Dynamic Hypothesis Testing: Mechanisms that drive decisions under uncertainty

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Table of contents

TABLE OF CONTENTS II

LIST OF TABLES VI

LIST OF FIGURES VII

ABSTRACT IX

DECLARATION OF ORIGINALITY OF RESEARCH XI

ACKNOWLEDGEMENTS XII

1. CONFIRMATION BIAS 1
1.1. EMPIRICAL EXAMPLES OF CONFIRMATION BIAS 3
1.1.1. What gets Confirmed? *3*
1.1.2. Measurement of Confirmation Bias *10*
1.1.2.1. Problem representation 13
1.1.2.2. Information selection 14
1.1.2.3. Information interpretation and quality assessment 19
1.1.2.4. Stopping and decision thresholds 21
1.1.2.5. Decision outcome 22
1.1.3. Direction gained from Empirical Studies *22*
1.2. SUMMARY: AN EMPIRICAL VIEW OF CONFIRMATION BIAS 23

2. WHY AND HOW: THEORETICAL REASONS AND MECHANISMS FOR CONFIRMATION BIAS (PART 1) 25
2.1. PROBLEM REPRESENTATION: THEORIES THAT DEFINE THE FOCAL DECISION OPTION 27
2.1.1. Relevance Theory (Sperber & Wilson, 1986, 2004) *28*
2.1.2. Heuristic-Analytic Theory (Evans, 2006) *29*
2.1.3. Argumentative Theory (Mercier & Sperber, 2011) *30*
2.1.4. Biased Hypothesis Testing (Pyszczynski & Greenberg, 1987) *31*
2.1.5. Pragmatic Hypothesis Testing (Trope & Liberman, 1996) *32*
2.1.6. Framing Theories and the Framed Decision Option *32*
2.1.6.1. Associative model of attribute framing 33
2.1.6.2. Information leakage model of attribute framing 34
2.1.7. HyGene Model (Dougherty et al., 2010) *35*
2.1.8. Theoretical Summary of Problem Representation *36*
2.2. INFORMATION SELECTION 37
2.2.1. Biased Hypothesis Testing (Pyszczynski & Greenberg, 1987) *39*
2.2.2. Motivated Reasoning (Kunda, 1990) *40*
2.2.3. Error Avoidance *41*
2.2.4. Argumentative Theory (Mercier & Sperber, 2011) *44*
2.2.5. Heuristic-Analytic Theory (Evans, 2006) *44*
2.2.6. Bayesian Rationality (Oaksford & Chater, 1994, 2009) *45*
2.2.7. Pragmatic Hypothesis Testing (Trope & Liberman, 1996) *47*
2.2.8. Relevance Theory (Sperber & Wilson, 1986, 2004) *48*
2.2.9. HyGene Model (Dougherty et al., 2010) *49*
2.2.10. Theoretical Summary of Information Selection *50*
2.3. INFORMATION INTERPRETATION: THEORIES THAT ADDRESS INFORMATION WEIGHTING, DISTORTION, AND COHERENCE SHIFTING 52
2.3.1. Biased Hypothesis Testing (Pyszczynski & Greenberg, 1987) *54*
2.3.2. Argumentative Theory (Mercier & Sperber, 2011) *55*
2.3.3. Pragmatic Hypothesis Testing (Trope & Liberman, 1996) *56*
2.3.4. Differentiation Consolidation (Dif Con) Theory (Svenson, 1992, 2006) *57*
2.3.5. Cognitive Consistency Theories and Parallel Constraint Satisfaction (PCS) (Holyoak & Simon, 1999; Simon, Snow, et al., 2004) *57*
2.3.6. The Belief-Adjustment Model (Hogarth & Einhorn, 1992) *59*

2.3.7. Theoretical Summary of Information Interpretation *62*
2.4. SUMMARY: THEORETICAL GAPS IN PROBLEM REPRESENTATION, INFORMATION SELECTION, AND INTERPRETATION 63

