discusses the data analysis presented in chapter four by using logical justification and responses obtained through the semi-structured interviews and card sort activity. Detailed data is presented in Appendix D, which the previous chapter has drawn from to highlight significant findings. The following sections say what was learnt from the participants and the literature review. This is important as it is; what the majority thought, what the literature indicated and from which the synthesized model was created and matched against participants thoughts and beliefs.

5.1 The Purpose of the MAP

It was evident from the replies that there is a robust and general consensus over the purpose and usefulness of the MAP. The consensus view is that the MAP is a powerful and useful tool for dealing with complexity in military decision making. Areas can be dissected and examined in detail with more than one credible solution produced. This understanding was important as it represented an understanding by the instructors on what it is there to do and therefore why it is an important tool. However replies spoke also to the significant frustrations and difficulty's imposed by artificial time constraints. These constraints limited the instruction and repeated application of the MAP by students. Some preference was therefore expressed for simplified processes such as the 7 Questions technique. The limitations however with such simplified processes are that they do not in the view of most adequately deal with higher degrees of complexity.

5.2 The MAP Strong Points

The MAP was expressed as having significant strength in being able to place complex problems into a logical process. Problems can then be deconstructed in order to define the issue into a key focus that is identified and used as the outcome goal for solutions to address. It was

therefore highly regarded for being able to define what the problem is and support the creation of more than one viable solution.

5.3 The MAP Weak Points

A key weakness of the MAP and identified by most, centered on the lack of responsiveness to changes in the environment. The MAP can appear to be remote and isolated from the problem environment it is meant to be working within to produce solutions for. Additionally the need for a sound experience and knowledge base from which to effectively operate the process makes it a significant weakness for new users. Instructors observed that new users find themselves unknowingly subject to bias in the steps of the MAP where key decisions are made which influence problem definition and solution development.

5.4 Common and Persistent Problems

People new to the military generally find the process to be confounding and frustrating. Until it has been practiced repeatedly thereby becoming familiar, people struggle with the nuances of; language, meaning, applied knowledge and understanding of military capabilities. This was evident in the observations of instructors who commented on the differences between ex-soldiers who bring their military experience and knowledge as students compared to those direct from school. A difference was also observed in students who had been to university and who instructors believed demonstrated superior critical and disciplined thinking. Such students it was observed were more prepared to adopt and apply a formal decision making process. However, regardless of background instructors observed that students under imposed time constraints often switch to templated default behaviors that instructors recognised in the biases used in the card sort activity.

5.5 The Benefit and Usefulness of a Checklist

Instructors shared a common and positive view towards the development of a checklist. They believe that it could allow them and the students to hold focused discussions on the effect of biases in the steps of the MAP. This would establish for them a common basis for understanding and contextualising biases. Biases can then be identified, understood and their potential effects addressed through knowing of them. As discussed in the first chapter, awareness and commitment to avoiding the errors we know about is a good place to start, in order to improve our decision making.

5.6 The Assertion

The empirical study supports the following response to the second research question:

2. *Yes, instructors of junior officers in the NZ Army acknowledge that the use of the MAP is subject to bias. Yes, they tend to agree with an allocation (theoretical reference model synthesised from the literature) of key heuristics and biases to specific steps of the MAP. Yes, on at least some steps of the MAP, the instructors have devised a better allocation for the NZ Army. Most importantly, yes, the instructors do believe that a heuristics and biases checklist could be developed to improve the use of the MAP by junior officers.*

This research asserts that; a checklist developed to address biases within the steps of the MAP is regarded by participants as beneficial and useful in potentially improving the instruction and use of the MAP by junior officers. The allocation of biases to steps in the MAP produced the basis for a checklist that can be developed and used in the next MAP instruction package. This subsequent trial can test the benefit and usefulness claimed by the participants in this research and belief that it can improve instruction and use of the MAP.

CHAPTER 6: CONCLUSION

This chapter concludes this report with a summary of the key findings and responses to the research questions. It relates the findings to the purpose of the research, states the implications, acknowledges the limitations of this study and gives recommendations for future research.

6.1 Responses to the Research Questions

There are significant numbers of biases and accompanying literature on how they influence decision making. How to address these within military decision making processes and specifically the MAP however is limited. This research addressed this problem by first reviewing the literature on biases and their effects. From this a theoretical model was synthesised and evaluated by interviews with subject matter experts in the MAP and further refined by a card sort activity.

The analysis of the data collected during the interviews and card sorting activity provided responses to the two research questions posed in Chapter 1:

1. *Have heuristics and biases important to the operational command Military Decision Making Process (MDMP) been identified? If so, have particular heuristics and biases been linked to specific steps in process models such as the Joint Military Appreciation Process (JMAP) employed by the Australian Defence Forces, or the Military Appreciation Process (MAP) employed by the NZ Army? Finally, have steps been taken to ensure awareness of heuristics and biases in the training and use of the JMAP and MAP?*

2. *Do instructors of junior officers in the NZ Army acknowledge that the use of the MAP is subject to bias? Do instructors tend to agree with an allocation (based*

on a theoretical reference model synthesised from the literature) of key heuristics and biases to specific steps of the MAP? Can the instructors devise a better allocation for the NZ Army? Do the instructors believe that a heuristics and biases checklist could be developed to improve the use of the MAP by junior officers?

The response to these questions is summarised below.

From the discussion previously:

1. Section 5.1 found there was consensus on the MAP being a powerful and useful tool for dealing with complexity in military decision making.

2. Section 5.2 found that the MAP places complex problems into a logical process thereby applying a critical thinking component to decision making.

3. Section 5.3 found that, the MAP is seen as isolated from the live environment it is meant to be working to solve problems within. Also the effective understanding and use of the MAP is contingent on the knowledge and experience of the user (which is minimal) thus making them vulnerable to the effect of biases.

4. Section 5.4 found that, for the inexperienced and uninitiated in the military the MAP is confounding and frustrating. Therefore common defaults and shortcuts are being employed by students to compensate for insufficient experience, knowledge and time allocation for learning and application.

5. Section 5.5 found there is strong consensus that a checklist developed from the research would be of benefit and usefulness to the instructors and their students and improve the instruction and use of the MAP by junior officers.

Therefore, in answer to the questions: *firstly* there was no research on the identification of heuristics and biases within steps of the MAP; *secondly* a checklist can now be developed for instruction of the MAP which instructors believe could improve the use of the process by junior officers. With these findings, the implications are now discussed.

6.2 Implications

This research has implications principally for the ACS where initial MAP instruction is conducted. These implications are:

1. *While the purpose is well understood the MAP is not well practiced*: The implication is that more time needs to be allocated to practice.

2. *The MAP is a powerful tool with which to address complex military problem solving*: The implication is that it requires the user to have an intimate understanding and familiarity with the process and military capabilities in order to unlock the power within the process.

3. *Students struggle with the perfect storm of; poor military capability awareness, poor understanding of language, terms and ability to meet artificially set time constraints. This perfect storm sets the conditions for biases to influence their decision making throughout the steps of the MAP*: The implication is that students need greater

investment during instruction than what is currently afforded. Repeated cycles of supervised use will establish a stronger foundation of learning and familiarity.

4. *The steps in the MAP are subject to the effects of biases and without knowledge of these they will unknowingly influence the decision making of the user*: The implication is that formal awareness of relevant biases identified in this research could improve instruction and use of the MAP. A checklist developed for use in the instruction and subsequent application by the student could contribute to better decision making under the uncertainties of military planning.

This research also has implications for other TRADOC training elements such as Tactical School where the MAP is applied in professional development courses. External to Army the JMAP is used within the NZ Defense Collage (NZDC) where interest has been expressed in this research by the Institute for Leadership Development and the NZDF Command and Staff College.

6.3 Contribution of this Research

Previous research focused on the identification and effect specific biases played on military decision making processes. This research contributes to the military decision making process literature an MAP model that identifies and explains relevant biases.

The main contribution of this research is the identification, explanation and awareness of these relevant biases at play in each step of the MAP. A second contribution is the confirmation and ordering of these biases forming the basis of a checklist to be developed that could be of use and benefit to instructors and students.

Finally, this research found a rich assortment of similarities and differences between participants card sort consensus model, the theoretical model (based on a synthesis of the literature), and a best fit model that, when summarised in a deceptively simple table (Table 12), forms the basis of a usable checklist.

6.4 Limitations

As discussed in section 3.4.2 the following limitations made by Bryman and Bell (2015) are acknowledged and commented on further:

1. *Qualitative research is too subjective*: The results do not prove anything and there is no truth confirmed that a checklist will improve junior officer performance in using the MAP. That requires a measure of performance to be defined then tested again after the application of a checklist. This has been agreed to occur post this research when the MAP package of instruction is next conducted.