3. WHY AND HOW: THEORETICAL REASONS AND MECHANISMS FOR CONFIRMATION BIAS (PART 2) 65
3.1. STOPPING AND DECISION THRESHOLDS 65
3.1.1. Theoretical Summary of Stopping and Decision Thresholds *68*
3.2. CONFIRMATION OUTCOMES: HOW DOES CONFIRMATION BIAS OCCUR? 68
3.2.1. Varieties of Confirmation Bias (Klayman, 1995) *68*
3.2.2. Confirmation Bias: A Ubiquitous Phenomenon in Many Guises (Nickerson, 1998) *70*
3.2.3. Confirmation Bias (Oswald & Grosjean, 2004) *71*
3.2.4. The Forensic Confirmation Bias: Problems, Perspectives, and Proposed Solutions (Kassin, Dror, & Kukucka, 2013) *74*
3.2.5. Theoretical Direction for Confirmation Outcomes *75*
3.3. WHY DOES CONFIRMATION BIAS OCCUR? 75
3.4. OVERVIEW AND CRITIQUE OF THEORIES 76
3.5. SUMMARY: A THEORETICAL VIEW OF CONFIRMATION BIAS 78

4. A NEW MODEL: DYNAMIC HYPOTHESIS TESTING (DHT) 80
4.1. MECHANISMS OF THE DHT MODEL: HOW DOES CONFIRMATION BIAS OCCUR? 80
4.2. DETAILED DHT MODEL 83
4.2.1. Problem Representation *83*
4.2.2. Information Selection *90*
4.2.3. Information Interpretation *91*
4.2.4. Stopping and Decision Threshold *93*
4.2.5. Decision Outcome *96*
4.3. SUMMARY: AN INTEGRATED VIEW OF CONFIRMATION BIAS 97

5. EXPERIMENT 1: EFFECTS OF FRAME AND PREFERENCE ON INFORMATION SELECTION IN A COMPLEX INFORMATION ENVIRONMENT 99
5.1. OVERVIEW OF EXPERIMENTS 99
5.2. EXPERIMENT 1 106
5.3. METHODS 116
5.3.1. Participants *116*
5.3.2. Design *117*
5.3.3. Apparatus and Materials *118*
5.3.3.1. Scenario 118
5.3.3.2. Information environment 119
5.3.3.3. Self-report measures 121
5.3.3.4. Behavioural measures 123
5.3.4. Procedure *123*
5.4. RESULTS 124
5.4.1. Manipulation Checks *124*
5.4.2. Information Selection *126*
5.5. DISCUSSION 127
5.6. SUMMARY OF RESULTS FROM EXPERIMENT 1 129

6. EXPERIMENT 2: EFFECTS OF FRAME AND PREFERENCE ON INFORMATION SELECTION UNDER SEQUENTIAL INFORMATION SEARCH CONDITIONS 130
6.1. METHODS 134
6.1.1. Participants *134*
6.1.2. Design *134*
6.1.3. Apparatus and Materials *134*
6.1.3.1. Scenario 134
6.1.3.2. Information environment 135
6.1.3.3. Self-report measures 137
6.1.3.4. Behavioural measures 137

6.1.4. Procedure *138*
6.2. RESULTS 139
6.2.1. Manipulation Checks *139*
6.2.2. Information Selection *140*
6.2.3. Confirmation Outcomes *142*
6.3. DISCUSSION 142
6.4. SUMMARY OF RESULTS FROM EXPERIMENTS 1 AND 2 145

7. EXPERIMENT 3: EFFECTS OF PREFERENCE AND EXPECTATION ON INFORMATION SELECTION, DECISION AND STOPPING THRESHOLDS, AND FINAL DECISIONS 146
7.1.1. Information Selection *146*
7.1.2. Decision Thresholds *150*
7.1.3. Stopping Threshold *151*
7.1.4. Final Decision *153*
7.2. METHODS 153
7.2.1. Participants *153*
7.2.2. Design *154*
7.2.3. Apparatus and Measures *154*
7.2.3.1. Scenario 154
7.2.3.2. Information environment 156
7.2.3.3. Self-report measures 157
7.2.3.4. Behavioural measures 159
7.2.4. Procedure *159*
7.3. RESULTS 159
7.3.1. Manipulation Checks *160*
7.3.2. Information Selection *162*
7.3.3. Decision Thresholds *163*
7.3.4. Stopping Threshold *163*
7.3.5. Confirmation Outcomes *164*
7.4. DISCUSSION 164
7.5. SUMMARY OF RESULTS FROM EXPERIMENT 3 167