2. *Difficult to replicate:* The questions and conduct of the interviews were carefully examined and validated. This was achieved through a key informant interview where the questions were tested and the conduct supervised by a senior Victoria of University academic research supervisor.

3. *Problems of generalisation:* This is acknowledged and confirmed as a significant limitation as it applies to a specific military context. The context is the New Zealand Army and the instructors of the MAP at the ACS. However, it does have applicability within the wider army.

Further significant limitations, are detailed below.

First, this research only pertains to Army Instructors and students within ACS. Therefore, the participant responses only refer to the opinion and experiences of biases affecting the MAP within this organisation. This means that wider application in how it affects the MAP in other units and formations within the Army and NZDF have not been included.

Second, a semi-structured interview and card sort activity was used as the research instrument, which has its own limitations. Questions however carefully constructed to be clear and concise remain open to the interpretation of the participant and the biases of the writer.

Finally, this research only involved a small number of participants. This is not ideal as a larger participant group would have provided greater fidelity and diversity of experience and opinion. This is somewhat countered with the participants representing a significant group as they represented the instructional staff capability at ACS. However, further wider research would be an enhancement.

6.5 Future Research

The body of work represented here is an exploratory move towards the development of a checklist based on the MAP and bias model that has been constructed. To that end further analysis of the data will be performed and further research is deemed necessary in order to increase the scope of the study.

Further research could be used to validate the results of this work and broaden its scope. In particular quantitative research could through survey methods capture a wider Army and NZDF participant group. This would gain more diversified data drawn from across organisations such as TRADOC and NZDC.

Additional research expansion can also be achieved through examination of the JMAP. The identification and examination of relevant biases within that decision making process while noting that as a process it has different dynamics to the MAP. The JMAP is a higher level process that crosses NZDF domains as opposed to the MAP which sits within the Army domain.

Finally, this research arrives at an interesting question to pose for future research: *what is the downstream career effect of how the MAP is presently learned, practiced and tested - what decision making processes are being reinforced as a result?* It may be that current training systems that produce NZ Army leaders encourage and singularly rely on Type 1 systems thinking or *thinking fast*. Outside of time constrained, templated and doctrinally driven problem solving environments how adaptive is this type of decision making? Thinking fast is initial and reflexive, while thinking slow is more considered and rational. Putting this into context how adaptive are military leaders who are advanced on the basis of their thinking fast capabilities to strategic military/political contexts? These areas often present novel and unprecedented situations.

In such situations military leaders have little background or experience from which to rely on. They therefore require the ability to exercise Type 2 systems or *thinking slow* decisions as well. The bias *Pattern Recognition* used on card 7 in Appendix C shows the effect of a commander *thinking fast* while the intelligence operator who would have provided the information and trained in *thinking slow* advises caution that the information is not actionable intelligence. The commander who ignores such advice and acts makes a Type 1 error committing forces to an action that on probability of risk-to-payoff should not be undertaken.

"Turning and turning in the widening gyre

The falcon cannot hear the falconer;

Things fall apart; the center cannot hold;

Mere anarchy is loosed upon the world,

The blood-dimmed tide is loosed, and everywhere

The ceremony of innocence is drowned;

The best lack all conviction, while the worst

Are full of passionate intensity.… …..”

William Butler Yeats – ‘The Second Coming’ 1st stanza

Like the falcon in Yeats’s poem the way we think and the type of thinking can become separated leaving our minds prone to the derailing effects of biased decision making. Our logic; falls apart, it cannot hold, our solutions fall and we confront failure. Bright people lack confidence in the process, while others are bent on demonstrating decisive action defending their decisions with passionate intensity. Failure in the military equates often with awful consequence.

As stated in the first chapter awareness and commitment to avoiding the errors we know about is a good place to start. A checklist therefore appears to be that good place.

REFERENCES

Barnes, T. (2008). American pragmatism: Towards a geographical introduction. *Geoforum, 39*(4), 1542-1554.

Bazerman, M., & Moore, D. (2009). *Judgment in managerial decision making / Max H. Bazerman, Don A. Moore* (7th ed.). Hoboken, NJ: John Wiley & Sons.

Bryman, A., & Bell, E. (2015). *Business research methods / Alan Bryman and Emma Bell.* (4th ed.). Oxford: Oxford Univ. Press.

Deetz, S. (1996). Describing Differences in Approaches to Organization Science: Rethinking Burrell and Morgan and Their Legacy. *Organization Science, 7*(2), 191-207.

DiCicco-Bloom, B., & Crabtree, B. (2006). The qualitative research interview. *Medical Education, 40*(4), 314-321.

Dobson-Keeffe, N., & Coaker, W. (2015). *Thinking more rationally: Cognitive biases and the joint military appreciation process. Australian Defence Force Journal,* (197), 5-16.

Eysenck, M. W., & Groome, D. (Eds.). (2015). *Cognitive Psychology: Revisiting the Classic Studies*. London, England: SAGE.

Faiks, A., & Hyland, N. (2000). Gaining user insight: A case study illustrating the card sort technique. *College & Research Libraries, 61*(4), 349-357.

Gawande, A. (2009). *The Checklist Manifesto: How to Get Things Right.* New York, NY: Henry Holt and Company.

Gigerenzer, G. (2014). *Risk savvy: How to make good decisions. London, England: Penguin Publishing Group.*

Gilovich, T., Griffin, D., & Kahneman, D. (2002). *Heuristics and biases: The psychology of intuitive judgment*. London, England: Cambridge University Press.

Google Scholar. (2016). *Judgement Under Uncertainty*. Retrieved from https://scholar.google.co.nz/scholar?hl=en&q=judgement+under+uncertainty&btnG=&as_sdt=1%2C5&as_sdtp

Hannah, S., Balthazard, P., Waldman, D., Jennings, P., & Thatcher, R. (2013). The Psychological and Neurological Bases of Leader Self-Complexity and Effects on Adaptive Decision-Making. *Journal of Applied Psychology, 98*(3), 393-411.

Janser, M. (2007). *Cognitive Biases in Military Decision Making*. Carlisle, PA: U.S. Army War College.

Kahneman, D. (2011). *Thinking, fast and slow*. New York, NY: Farrar, Straus and Giroux.

Kahneman, D., Slovic, P., & Tversky, A. (1982). *Judgment under uncertainty: Heuristics and biases. Cambridge, United Kingdom*: Cambridge University Press.

Lehrer, J. (2009). *The decisive moment: How the brain makes up its mind.* Melbourne, Australia: Text Publishing.

McDonald, P., & Tang, Y. (2014). Neuroscientific Insights Into Management Development. *Group & Organization Management, 39*(5), 475-503.

Nobel media. (2014). *Daniel Kahneman – Biographical.* Retrieved from http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2002/kahneman-bio.html

Roth, R., Finch, B., Blanford, J., Klippel, A., Robinson, A., & MacEachren, A. (2011). Card Sorting For Cartographic Research and Practice. *Cartography and Geographic Information Science, 38*(2), 89-99.

Santos, G. (2006). Card sort technique as a qualitative substitute for quantitative exploratory factor analysis. *Corporate Communications: An International Journal, 11*(3), 288-302.

Sheffield, J. (2005) Systemic Knowledge and the V-model. *International Journal of Business Information Systems,* vol1, 1-2, p. 83-101.

Sheffield, J. (2015). Critical reflections on decisive moments. *Emergence: Complexity and Organization*, 17(4), 1-14.

Sheffield, J., & Margetts, R. (2016). The Soldier: My Decisive Moment in Afghanistan. *Emergence: Complexity and Organization*, *18*(1), 1-12.

Tactical School Guide [TSG]. (2015). *Military Appreciation Process. Wellington, New Zealand:* New Zealand Army.

Waldman, D., Balthazard, P., & Peterson, S. (2011). Leadership and neuroscience: Can we revolutionize the way that inspirational leaders are identified and developed. *The Academy of Management Perspectives, 25*(1), 60-74.

Williams, B. (2010). Heuristics and biases in military decision making. *Military Review*, *90*(5), 40.

APPENDICES

Appendix A: Letter of Request for a personal interview

Letter Request for a Personal Interview

28 July 2016

Lt Col Roger Margetts, ONZM

NZDF
2 Aitken Street
Thorndon, 6011
WELLINGTON

Dear XXXXX

I would like the opportunity to interview you as part of my MBA Business Research Project. As cognitive shortcuts heuristics and biases can affect decision making leading to suboptimal outcomes. Present introduction and instruction on the use of the Military Appreciation Process (MAP) does not formally present heuristics and biases to be aware of or offer any tool to recognise and appreciate their impact on effective decision making. By conducting this research it is proposed that these deficiencies are identified and addressed.

The interview is designed to take between 60-90 minutes. The Commandant of Army Command School has agreed to your participation in this research.

The success of this research is reliant upon your honest opinion so maintaining confidentiality is of the utmost importance. **Under no circumstances will the information presented during the interview be attributed to any one individual. The organisation will be identified but your name and title will remain anonymous.** Interview tapes and transcripts will be kept in a locked office, and will be destroyed at the conclusion of the research. The research findings will be published in the Victoria University library and excerpts may be included in academic publications and/or academic conferences.

Victoria University of Wellington has granted ethical approval as a teaching activity and this project has been reviewed by the Course Coordinator.

With your permission the interview will be recorded and a summary of the report will be provided before the project is submitted for examination. If you for any reason would like to make contact regarding this research please contact one of the following:

Roger Margetts	021 419 611	margetroge@myvuw.ac.nz
Dr Jim Sheffield	04 463 5085	jim.sheffield@vuw.ac.nz

Yours sincerely

[Name]

Appendix B: Consent form for Personal Interview

Consent Form for Personal Interview

Personal Interview

CONSENT FORM

I agree to be interviewed by Lt Col Roger Margetts for the purposes of his MBA Business Research Project and consent to the use of my opinions and information. I understand that none of the opinions or statements that I make during the interview will be attributed to me personally, and that I may withdraw from the research before the 29th of August. I am also aware that the findings derived from this study will be published in the Victoria University Library and excerpts may be included in academic publications and/or academic conferences.

I have been informed of the purpose of the research and the confidentiality conditions.

I understand that raw data collected during the interview will only be available to the researcher, Lt Col Margetts, and his supervisor, Dr Jim Sheffield.

I have been informed that a summary of the report will be provided before the project is submitted for examination.

Name: …… Date: ……

Signed: ……..

If you would like a copy of the research summary please add your email/address below:

……..

Appendix C: Interview Guide

Interview Guide Interview # **Participant:**

Thank you for agreeing to being interviewed as part of my MBA Business Research Project.

Cognitive shortcuts heuristics and biases can affect decision making leading to suboptimal outcomes.

Present introduction and instruction on the use of the Military Appreciation Process (MAP) does not formally present heuristics and biases to be aware of or offer any tool to recognise and appreciate their impact on effective decision making. By conducting this research it is proposed that these deficiencies are identified and addressed.

The interview is designed to take between 60-90 minutes and will be in two parts. Part one where you will be asked a series of open questions and Part two where you will be asked to sort cards to steps in the MAP.

The success of this research is reliant upon your honest opinion so maintaining confidentiality is of the utmost importance. **Under no circumstances will the information presented during the interview be attributed to any one individual. The organisation will be identified but your name and title will remain anonymous.** Interview tapes and transcripts will be kept in a locked office, and will be destroyed at the conclusion of the research. The research findings will be published in the Victoria University library and excerpts may be included in academic publications and/or academic conferences.

Victoria University of Wellington has granted ethical approval as a teaching activity and this project has been reviewed by the Course Coordinator.

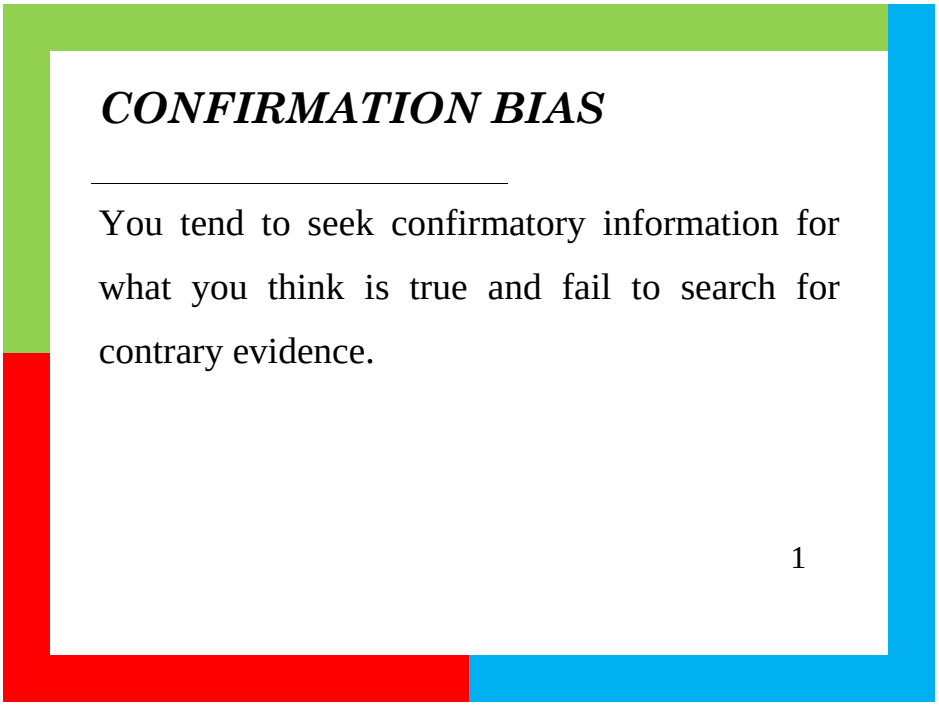
With your permission the interview will be recorded and a summary of the report will be provided before the project is submitted for examination.

Check consent form signed.

Participant Demographics

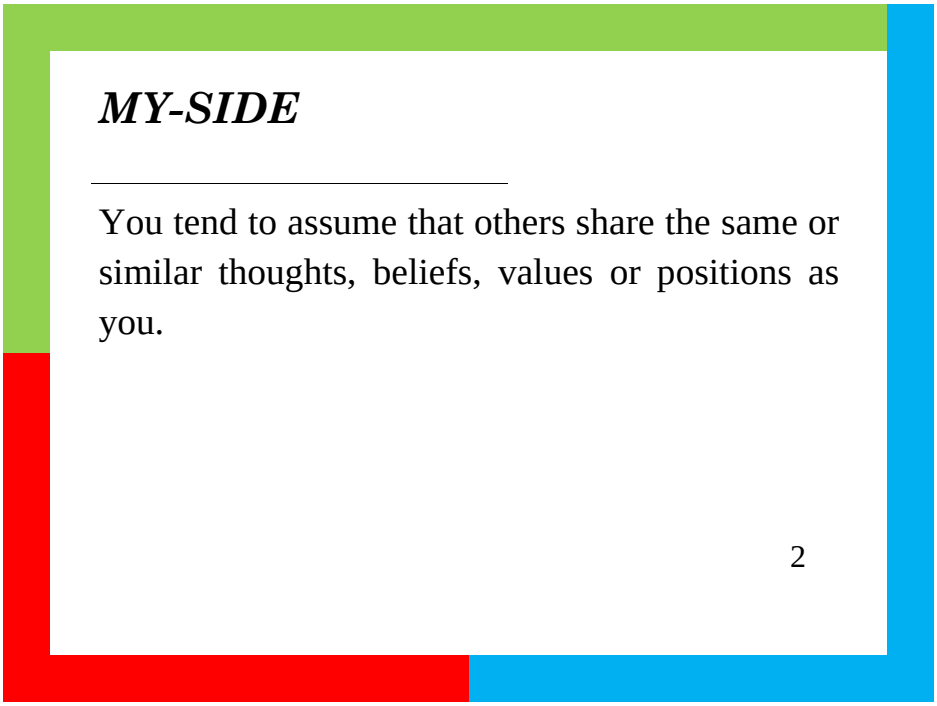
Number of years in the military.	
Number of deployments.	
Number of development exercises.	
Number of professional courses.	

Part One: **Open Questions**	**Interview #**
I am about to ask you 7 questions that are to do with the MAP and your experience and opinion on it.	
Warm up questions: 1. What is the purpose of the MAP and how useful is it to make decisions using the MAP in critical situations? 2. What do you think are the MAPs greatest strengths and why? 3. What are its greatest's weaknesses and why? 4. What are the difficulties those new to using it find? 5. Do you see any pattern to these problems? 6. Are these problems persistent? 7. Would a checklist be useful?	
Part Two: **Card Sort**	**Interview #**
We will now use the cards sort to see how you apply them to the steps in the MAP which I have put up on the wall.	
A. Sort bias cards onto the MAP steps that you feel align with your experience of where they fit. B. You can sort the cards across more than one step.	