8. EXPERIMENT 4: EFFECTS OF PREFERENCE AND EXPECTATION ON INFORMATION SELECTION AND INTERPRETATION, DECISION AND STOPPING THRESHOLDS, AND FINAL DECISIONS 168
8.1.1. Model Predictions *171*
8.1.1.1. Influence of accessible characteristics on decision elements 172
8.1.1.2. Influence of accessible characteristics on information selection and interpretation via decision elements 173
8.1.1.3. Information distortion 174
8.1.2. Decision and Stopping Thresholds *179*
8.2. METHODS 181
8.2.1. Participants *181*
8.2.2. Design *182*
8.2.3. Apparatus and Measures *183*
8.2.3.1. Scenario 183
8.2.3.2. Information environment 184
8.2.3.3. Self-report measures 185
8.2.3.4. Behavioural measures 187
8.2.4. Procedure *188*
8.3. RESULTS 188
8.3.1. Manipulation Checks *189*
8.3.2. Test of the DHT Model *191*
8.3.2.1. Influence of accessible characteristics on decision elements 192
8.3.2.2. Influence of accessible characteristics on information selection and interpretation via decision elements 194
8.3.2.3. Information distortion 196
8.3.3. Decision and Stopping Thresholds *206*

8.4. DISCUSSION 208
8.5. SUMMARY OF RESULTS FROM EXPERIMENT 4 222

9. GENERAL DISCUSSION: THE DHT MODEL, IMPLICATIONS FOR THEORIES OF CONFIRMATION BIAS AND PRACTICAL APPLICATIONS 224
9.1. THE FINAL DHT MODEL 225
9.1.1. Problem Representation 226
9.1.2. Information Selection 227
9.1.3. Information Interpretation 233
9.1.4. Decision and Stopping Thresholds 234
9.1.5. Decision Outcome 238
9.1.6. Accessible Characteristics 239
9.2. DHT MODEL: WHY DOES CONFIRMATION BIAS OCCUR? 240
9.3. STRENGTHS AND LIMITATIONS 244
9.4. PRACTICAL IMPLICATIONS 249
9.5. THESIS CONTRIBUTIONS AND CONCLUSION 254

10. APPENDICES 256
10.1. APPENDIX A: GLOSSARY 256
10.2. APPENDIX B: BUSINESS SCENARIO 278
10.2.1. Experiments 1 and 2 278
10.2.2. Experiments 3 and 4 279
10.2.2.1. Treatment group 279
10.2.2.2. Control group (Experiment 4) 281
10.3. APPENDIX C: COMPLETE SET OF QUESTIONS AND INSTRUCTIONS 284
10.3.1. Experiment 1 284
10.3.2. Experiment 2 294
10.3.3. Experiment 3 299
10.3.4. Experiment 4 311
10.4. APPENDIX D: MANIPULATION CHECKS FOR EXPERIMENTS 1 TO 5 317
10.4.1. Preference Manipulation 317
10.4.2. Title Perception 318
10.4.3. Impact of Manipulations on Action Decision 321
10.4.4. Impact of Information Condition on Final Release Probability 322
10.5. APPENDIX E: EXPERIMENT 5, REPLICATING THE FRAME-BASED EFFECT ON SELECTION . 323
10.5.1. Methods 323
10.5.1.1. Participants 323
10.5.1.2. Design 324
10.5.1.3. Apparatus and materials 324
10.5.1.4. Procedure 324
10.5.2. Results 325
10.5.2.1. Manipulation checks 325
10.5.2.2. Frame-based PTS 326
10.5.3. Discussion 327
10.6. APPENDIX F: DETAILS OF MULTI-LEVEL ANALYSES USED IN CHAPTER 7 329
10.6.1. Dependent Variable: Release Probability 330
10.6.2. Dependent Variable: Information Selection 332
10.6.3. Dependent Variable: Information Interpretation 334
10.6.4. Dependent Variable: Final Release Probability 336
10.7. APPENDIX G: FINAL ETHICS APPROVALS 339