MILITARY EXAMPLE

Based on your knowledge of enemy tactics, techniques and procedures you will explain any observation of enemy action as *conforming* to this knowledge *even* when it may be unwise to do so as it restricts a wider assessment of enemy actions that could indicate the enemy is employing deception in order to lead you into a predicted course of action.



MILITARY EXAMPLE

You appreciate the actions and reactions of the enemy from the position of your perspective (beliefs, values or positions) and *not* the enemy's.

This leads to incorrect assumptions made in *your analysis* of the enemy.

ILLUSORY CORRELATION

You draw loose conclusions from the situation and previous experiences.

This comes from relationships between factors that do not exist.

3

MILITARY EXAMPLE

You note from the *situation* that the enemy is preparing an attack and has deployed a security element to a flank. When the enemy did this *previously* they also positioned their anti-armor assets there as well.

However, this is not the case just because that's what they did before. This bias has led you to see a *correlation* where there is none and so has exposed the weaknesses of your plan.

OVER-CONFIDENCE

You tend to be *overconfident* of your judgements when answering moderately to extremely difficult questions.

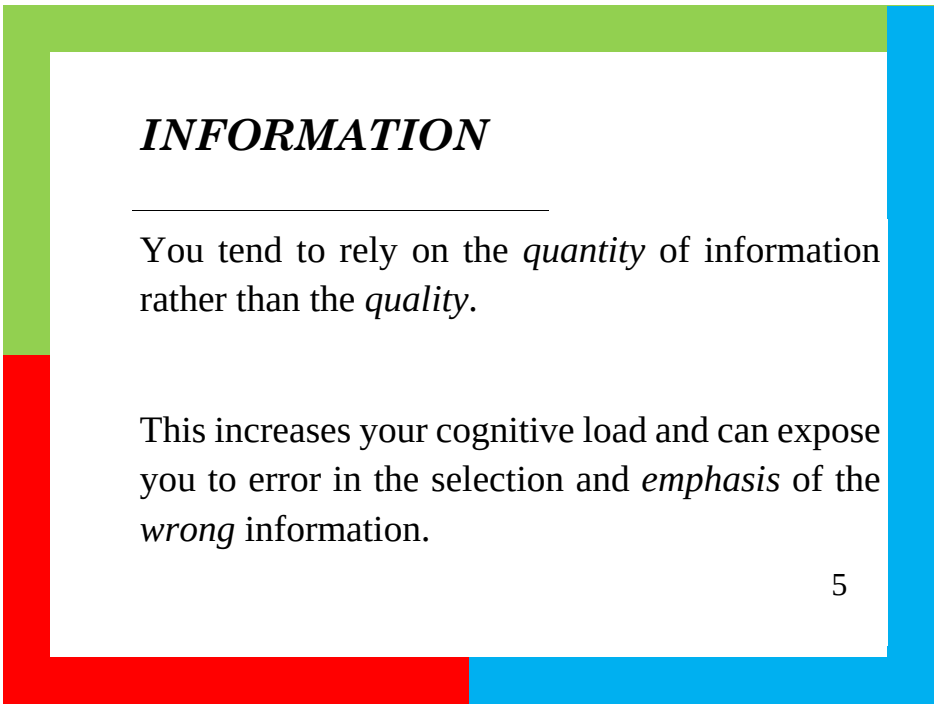
Seen where *confidence* systematically *exceeds* accuracy you are more sure you are right than you *deserve* to be.

4

MILITARY EXAMPLE

You have arrived at a decision on the most likely enemy course of action; you are so *confident* that you form your plan around addressing this specific threat to your plan.

However, this *confidence* has seen you *under appreciate* the risk of other actions the enemy could take and seen you also *overestimate* the *effectiveness* of your plan to deal with them.



MILITARY EXAMPLE

You have been conducting your appreciation based on the planning information provided and believe that by processing *all the information available* you will make a better decision.

However, this leads you to a *paralysis through analysis* where you are now under self-induced time/performance pressure and must make a decision. You have not been able to think through the most relevant information and devise a plan which therefore leads to a poor analysis and detailed plan.

AVAILABILITY

The more times you can recall a particular situation or occurrence, the more likely you will believe that it will happen again.

6

MILITARY EXAMPLE

You have observed a repeated patrol pattern where the enemy will fly a helicopter through an area close to you not stopping. Another day and the flight is detected and you assume it will conform to the other previous patterns and therefore take no further action.

However, on this occurrence the helicopter inserts a team into your area undetected by you. You *missed* this.

PATTERN RECOGNITION

You tend to make sense of something by seeing a pattern to explain something where in fact *no* pattern exists.

It is an attempt to *fill in the gaps* in what we can see and understand. You seek to make sense of an *incomplete* data set.

7

MILITARY EXAMPLE

You are performing analysis of the intelligence estimates. You are looking at the pattern formed by the number of communications intercepts and plot them on a map of the area you are concerned with. You now see a pattern that leads you to conclude enemy concentration areas.

However, these intercepts are random and do not substantiate the pattern and conclusions you have reached.

FRAMING (Gain vs Loss)

You tend to react to a particular choice in different ways depending on *how* it is presented; as a *gain* or as a *loss*.

You therefore tend to *accept loss* when a *positive frame* is used.

8

MILITARY EXAMPLE

You have selected a course of action on the identification of the *survival rate (a gain)* prediction for the plan.

However, this was *framed* by you when creating the courses of action. This has meant you *minimized* the real appreciation of the risk by avoiding the *casualty rate (a loss)*

prediction for the plan.

SUNK COST EFFECT

You maintain and/or increase your commitment to a course of action or effort *despite* new evidence indicating the *benefit of doing so* is outweighed by the *cost* and/or risk.

This is irrational; however the drive to not waste this effort is strong.

9

MILITARY EXAMPLE

You have been assessing information and made a plan. You have then noticed an aspect that you have overlooked which if appreciated earlier would have led to the development of a different plan. You decide you are too far in to change the plan and so justify maintaining commitment to the current plan.

This shows that you have *ignored* relevant or new information that *challenges* the ideas you had when making a decision.

ILLUSION OF CONTROL

You have a strong tendency to believe that you can *control* the environment.

This leads to you *underestimate risks*. It also makes you vulnerable to *surprises* that will have a major effect on you.

10

MILITARY EXAMPLE

You have selected a course of action that is based on the prediction of *controlling* a particular enemy reaction where they will accept decisive engagement at a specific time and place. The enemy will then commit their reserve which you will counter and destroy.

However, the enemy *does not conform* to your prediction. They launch an attack early into your flank. This was *unexpected. Y*ou have no response for this as your reserve is positioned to react to how *you* saw the enemy would react to *your* plan. You have been *surprised*.

Appendix D: Analysis at the Step Level (Table 10)

Explanation

1. Analyse the match of participant bias assignments to steps, clusters of steps, and the MAP as a whole with reference to the criteria in an empirically-derived consensus model.
2. Analyse the match of participant bias assignments to steps, clusters of steps, and the MAP as a whole with reference to the criteria in a theoretical best-practice model.
3. Analyse the match of participant bias assignments to steps, clusters of steps, and the MAP as a whole with reference to a best-fit model.
4. Extract certain parameters from each analysis, including the number of assignments meeting:
    a. Both empirical and theoretical Models (BM), the Empirical Model only (EO), the Theoretical Model only (TO), Neither Model (NM).
    b. Note that assignments on the basis of the empirical model EM=BM+EO and assignments on the basis of the theoretical model TM=BM+TO.
    c. Model Difference (MD) (i.e., EO+TO) is an accurate/detailed/specific, and useful measure formed by adding all assignments where the basis for inclusion gave different results.
    d. Model Improvement (MI): (The positive or negative value of) TO minus EO. Net number of biases included as a result of applying theoretical criteria instead of empirical criteria.
    e. Model Difference (EO+TO) (MD) is a more detailed, and useful measure formed by adding all assignments where the basis for inclusion gave different results.
    f. The Worst Fit Model (WFM), i.e., BFM plus MIN (EO, TO) and most importantly, the Best Fit Model (BFM), i.e., BFM plus MAX (EO, TO).

Source of data: Table 10 page 47.

Step in	Possible	Biases assigned by participants									Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	1	14%
1	1										0	N	EM		
1	2										0	N	Correct	5	71%
1	3	1									1	N	Incorrect	2	29%
1	4										0	N			
1	5	1	1	1	1		1				5	Y	**TM (best fit model)**		
1	6						1				1	Y	Correct*	6	86%
1	7										0	Y	Incorrect	1	14%
1	8										0	N			
1	9										0	N	MI		
1	10										0	N	Correct	1	14%
Total counts		2	1	1	1	0	2	0	0	0	**7**		Incorrect	-1	-14%
Parameters	**BM:**	**5**	**EO:**	**0**	**TO:**	**1**	**NM:**	1	**WFM**	5	5	6	**BFM**	6	85.7%

Step in	Possible	Biases assigned by participants									Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	10	38%
2	1								1	1	2	Y	**EM (equal best fit)**		
2	2		1	1	1	1	1			1	6	Y	Correct	16	62%
2	3		1	1	1						3	Y	Incorrect	10	38%
2	4		1	1	1		1	1			5	Y			
2	5		1	1		1	1	1			5	N	**TM (equal best fit)**		
2	6									1	1	N	Correct*	16	62%
2	7			1							1	N	Incorrect	10	38%
2	8						1		1		2	N			
2	9								1		1	N	MI		
2	10										0	N	Correct	0	0%
Total counts		0	4	5	3	2	4	2	3	3	**26**		Incorrect	0	0%
Parameters	**BM:**	**11**	**EO:**	**5**	**TO:**	**5**	**NM:**	5	**WFM**	16	16	16	**BFM**	16	61.5%

Step in	Possible	Biases assigned by participants									Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	25	52%
3	1		1	1	1	1	1	1		1	7	N	**EM (best fit model)**		
3	2	1	1	1	1	1		1	1	1	8	N	Correct	36	75%
3	3						1	1	1		3	N	Incorrect	12	25%
3	4	1				1		1			3	N			
3	5				1			1	1	1	4	Y	TM		
3	6	1	1	1	1	1				1	6	Y	Correct*	19	40%
3	7	1	1	1	1	1	1	1	1	1	9	Y	Incorrect	29	60%
3	8										0	N			
3	9					1				1	2	N	MI		
3	10	1	1		1	1		1	1		6	N	Correct	-17	-35%
Total counts		5	5	4	6	7	3	7	5	6	**48**		Incorrect	17	35%
Parameters	**BM:**	**15**	**EO:**	**21**	**TO:**	**4**	**NM:**	8	**WFM**	19	36	19	**BFM**	36	75.0%

Steps in	Possible		Biases assigned by participants								Basis of inclusion		CLUSTER 1		
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	36	44%
1, 2, AND 3	1	0	1	1	1	1	1	1	1	2	9	Y	EM (best fit model)		
1, 2, AND 3	2	1	2	2	2	2	1	1	1	2	14	Y	Correct	57	70%
1, 2, AND 3	3	1	1	1	1	0	1	1	1	0	7	Y	Incorrect	24	57%
1, 2, AND 3	4	1	1	1	1	1	1	2	0	0	8	Y			
1, 2, AND 3	5	1	2	2	2	1	2	2	1	1	14	Y	TM		
1, 2, AND 3	6	1	1	1	1	1	1	0	0	2	8	Y	Correct*	41	51%
1, 2, AND 3	7	1	1	2	1	1	1	1	1	1	10	Y	Incorrect	40	95%
1, 2, AND 3	8	0	0	0	0	0	1	0	1	0	2				
1, 2, AND 3	9	0	0	0	0	1	0	0	1	1	3		MI		
1, 2, AND 3	10	1	1	0	1	1	0	1	1	0	6		Correct*	-16	-20%
Total counts		7	10	10	10	9	9	9	8	9	**81**		Incorrect	16	20%
Parameters	**BM:**	**31**	**EO:**	**26**	**TO:**	**10**	**NM:**	**14**	**WFM**	41	57	41	**BFM**	58	71.6%

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	3	13%
4	1							1			1	Y	EM		
4	2		1						1		2	Y	Correct	12	52%
4	3	1	1	1	1	1	1		1		7	Y	Incorrect	11	48%
4	4	1		1			1	1	1		5	Y			
4	5										0	N	TM (best fit model)		
4	6	1	1	1							3	N	Correct*	15	65%
4	7				1					1	2	N	Incorrect	8	35%
4	8				1						1	N			
4	9			1							1	N	MI		
4	10		1								1	N	Correct	3	13%
Total counts		3	4	4	3	1	2	2	3	1	**23**		Incorrect	-3	-13%
Parameters	**BM:**	**12**	**EO:**	**0**	**TO:**	**3**	**NM:**	8	**WFM**	12	12	15	**BFM**	15	65.2%

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	6	25%
5	1				1				1	1	3	Y	EM		
5	2	1								1	2	Y	Correct	6	25%
5	3							1			1	Y	Incorrect	18	75%
5	4	1		1	1	1			1	1	6	Y			
5	5										0	N	TM (best fit model)		
5	6				1				1		2	N	Correct*	12	50%
5	7							1			1	N	Incorrect	12	50%
5	8	1	1			1				1	4	N			
5	9							1		1	2	N	MI		
5	10					1		1	1		3	N	Correct	6	25%
Total counts		3	1	1	3	3	0	4	4	5	**24**		Incorrect	-6	-25%
Parameters	**BM:**	**6**	**EO:**	**0**	**TO:**	**6**	**NM:**	12	**WFM**	6	6	12	**BFM**	12	50.0%

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	4	33%
6	1	1		1							2	Y	EM		
6	2			1							1	Y	Correct	0	0%
6	3										0	Y	Incorrect	12	100%
6	4		1								1	Y			
6	5								1		1	N	**TM (best fit model)**		
6	6						1	1			2	N	Correct*	4	33%
6	7		1								1	N	Incorrect	8	67%
6	8							1			1	N			
6	9					1					1	N	MI		
6	10	1					1				2	N	Correct	4	33%
Total counts		2	2	2	0	1	2	2	1	0	**12**		Incorrect	-4	-33%
Parameters	**BM:**	**0**	**EO:**	**0**	**TO:**	**4**	**NM:**	8	**WFM**	0	0	4	**BFM**	4	33.3%

Steps in	Possible		Biases assigned by participants								Basis of inclusion		**CLUSTER 2**		
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	13	22%
4, 5, AND 6	1	1	0	1	1	0	0	1	1	1	6	Y	EM		
4, 5, AND 6	2	1	1	1	0	0	0	0	1	1	5	Y	Correct	18	31%
4, 5, AND 6	3	1	1	1	1	1	1	1	1	0	8	Y	Incorrect	41	69%
4, 5, AND 6	4	2	1	2	1	1	1	1	2	1	12	Y			
4, 5, AND 6	5	0	0	0	0	0	0	0	1	0	1		**TM (best fit model)**		
4, 5, AND 6	6	1	1	1	1	0	1	1	1	0	7		Correct*	31	53%
4, 5, AND 6	7	0	1	0	1	0	0	1	0	1	4		Incorrect	28	47%
4, 5, AND 6	8	1	1	0	1	1	0	1	0	1	6				
4, 5, AND 6	9	0	0	1	0	1	0	1	0	1	4		MI		
4, 5, AND 6	10	1	1	0	0	1	1	1	1	0	6		Correct*	13	22%
Total counts		8	7	7	6	5	4	8	8	6	**59**		Incorrect	-13	-22%
Parameters	**BM:**	**18**	**EO:**	**0**	**TO:**	**13**	**NM:**	**28**	**WFM**	18	18	31	**BFM**	31	52.5%

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	11	55%
7	1					1	1				2	Y	EM		
7	2							1			1	Y	Correct	5	25%
7	3								1		1	Y	Incorrect	15	75%
7	4					1	1				2	Y			
7	5									1	1	N	**TM (best fit model)**		
7	6						1	1			2	N	Correct*	6	30%
7	7										0	N	Incorrect	14	70%
7	8	1		1				1	1		4	N			
7	9	1		1	1		1	1			5	N	MI		
7	10			1					1		2	N	Correct	1	5%
Total counts		2	0	3	1	2	4	4	3	1	20		Incorrect	-1	-5%
Parameters	**BM:**	**0**	**EO:**	**5**	**TO:**	**6**	**NM:**	9	**WFM**	5	5	6	**BFM**	6	30.0%