11. REFERENCES 345

List of Tables

TABLE 1: DECISION-MAKING PROCESSES DESCRIBED BY THEORISTS 11
TABLE 2: EXAMPLE CONTENT PROVIDED IN DIFFERENT INFORMATION SELECTION PARADIGMS 15
TABLE 3: CONFIRMATION PROCESSES ADDRESSED BY EACH THEORY 26
TABLE 4: TYPE OF INFORMATION SELECTED IN THE THREE MAIN SELECTION PROCESSES 38
TABLE 5: TERMINOLOGY USED TO DESCRIBE THE OUTCOMES OF ACTIONS IN DIFFERENT SITUATIONS 42
TABLE 6: DISTINCTIONS BETWEEN, AND DEFINITIONS OF, THREE INTERPRETATION EFFECTS 53
TABLE 7: DIFFERENTIATION PROCESSES PROPOSED IN THE DIF CON THEORY 57
TABLE 8: THE THREE SUB-PROCESSES AND MODES OF THE ANCHORING AND ADJUSTMENT MODEL 60
TABLE 9: DHT MODEL ASSERTIONS EXAMINED IN EACH THESIS EXPERIMENT 105
TABLE 10: HOW THEORIES EXPLAIN THE PREFERENTIAL SELECTION OF TITLES ASSOCIATED WITH THE FRAMED DECISION OPTION 110
TABLE 11: CHARACTERISTICS OF MANIPULATED PREFERENCE CONDITIONS 118
TABLE 12: THE CONCLUSION SUPPORTED BY THE INFORMATION AVAILABLE IN MANIPULATED INFORMATION CONDITIONS 154
TABLE 13: AMOUNT OF EACH TYPE OF INFORMATION AVAILABLE IN MANIPULATED INFORMATION CONDITIONS 157
TABLE 14: DEMOGRAPHICS OF PARTICIPANTS IN YOKED GROUPS 181
TABLE 15: COMPARISON OF PROCEDURE IN THE TREATMENT AND CONTROL GROUPS 183
TABLE 16: SUMMARY OF DHT MODEL ASSERTIONS EMPIRICALLY TESTED THROUGH EXPERIMENTS 1 TO 5 224
TABLE A1: GLOSSARY OF TERMS 256
TABLE D1: DEGREE TO WHICH PREFERENCE CONDITION PRODUCED ATTRACTION TO INACTION AND ACTION IN ALL EXPERIMENTS 317
TABLE D2: SIGNIFICANCE AND EFFECT SIZE OF THE IMPACT OF PREFERENCE CONDITION ON ATTRACTION TO INACTION AND ACTION IN ALL EXPERIMENTS 318
TABLE D3: THE DEGREE TO WHICH TITLES WERE PERCEIVED AS INDICATIVE OF A COMPETITIVE RELEASE ON A 9-POINT SCALE 319
TABLE D4: SIGNIFICANCE AND EFFECT SIZE OF THE INFLUENCE OF TITLE TYPE ON TITLE PERCEPTION 319
TABLE D5: SIGNIFICANCE AND EFFECT SIZE OF THE INFLUENCE OF THE TITLE TYPE BY SELECTED TITLES INTERACTION ON TITLE PERCEPTION 321
TABLE D6: THE PERCENTAGE OF PARTICIPANTS WHO CHOSE ACTION OVER INACTION WITHIN PREFERENCE AND INFORMATION CONDITIONS ACROSS EXPERIMENTS 2 TO 4 322
TABLE D7: FINAL RELEASE PROBABILITY ACROSS INFORMATION CONDITIONS IN EXPERIMENTS 3 AND 4 322

List of Figures

FIGURE 1: DEPICTION OF THE DECISION-MAKING PROCESS. 13
FIGURE 2: THE DYNAMIC HYPOTHESIS TESTING (DHT) MODEL 83
FIGURE 3: REPRESENTATION OF THE INFORMATION GRID THAT PARTICIPANTS SELECTED TITLES FROM IN EXPERIMENTS 1 TO 3. 121
FIGURE 4: ATTRACTION TO ACTION WAS HIGHER IN THE PREFER-ACTION (N = 29) CONDITION AND LOWER IN THE PREFER-INACTION (N = 28), COMPARED TO ATTRACTION TO INACTION. THE NO-PREFERENCE (N = 28) CONDITION SHOWED NO DIFFERENCE BETWEEN INACTION AND ACTION ATTRACTION. ERROR BARS REPRESENT 95% CI. 125
FIGURE 5: INTERACTIVE INFORMATION GRID THAT ALLOWS PARTICIPANTS TO OPEN AND CLOSE CELLS. 135
FIGURE 6: THE PERCENTAGE OF PARTICIPANTS WHO CHOSE EACH OF THE FOUR ACTIONS DID NOT DIFFER SIGNIFICANTLY ACROSS THE PREFER-INACTION (N = 28), NO-PREFERENCE (N = 28), AND PREFER-ACTION (N = 25) CONDITIONS. 140
FIGURE 7: PARTICIPANTS SELECTED MORE RELEASE-CONSISTENT THAN RELEASE-INCONSISTENT TITLES IN THE SIMULTANEOUS (N = 85) BUT NOT SEQUENTIAL (N = 111) INFORMATION SEARCH EXPERIMENT. ERROR BARS REPRESENT 95% CI. 141
FIGURE 8: PARTICIPANTS IN THE PREFER-INACTION (N = 57) CONDITION REPORTED MUCH GREATER ATTRACTION TO INACTION THAN ACTION. THE REVERSE WAS TRUE OF PARTICIPANTS IN THE PREFER-ACTION (N = 54) CONDITION. ERROR BARS REPRESENT 95% CI. 160
FIGURE 9: THE PERCENTAGE OF PARTICIPANTS WHO CHOSE ACTION OVER INACTION WAS GREATER FOR PARTICIPANTS IN THE RELEASE INFORMATION CONDITION COMPARED TO OTHER INFORMATION CONDITIONS, AND FOR PARTICIPANTS IN THE PREFER-ACTION CONDITION COMPARED TO THE PREFER-INACTION CONDITION (N = 17-20 IN EACH OF THE 6 CONDITIONS). 161
FIGURE 10: THE ORIGINAL DHT MODEL. 169
FIGURE 11: THE ORIGINAL DHT MODEL OPERATIONALISED FOR EMPIRICAL EXAMINATION. 170
FIGURE 12: REPRESENTATION OF THE INFORMATION GRID THAT PARTICIPANTS SELECTED TITLES FROM IN EXPERIMENTS 4 AND 5 (APPENDIX E). 185
FIGURE 13: TITLES WERE PERCEIVED AS MORE INDICATIVE OF RELEASE IN THE RELEASE (N = 27) COMPARED TO NO-RELEASE (N = 27) CONDITION IN THE TREATMENT GROUP (N = 84) BUT NOT IN THE CONTROL GROUP (N = 84). ERROR BARS REPRESENT 95% CI. 190
FIGURE 14: THE PERCENTAGE OF PARTICIPANTS WHO CHOSE ACTION WAS GREATER FOR PARTICIPANTS IN THE RELEASE INFORMATION CONDITION COMPARED TO THE NO-RELEASE INFORMATION CONDITION, AND FOR PARTICIPANTS IN THE PREFER-ACTION CONDITION COMPARED TO THE PREFER-INACTION CONDITION (N = 13-15 IN EACH OF THE 6 CONDITIONS). 191
FIGURE 15: THE RESULTS OF MULTILEVEL MEDIATION ANALYSES FOR THE DHT MODEL. UNSTANDARDISED COEFFICIENTS WITH STANDARD ERROR AND 95% CONFIDENCE INTERVAL INCLUDED. 192
FIGURE 16: THERE WAS A GREATER DIFFERENCE BETWEEN TREATMENT AND CONTROL GROUPS WHEN BOTH INFORMATION AND PREFERENCE CONDITION FAVOURED NO RELEASE AND INACTION (LEFT; N = 13) THAN WHEN ONLY THE INFORMATION CONDITION FAVOURED NO RELEASE (RIGHT; N = 14). ERROR BARS REPRESENT 95% CI. 198
FIGURE 17: THE DIFFERENCE BETWEEN TREATMENT AND CONTROL GROUPS WAS CONSTANT WHEN INFORMATION CONDITION FAVOURED RELEASE AND ACTION WHETHER PREFERENCE FAVOURED RELEASE (RIGHT; N = 13) OR NO RELEASE (LEFT; N = 14). ERROR BARS REPRESENT 95% CI. 198
FIGURE 18: TREATMENT PARTICIPANTS WITH OPPOSING PREFERENCES (N = 15 PER CONDITION) FELL EITHER SIDE OF THEIR YOKED CONTROL GROUP WITH NO PREFERENCE WHEN IN THE MIXED INFORMATION CONDITION. ERROR BARS REPRESENT 95% CI. 199
FIGURE 19: PARTICIPANTS IN THE PREFER-INACTION (N = 42) CONDITION GAVE LOWER ESTIMATES OF FINAL RELEASE PROBABILITY THAN THEIR YOKED CONTROL GROUP (N = 42). THE DIFFERENCE WAS NOT STATISTICALLY SIGNIFICANT FOR PARTICIPANTS IN THE PREFER-ACTION (N = 42) CONDITION AND THEIR YOKED CONTROL GROUP. ERROR BARS REPRESENT 95% CI. 200
FIGURE 20: THE DIFFERENCE IN FINAL RELEASE PROBABILITY BETWEEN NO-RELEASE (N = 27) AND RELEASE (N = 27) INFORMATION CONDITIONS WAS EXAGGERATED IN THE TREATMENT GROUP (N = 84) COMPARED TO THE CONTROL GROUP (N = 84). ERROR BARS REPRESENT 95% CI. 201
FIGURE 21: EFFECTS OF PREFERENCE AND INFORMATION CONDITION ON INFORMATION INTERPRETATION AND FINAL RELEASE PROBABILITY WERE STRONGER IN THE TREATMENT (N = 84) THAN IN THE CONTROL (N = 84) GROUP. PARTIAL MEDIATION WAS STATISTICALLY SIGNIFICANT ONLY IN THE TREATMENT GROUP. 203
FIGURE 22: THE INCREASE IN RELEASE PROBABILITY BETWEEN SECOND LAST AND FINAL TRIALS WAS GREATER FOR PARTICIPANTS WHO CHOSE ACTION (N = 45) THAN THOSE WHO CHOSE INACTION (N = 39). ERROR BARS REPRESENT 95% CI. 205