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	8	36%
8	1			1						1	2	N	EM		
8	2									1	1	N	Correct	5	23%
8	3					1				1	2	N	Incorrect	17	77%
8	4									1	1	N			
8	5	1									1	N	TM (best fit model)		
8	6									1	1	N	Correct*	13	59%
8	7									1	1	N	Incorrect	9	41%
8	8		1	1	1		1			1	5	Y			
8	9		1				1	1		1	4	Y	MI		
8	10		1	1	1					1	4	Y	Correct	8	36%
Total counts		1	3	3	2	1	2	1	0	9	22		Incorrect	-8	-36%
Parameters	**BM:**	**5**	**EO:**	**0**	**TO:**	**8**	**NM:**	9	**WFM**	5	5	13	**BFM**	13	59.1%

Steps in	Possible		Biases assigned by participants								Basis of inclusion		**CLUSTER 3**		
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	19	45%
7, AND 8	1	0	0	1	0	1	1	0	0	1	4	Y	EM		
7, AND 8	2	0	0	0	0	0	0	1	0	1	2	Y	Correct	10	24%
7, AND 8	3	0	0	0	0	1	0	0	1	1	3	Y	Incorrect	32	76%
7, AND 8	4	0	0	0	0	1	1	0	0	1	3	Y			
7, AND 8	5	1	0	0	0	0	0	0	0	1	2		TM (best fit model)		
7, AND 8	6	0	0	0	0	0	1	1	0	1	3		Correct*	19	45%
7, AND 8	7	0	0	0	0	0	0	0	0	1	1		Incorrect	23	55%
7, AND 8	8	1	1	2	1	0	1	1	1	1	9	Y			
7, AND 8	9	1	1	1	1	0	2	2	0	1	9	Y	MI		
7, AND 8	10	0	1	2	1	0	0	0	1	1	6	Y	Correct*	9	21%
Total counts		3	3	6	3	3	6	5	3	10	42		Incorrect	-9	-21%
Parameters	**BM:**	**5**	**EO:**	**5**	**TO:**	**14**	**NM:**	**18**	**WFM**	**10**	10	19	**BFM**	19	45.2%

Steps in	Possible		Biases assigned by participants								Basis of inclusion **MAP-ASSIGNMENT TO SPECIFIC STEPS**				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	68	37%
Each & every step	1	1	1	3	2	2	2	2	2	4	19	Y	EM		
Each & every step	2	2	3	3	2	2	1	2	2	4	21	Y	Correct	85	46.7%
Each & every step	3	2	2	2	2	2	2	2	3	1	18	Y	Incorrect	97	53%
Each & every step	4	3	2	3	2	3	3	3	2	2	23	Y			
Each & every step	5	2	2	2	2	1	2	2	2	2	17	Y	TM (best fit model)		
Each & every step	6	2	2	2	2	1	3	2	1	3	18	Y	Correct*	91	50%
Each & every step	7	1	2	2	2	1	1	2	1	3	15	Y	Incorrect	91	50%
Each & every step	8	2	2	2	2	1	2	2	2	2	17	Y			
Each & every step	9	1	1	2	1	2	2	3	1	3	16	Y	MI		
Each & every step	10	2	3	2	2	2	1	2	3	1	18	Y	Correct*	6	3%
Total counts		18	20	23	19	17	19	22	19	25	182		Incorrect	-6	-3%
Parameters	**BM:**	54	**EO:**	31	**TO:**	37	**NM:**	60	**WFM**	69	85	91	**BFM**	108	59.3%

													MAP AS A WHOLE		
Steps in	Possible		Biases assigned by participants								Basis of inclusion		ASSIGNMENT TO ANY STEP		
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	0	0%
Any step	1	1	1	3	2	2	2	2	2	4	19	Y	EM		
Any step	2	2	3	3	2	2	1	2	2	4	21	Y	Correct	182	100%
Any step	3	2	2	2	2	2	2	2	3	1	18	Y	Incorrect	0	0%
Any step	4	3	2	3	2	3	3	3	2	2	23	Y			
Any step	5	2	2	2	2	1	2	2	2	2	17	Y	TM		
Any step	6	2	2	2	2	1	3	2	1	3	18	Y	Correct*	182	100%
Any step	7	1	2	2	2	1	1	2	1	3	15	Y	Incorrect	0	0%
Any step	8	2	2	2	2	1	2	2	2	2	17	Y			
Any step	9	1	1	2	1	2	2	3	1	3	16	Y	MI		
Any step	10	2	3	2	2	2	1	2	3	1	18	Y	Correct	0	0%
Total counts		18	20	23	19	17	19	22	19	25	182		Incorrect	0	0%
Parameters		Number of assignments that meet the critierion									N/A	N/A	**BFM**		
Average, all 10 biases assigned to a single step		2.25	2.5	2.9	2.4	2.1	2.4	2.8	2.4	3.1	22.8				
Average assignment for a bias		1.8	2	2.3	2	1.7	1.9	2	1.9	2.5	18.2				

Comment:

Participants made 91 assignments on the basis of theory (TM), and 85 assignments on the basis of consensus (EM).

This suggests that, while the consensus criteria is 7% more restrictive than the theory criterion, both are similar enough for direct comparisons to be made.

To avoid loss of information the complete analysis was first be conducted at the level of each step, then at the level of clusters, then the MAP as a whole

Analysis at the step level promotes rigor and provides the basis for an aggregation to a higher level (cluster) that may provide a more useful starting point for the development of a checklist.

In this version, numbers in columns N, O, and P record the total step-specific assignments to individual steps in the cluster.

Note the impact of the more rigorous "AND" logic approach to step & cluster analyses in Appendix D, and the more relaxed "OR" logic approach to step & cluster analyses in Appendix E

The analysis at the step level identifies:

- The most important step (i.e. biggest target of biases) (step 3 was the target of 48 biases).
- (EM=BM+EO) the step where the empirical results produced the strongest consensus (step 3 had a 75% consensus).
- (EM=BM+EO) the step where the empirical results produced the weakest consensus (step 6 had 0% consensus).

- (TM=BM+TO) the step where the theoretical results produced the strongest prediction (step 1 had 86% match).

- (TM=BM+TO) the step where the theoretical results produced the weakest prediction (step 7 had 30% match).

- (MD) the step where the difference between empirical and theoretical results was greatest (step 7: 55% closely followed by step 3 with a 52% difference).

- (MD) the step where the difference between empirical and theoretical results was the least (steps 1 and 4 with a 13% difference).

- (MI) the step where the net improvement between empirical and theoretical predictions was most positive (step 8 had a 36% net improvement, step 6 had a 33% net improvement).

- (MI) the step where the net improvement between empirical and theoretical predictions was most negative (step 3: negative 35% net improvement).

The analysis at the step & cluster level (AND logic) identifies:

- The most important cluster (ie biggest target of biases) (cluster 1 was the target of 81, followed by cluster 2 (59 biases), and cluster 3 (42 biases)).

- (EM=BM+EO) the cluster where the empirical results produced the strongest consensus (cluster 1 had 70% consensus, followed by cluster 2 (31%), and cluster 3 (24%)).

- (EM=BM+EO) the cluster where the empirical results produced the weakest consensus (see above).

- (TM=BM+TO) the cluster where the theoretical results produced the strongest prediction (all are close -cluster 1 had 51% match, cluster 2 had 53% match, cluster 3 had 45% match).

- (TM=BM+TO) the cluster where the theoretical results produced the weakest prediction (see above).

- (MD) the cluster where the difference between empirical and theoretical predictions was greatest (cluster 3 45% difference, closely followed by cluster 1 44% difference, cluster 2 22% difference).

- (MD) the cluster where the difference between empirical and theoretical predictions was the least (see above).

- (MI) the cluster where the net improvement between empirical and theoretical predictions was most positive while cluster 2 had a 22% improvement.

- Followed closely by cluster 3 with a 21% improvement, while cluster 1 had a negative 20% net improvement.

- (MI) the step where the net improvement between empirical and theoretical predictions was most negative (see above).

Appendix E: Analysis at the Step OR Cluster Levels (Table 11)

Explanation

1. Analyse the match of participant bias assignments to steps, clusters of steps, and the MAP as a whole with reference to the criteria in an empirically-derived consensus model.
2. Analyse the match of participant bias assignments to steps, clusters of steps, and the MAP as a whole with reference to the criteria in a theoretical best-practice model.
3. Analyse the match of participant bias assignments to steps, clusters of steps, and the MAP as a whole with reference to a best-fit model.
4. Extract certain parameters from each analysis, including the number of assignments meeting:
    a. Both empirical and theoretical Models (BM), the Empirical Model only (EO), the Theoretical Model only (TO), Neither Model (NM).
    b. Note that assignments on the basis of the empirical model EM=BM+EO and assignments on the basis of the theoretical model TM=BM+TO.
    c. Model Difference (MD) (i.e., EO+TO) is an accurate/detailed/specific, and useful measure formed by adding all assignments where the basis for inclusion gave different results.
    d. Model Improvement (MI): (The positive or negative value of) TO minus EO. Net number of biases included as a result of applying theoretical criteria instead of empirical criteria.
    e. Model Difference (EO+TO) (MD) is a more detailed, and useful measure formed by adding all assignments where the basis for inclusion gave different results.
    f. The Worst Fit Model (WFM), i.e., BFM plus MIN (EO, TO) and most importantly, the Best Fit Model (BFM), i.e., BFM plus MAX (EO, TO).

Source of data: Table 10 page 47.

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	1	14%
1	1										0	Y	EM		
1	2										0	Y	Correct	6	86%
1	3	1									1	Y	Incorrect	1	14%
1	4										0	Y			
1	5	1	1	1	1		1				5	Y	**TM (best fit model)**		
1	6						1				1	Y	Correct*	7	100%
1	7										0	Y	Incorrect	0	0%
1	8										0	N			
1	9										0	N	MI		
1	10										0	N	Correct	1	14%
Total counts		2	1	1	1	0	2	0	0	0	**7**		Incorrect	-1	-14%
Parameters	**BM:**	**6**	**EO:**	**0**	**TO:**	**1**	**NM:**	0	**WFM**	6	6	7	**BFM**	7	100%

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	3	12%
2	1								1	1	2	Y	EM		
2	2		1	1	1	1	1			1	6	Y	Correct	20	77%
2	3		1	1	1						3	Y	Incorrect	6	23%
2	4		1	1	1		1	1			5	Y			
2	5		1	1		1	1	1			5	Y	TM (best fit model)		
2	6									1	1	Y	Correct*	23	88%
2	7			1							1	Y	Incorrect	3	12%
2	8						1		1		2	N			
2	9								1		1	N	MI		
2	10										0	N	Correct	3	12%
Total counts		0	4	5	3	2	4	2	3	3	26		Incorrect	-3	-12%
Parameters	BM:	20	EO:	0	TO:	3	NM:	3	WFM	20	20	23	BFM	23	88.5%

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	9	19%
3	1		1	1	1	1	1	1		1	7	Y	**Empirical basis (best fit model)**		
3	2	1	1	1	1	1		1	1	1	8	Y	Correct	43	90%
3	3						1	1	1		3	Y	Incorrect	5	10%
3	4	1				1		1			3	Y			
3	5				1			1	1	1	4	Y	**TM**		
3	6	1	1	1	1	1				1	6	Y	Correct*	40	83%
3	7	1	1	1	1	1	1	1	1	1	9	Y	Incorrect	8	17%
3	8										0	N			
3	9					1				1	2	N	MI		
3	10	1	1		1	1		1	1		6	N	Correct	-3	-6%
Total counts		5	5	4	6	7	3	7	5	6	**48**		Incorrect	3	6%
Parameters	**BM:**	**37**	**EO:**	**6**	**TO:**	**3**	**NM:**	2	**WFM**	40	43	40	**BFM**	43	89.6%

Steps in	Possible		Biases assigned by participants								Basis of inclusion		CLUSTER 1		
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	13	16%
1, 2, OR 3	1	0	1	1	1	1	1	1	1	2	9	Y	**EM**		
1, 2, OR 3	2	1	2	2	2	2	1	1	1	2	14	Y	Correct	69	85%
1, 2, OR 3	3	1	1	1	1	0	1	1	1	0	7	Y	Incorrect	12	29%
1, 2, OR 3	4	1	1	1	1	1	1	2	0	0	8	Y			
1, 2, OR 3	5	1	2	2	2	1	2	2	1	1	14	Y	**TM (best fit model)**		
1, 2, OR 3	6	1	1	1	1	1	1	0	0	2	8	Y	Correct*	70	86%
1, 2, OR 3	7	1	1	2	1	1	1	1	1	1	10	Y	Incorrect	11	26%
1, 2, OR 3	8	0	0	0	0	0	1	0	1	0	2				
1, 2, OR 3	9	0	0	0	0	1	0	0	1	1	3		MI		
1, 2, OR 3	10	1	1	0	1	1	0	1	1	0	6		Correct	1	1%
Total counts		7	10	10	10	9	9	9	8	9	**81**		Incorrect	-1	-1%
Parameters	**BM:**	**63**	**EO:**	**6**	**TO:**	**7**	**NM:**	**5**	**WFM**	69	69	70	**BFM**	73	90.1%

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	3	13%
4	1							1			1	Y	**EM**		
4	2		1						1		2	Y	Correct	12	52%
4	3	1	1	1	1	1	1		1		7	Y	Incorrect	11	48%
4	4	1		1			1	1	1		5	Y			
4	5										0	N	**TM (best fit model)**		
4	6	1	1	1							3	N	Correct*	15	65%
4	7				1					1	2	N	Incorrect	8	35%
4	8				1						1	N			
4	9			1							1	N	MI		
4	10		1								1	N	Correct	3	13%
Total counts		3	4	4	3	1	2	2	3	1	**23**		Incorrect	-3	-13%
Parameters	**BM:**	**12**	**EO:**	**0**	**TO:**	**3**	**NM:**	8	**WFM**	12	12	15	**BFM**	15	65.2%

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	5	21%
5	1				1				1	1	3	Y	**EM**		
5	2	1								1	2	Y	Correct	7	29%
5	3							1			1	Y	Incorrect	17	71%
5	4	1		1	1	1			1	1	6	Y			
5	5										0	N	**TM (best fit model)**		
5	6				1				1		2	N	Correct*	12	50%
5	7							1			1	N	Incorrect	12	50%
5	8	1	1			1				1	4	N			
5	9							1		1	2	N	MI		
5	10					1		1	1		3	N	Correct	5	21%
Total counts		3	1	1	3	3	0	4	4	5	**24**		Incorrect	-5	-21%
Parameters	**BM:**	**7**	**EO:**	**0**	**TO:**	**5**	**NM:**	12	**WFM**	7	7	12	**BFM**	12	50.0%

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	3	25%
6	1	1		1							2	Y	**EM**		
6	2			1							1	Y	Correct	1	8%
6	3										0	Y	Incorrect	11	92%
6	4		1								1	Y			
6	5								1		1	N	**TM (best fit model)**		
6	6						1	1			2	N	Correct*	4	33%
6	7		1								1	N	Incorrect	8	67%
6	8							1			1	N			
6	9					1					1	N	MI		
6	10	1					1				2	N	Correct	3	25%
Total counts		2	2	2	0	1	2	2	1	0	**12**		Incorrect	-3	-25%
Parameters	**BM:**	**1**	**EO:**	**0**	**TO:**	**3**	**NM:**	8	**WFM**	1	1	4	**BFM**	4	33.3%

Steps in	Possible		Biases assigned by participants								Basis of inclusion		**CLUSTER 2**		
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	11	19%
4, 5, OR 6	1	1	0	1	1	0	0	1	1	1	6	Y	**EM**		
4, 5, OR 6	2	1	1	1	0	0	0	0	1	1	5	Y	Correct	20	34%
4, 5, OR 6	3	1	1	1	1	1	1	1	1	0	8	Y	Incorrect	39	66%
4, 5, OR 6	4	2	1	2	1	1	1	1	2	1	12	Y			
4, 5, OR 6	5	0	0	0	0	0	0	0	1	0	1		**TM (best fit model)**		
4, 5, OR 6	6	1	1	1	1	0	1	1	1	0	7		Correct*	31	52.5%
4, 5, OR 6	7	0	1	0	1	0	0	1	0	1	4		Incorrect	28	47%
4, 5, OR 6	8	1	1	0	1	1	0	1	0	1	6				
4, 5, OR 6	9	0	0	1	0	1	0	1	0	1	4		MI		
4, 5, OR 6	10	1	1	0	0	1	1	1	1	0	6		Correct	11	19%
Total counts		8	7	7	6	5	4	8	8	6	**59**		Incorrect	-11	-19%
Parameters	**BM:**	**20**	**EO:**	**0**	**TO:**	**11**	**NM:**	**28**	**WFM**	20	20	31	**BFM**	31	52.5%

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	8	40%
7	1					1	1				2	Y	**EM**		
7	2							1			1	Y	Correct	9	45%
7	3								1		1	Y	Incorrect	15	75%
7	4					1	1				2	Y			
7	5									1	1	N	**TM (best fit model)**		
7	6						1	1			2	N	Correct*	17	85%
7	7										0	N	Incorrect	14	70%
7	8	1		1				1	1		4	Y			
7	9	1		1	1		1	1			5	Y	MI		
7	10			1					1		2	Y	Correct	8	40%
Total counts		2	0	3	1	2	4	4	3	1	20		Incorrect	-8	-40%
Parameters	**BM:**	**9**	**EO:**	**0**	**TO:**	**8**	**NM:**	3	**WFM**	9	9	17	**BFM**	17	85.0%