Figure 23: The final Dynamic Hypothesis Testing (DHT) model. 226
Figure E1: Participants selected more release-consistent than release-inconsistent titles in the simultaneous (N = 49) but not sequential (N = 84) information search experiment. Error bars represent 95% CI. 327
Figure F1: Predictors of Release Probability based on the DHT model. 330
Figure F2: Predictors of information selection based on the DHT model. 332
Figure F3: Predictors of information interpretation based on the DHT model. 334
Figure F4: Moderation by group of the mediated model predicting final release probability based on the DHT Model. 336

Abstract

When assessing a situation to choose the best action, confirmation bias is a potential problem. Confirmation bias is where the final decision is pulled towards the focal decision option. The focal decision option is whichever decision option is the focus of the individual's attention. Attention commonly focuses on the decision option that is preferred (preferred decision option), the decision option that is expected to fit the situation (expected decision option), or the decision option that is suggested by the information provided (framed decision option). A framework is developed that breaks confirmation bias down into confirmation of preference, confirmation of expectation, and confirmation of frame, based on which decision option is the focus of attention. Confirmation bias is also distinguished from four groups of confirmation processes. A new model, the dynamic hypothesis testing (DHT) model, is developed towards a unified explanation of the three types of confirmation bias and the associated confirmation processes.

Methods: Four experiments were conducted with university students paid for their time. Participants were required to make an action decision based on their situation assessment of a novel business competition scenario. Participants formed situation assessments and chose actions based on information they selected from a grid of information. Action preferences were manipulated in all four experiments. The situation supported by the information was manipulated in the third and fourth experiments.

Results: In Experiments 1 and 2, the framed decision option influenced information selection when participants were asked to select all the information required prior to receiving the requested information, but the framed decision option had no effect on information selection when participants received the information immediately after selecting each item of information.

Experiments 3 and 4 found that the preferred and expected decision options influenced final situation assessments and chosen actions, but not information selection. Experiments 3 and 4 also found that the preferred decision option influenced decision thresholds, which determine which action is chosen given the situation assessment.

Experiment 4 demonstrated that preferred and expected decision options influenced final situation assessments via information interpretation. Both information interpretations and situation assessments were exaggerated by the preferred and expected decision options compared to a yoked control group who were not required to make a decision. When the expected and preferred decision options opposed each other, there was some indication that the expected decision option had a greater influence on information interpretation and final situation assessments than the preferred decision option in this case.

Discussion: Empirical findings are used to refine the DHT model. The DHT model provides advancement towards a unified explanation of confirmation of frame, expectation, and preference. A variety of processes that have been called confirmation bias are incorporated into the model and their relationship with confirmation outcomes are outlined. The DHT model expands on parallel constraint satisfaction mechanisms in an associative network to explain confirmation bias processes and outcomes. Implications for theory, research, and practice are discussed.

Declaration of originality of research

I certify that the research described in this dissertation has not already been submitted for any other degree.

Ethics Committee approval was gained for all experimental work (Ethics codes 5201000943 and 5201100069D; See Appendix G).

I certify that to the best of my knowledge all sources used and any help received in the preparation of this dissertation have been acknowledged.

Signature...

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My understanding of statistics has developed a lot throughout this thesis. Thank you to Alan Taylor for helping me with research design, figuring out how best to utilise my results to answer research questions without losing the complexity of my data, and even coming out of retirement to meet with me. Naomi Sweller was instrumental in helping me with the specifics of multi-level analysis and in clarifying my understanding of statistical principals. Thank you Naomi.

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1. Confirmation Bias

Effective action often requires an accurate assessment of the situation. Pilots need to accurately assess a weather system to determine the best course. Market analysts need to understand the competition to recommend the best business strategy. Potential homebuyers need to assess the property market to determine whether now is a good time to buy. A potential obstacle to an accurate situation assessment and action is the phenomenon of confirmation bias. Confirmation bias[1] occurs when information search, interpretation, and recall systematically favours one decision, termed the focal decision option, over alternatives (Oswald & Grosjean, 2004; Tetlock, 2005). The focal decision option is commonly called a hypothesis, or focal hypothesis, and refers to a single possible situation or action, that an individual dedicates attention to testing or evaluating. The focal decision option refers to whichever possibility is most salient to the decision maker at the time, and could correspond to the preferred or expected decision option, or the decision option implied by the presentation of the problem. Throughout this thesis the new terminology 'focal decision option' is used, rather than the more common term 'focal hypothesis', to avoid confusion with the empirical hypotheses tested in future chapters and to highlight the focus of attention on one of many possible decision options.

The focal decision option is the single situation assessment or action that the decision maker is focused on. Situation assessments are where an individual is required to acquire and interpret information to form an understanding of the current state of a system (Wiggins, 2014), such as the business competition or housing market. Actions are the behavioural choices one makes, often in response to a situation assessment, such as whether, and how, to react to competitive business pressures, or whether or not to buy a house, and which house to buy. Accordingly, two types of focal decision options are referred to throughout this thesis: a

[1] The glossary in Appendix A contains definitions of terms referred to throughout this thesis.

focal situation assessment and a focal action. The focal situation assessment is the situational possibility that the individual is focused on, such as high competition, or increasing house prices. When individuals are required to judge the situation on a scale of severity or likelihood, the focal situation assessment refers to the end of that scale that is most salient to the individual. The focal action is the action that is most salient to the individual at the time, such as reacting to competitive pressures in a certain way, or buying a house.

As implied previously, confirmation bias is where final decisions are swayed towards confirming, rather than refuting, the original focal decision option, which could be a situation assessment, or action. Consider a bias towards confirming these decision options put forward for investigation:

'Country X has weapons of mass destruction'

'Joe Blogs is guilty of murder'

'Patient X is infertile'

'Buying a house now would be a good investment'

There is little agreement over what types of decision options are and are not confirmed, nor exactly what processes comprise confirmation bias, as detailed in the remainder of this chapter. As a result, theories that attempt to explain confirmation bias tend to apply to only a limited number of confirmation processes or types of decision options, as detailed in Chapters 2 and 3. A confirmation process is defined here as any human process or behaviour that can, in isolation or in combination with other processes, produce a tendency towards accepting, rather than rejecting, the focal decision option.

The aim of this thesis is to integrate the confirmation bias literature by putting forward a model, called the dynamic hypothesis testing (DHT) model, that can accommodate confirmation of multiple types of decision options and explain numerous confirmation processes. This chapter explores the nature of confirmation bias by drawing on empirical demonstrations of confirmation bias to examine what was confirmed and how confirmation processes were measured. In Chapters 2 and 3, theoretical accounts for why and how confirmation bias occurs are explored. Chapter 4 presents a new model of confirmation bias that draws on, and unifies, the theoretical accounts presented in Chapters 2 and 3, while explaining empirical observations outlined in Chapter 1. Predictions are drawn from the new model, dynamic hypothesis testing (DHT), and guide the experimental work presented in Chapters 5 to 8. Finally, Chapter 9 explores the implications of the empirical results for the DHT model of confirmation bias and presents the final model.