Step in	Possible		Biases assigned by participants								Basis of inclusion				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	10	45%
8	1			1						1	2	Y	Empirical basis		
8	2									1	1	Y	**EM**	9	41%
8	3					1				1	2	Y	Incorrect	17	77%
8	4									1	1	Y			
8	5	1									1	N	**TM (best fit model)**		
8	6									1	1	N	Correct*	19	86%
8	7									1	1	N	Incorrect	9	41%
8	8		1	1	1		1			1	5	Y			
8	9		1				1	1		1	4	Y	MI		
8	10		1	1	1					1	4	Y	Correct	10	45%
Total counts		1	3	3	2	1	2	1	0	9	22		Incorrect	-10	-45%
Parameters	**BM:**	**9**	**EO:**	**0**	**TO:**	**10**	**NM:**	3	**WFM**	9	9	19	**BFM**	19	86.4%

Steps in	Possible		Biases assigned by participants								Basis of inclusion		**CLUSTER 3**		
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	18	43%
7, OR 8	1	0	0	1	0	1	1	0	0	1	4	Y	**EM**		
7, OR 8	2	0	0	0	0	0	0	1	0	1	2	Y	Correct	18	43%
7, OR 8	3	0	0	0	0	1	0	0	1	1	3	Y	Incorrect	32	76%
7, OR 8	4	0	0	0	0	1	1	0	0	1	3	Y			
7, OR 8	5	1	0	0	0	0	0	0	0	1	2		**TM (best fit model)**		
7, OR 8	6	0	0	0	0	0	1	1	0	1	3		Correct*	36	86%
7, OR 8	7	0	0	0	0	0	0	0	0	1	1		Incorrect	23	55%
7, OR 8	8	1	1	2	1	0	1	1	1	1	9	Y			
7, OR 8	9	1	1	1	1	0	2	2	0	1	9	Y	MI		
7, OR 8	10	0	1	2	1	0	0	0	1	1	6	Y	Correct	18	43%
Total counts		3	3	6	3	3	6	5	3	10	42		Incorrect	-18	-43%
Parameters	**BM:**	**18**	**EO:**	**0**	**TO:**	**18**	**NM:**	**6**	**WFM**	**18**	18	36	**BFM**	36	85.7%

Steps in	Possible		Biases assigned by participants								Basis of inclusion **MAP-ASSIGNMENT TO SPECIFIC STEPS**				
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	42	23%
Each & every step	1	1	1	3	2	2	2	2	2	4	19	Y	**EM**		
Each & every step	2	2	3	3	2	2	1	2	2	4	21	Y	Correct	107	58.8%
Each & every step	3	2	2	2	2	2	2	2	3	1	18	Y	Incorrect	83	46%
Each & every step	4	3	2	3	2	3	3	3	2	2	23	Y			
Each & every step	5	2	2	2	2	1	2	2	2	2	17	Y	**TM (best fit model)**		
Each & every step	6	2	2	2	2	1	3	2	1	3	18	Y	Correct*	137	75%
Each & every step	7	1	2	2	2	1	1	2	1	3	15	Y	Incorrect	62	34%
Each & every step	8	2	2	2	2	1	2	2	2	2	17	Y			
Each & every step	9	1	1	2	1	2	2	3	1	3	16	Y	MI		
Each & every step	10	2	3	2	2	2	1	2	3	1	18	Y	Correct	30	16%
Total counts		18	20	23	19	17	19	22	19	25	182		Incorrect	-30	-16%
Parameters	**BM:**	##	**EO:**	6	**TO:**	36	**NM:**	39	**WFM**	107	107	137	**BFM**	140	76.9%

														MAP AS A WHOLE	
Steps in	Possible		Biases assigned by participants								Basis of inclusion			ASSIGNMENT TO ANY STEP	
the MAP	biases	PA	PB	PC	PD	PE	PF	PG	PH	PI	Total	Total*	MD	0	0%
Any step	1	1	1	3	2	2	2	2	2	4	19	Y	**EM**		
Any step	2	2	3	3	2	2	1	2	2	4	21	Y	Correct	182	100%
Any step	3	2	2	2	2	2	2	2	3	1	18	Y	Incorrect	0	0%
Any step	4	3	2	3	2	3	3	3	2	2	23	Y			
Any step	5	2	2	2	2	1	2	2	2	2	17	Y	**TM**		
Any step	6	2	2	2	2	1	3	2	1	3	18	Y	Correct*	182	100%
Any step	7	1	2	2	2	1	1	2	1	3	15	Y	Incorrect	0	0%
Any step	8	2	2	2	2	1	2	2	2	2	17	Y			
Any step	9	1	1	2	1	2	2	3	1	3	16	Y	MI		
Any step	10	2	3	2	2	2	1	2	3	1	18	Y	Correct	0	0%
Total counts		18	20	23	19	17	19	22	19	25	182		Incorrect	0	0%
Parameters		Number of assignments that meet the critierion									N/A	N/A	**BFM**		
Note 1		2.25	2.5	2.9	2.4	2.1	2.4	2.8	2.4	3.1	22.8				
Note 2		1.8	2	2.3	2	1.7	1.9	2	1.9	2.5	18.2				

Note 1 - Average, all 10 biases assigned to a single step.

Note 2 - Average assignment for a bias.

Comment:

Participants made 91 assignments on the basis of theory, and 85 assignments on the basis of consensus.

This suggests that, while the consensus criteria is 7% more restrictive than the theory criterion, both are similar enough for direct comparisons to be made.

To avoid loss of information the complete anlaysis was first be conducted at the level of each step, then at the level of clusters, then the MAP as a whole.

Analysis at the step level promotes rigour and provides the basis for an aggregation to a higher level (cluster) that may provide a more useful starting point for the delopment of a checklist.

In this version, numbers in columns N, O, and P record the total step-specific assignments to individual steps in the cluster.

Note the more rigorous "AND" logic approach to step & cluster analyses in Appendix D, and the more relaxed "OR" logic approach to step & cluster analyses in Appendix E.

The analysis at the step & cluster level (OR logic) identifies:

- The most important cluster (ie biggest target of biases) (cluster 1 was the target of 81, followed by cluster 2 (59 biases), and cluster 3 (42 biases)).

- (EM=BM+EO) the cluster where the empirical results produced the strongest consensus (cluster 1 had 85% consensus, followed by cluster 3 (43%), and cluster 2 (34%)).

- (EM=BM+EO) the cluster where the empirical results produced the weakest consensus (see above).

- (TM=BM+TO) the cluster where the theoretical results produced the strongest prediction (cluster 1 and cluster 3 had 86% match, cluster 2 had 53% accuracy).

- (TM=BM+TO) the cluster where the theoretical results produced the weakest prediction (see above).

- (MD) the cluster where the difference between empirical and theoretical predictions was greatest (cluster 3 43% difference, closely followed by cluster 2 19% difference, cluster 1 16% difference).

- (MD) the cluster where the difference between empirical and theoretical predictions was the least (see above).

- (MI) the cluster where the net improvement between empirical and theoretical predictions was most positive (cluster 3 had a 43% net improvement.

- While cluster 2 had a 19% improvement, followed by cluster 1 with a 1%), these positive values suggest the importance of the theoretical model.

- (MI) the step where the net improvement between empirical and theoretical predictions was most negative (see above).

The analysis at the level of the MAP as a whole identifies:

- That 182 biases were assigned, for an average of 22.8 in each of the eight steps, and an average of 18.2 for each of the 10 biases (2.02 assigned to each step by each of the 9 participants).

- There was 100% consensus that all 10 biases should be included on the basis of the empirical model (Inclusion of a bias in the MAP as a whole required 15 assignments, or three times that required for inclusion in each constituent cluster).

- The bias where the empirical results produced the weakest consensus. This is bias 7 (Pattern Recognition), perhaps the most sophisticated of the 10 biases and therefore difficult to assign to a particulat step or cluster. Note however that it garnered more than the minimum assignments (equivalent to a simple majority of 5 of 9 participants in each of the constituent clusters).

- There was 100% consensus that all 10 biases should be included on the basis of the theoretical model.

- There was little difference in aggregate between the consensus obtained on the basis of empirical (85) and theoretical (91) approaches.