1.1. Empirical Examples of Confirmation Bias

Theoretical discussions of confirmation bias express varying degrees of frustration at the wide range of phenomena labelled confirmation bias. For example, Fischhoff and Beyth-Marom (1983) recommended that the term 'confirmation bias' be retired due to too many definitions, some of which conflict, and Klayman (1995, p. 385) observed that the "heterogeneous set of findings" should be considered "a set of confirmation biases, rather than one unified confirmation bias". The reason for this frustration is that confirmation bias as a concept originated in, and has been largely perpetuated by, empirical demonstrations with diverse definitions and measurements of confirmation bias.

To define confirmation bias in a way that captures the bulk of empirical work, two questions within the empirical confirmation bias literature are examined:

1. What types of decision options are subject to confirmation?
2. How is confirmation measured?

1.1.1. What gets Confirmed?

Decisions are usually made between at least two decision options. These could be distinct options or actions such as product choices, or points on a scale such as the likelihood or severity of business competition. To determine which action or which end of the scale will be subject to confirmation bias the manipulations used to demonstrate confirmation bias are examined. Three common types of decision options that are subject to confirmation are drawn from these manipulations: preferred decision options, expected decision options, and framed decision options. The DHT model detailed in Chapter 4 argues that any of the three types of decision option can become the focus of attention (the focal decision option) and that the focal decision option is likely to be confirmed.

Common techniques for demonstrating confirmation bias are:

1. *Opposing views:* Experimenters observe participants with opposing preferences, attitudes, or beliefs. Confirmation processes support the individual's prior preference, attitude or belief such that the behaviour and conclusions of participants with opposing views polarise. This is achieved by selecting participants with opposing views, such as those for and against capital punishment (e.g. Lord, Ross, & Lepper, 1979), or observing correlations between original viewpoint and behaviour or conclusions (e.g. Hernandez & Preston, 2013; Knobloch-Westerwick & Kleinman, 2012), or randomly allocating participants to read information that supports or contradicts a theory that the participant believes in or does not believe in. For example, Hergovich, Schott, and Burger (2010) observed that psychologists' rated fictitious research that confirmed the Big Five personality theory or refuted astrology to be of better quality than research that confirmed astrology or refuted the Big Five personality theory.

2. *Decision Leaning:* A decision leaning is also called a preliminary decision and refers to the decision option that a participant considers to be leading at any point in time. A decision leaning could be a favoured product for purchase, a preliminary verdict in a trial, a prime suspect in an investigation, or a favoured business action. Participants' decision leanings are measured or manipulated, and the impact on decision-making behaviour and conclusions is observed. This is similar to 'opposing views', except that the cases are novel to

the participant, such that opinions are not likely to be well-instantiated beliefs. Examples of decisions include guilt in criminal cases (Hill, Memon, & McGeorge, 2008), choosing between hypothesised causes of an explosion (Lehner, Adelman, Cheikes, & Brown, 2008), and choosing between product A and B in consumer choices (Russo, Meloy, & Medvec, 1998). In some cases, the original decision leaning is manipulated through the original information such that all participants hold a relatively uniform view (Lehner et al., 2008; Marks & Fraley, 2006; Mendel et al., 2011; O'Brien, 2009), different groups hold different views (Hill et al., 2008; Marsh & Hanlon, 2007; Muris et al., 2009; Powell, Hughes-Scholes, & Sharman, 2012), or different groups are more or less confident in the preliminary decision (Evans, Venn, & Feeney, 2002). Alternatively, each participant's original decision leaning may be used as the anchor for confirmation measurements (Huang, Hsu, & Ku, 2012; Masnick & Zimmerman, 2009; Mynatt, Doherty, & Tweney, 1977; Rassin, Eerland, & Kuijpers, 2010; Schwind & Buder, 2012; Schwind, Buder, Cress, & Hesse, 2012). Confirmation processes such as information selection (e.g. Hill et al., 2008; Mynatt et al., 1977; O'Brien, 2009; Rassin et al., 2010) and interpretation (e.g. DeKay, Stone, & Miller, 2011; Lehner et al., 2008; O'Brien, 2009; Russo & Yong, 2011) tend to favour the original, or most recently assessed decision leaning.

3. *Threat:* Experimenters use manipulations that threaten one group of participants but not the other. The threatened group use techniques to dismiss the threat, whereas participants not personally threatened do not. For example, a number of experiments use a fictitious medical test called the 'TAA Saliva Reaction Test'. Although all participants get a reaction that ostensibly indicates TAA positivity, whether this condition is reported to be beneficial or detrimental to health is manipulated (Croyle & Ditto, 1990; Ditto & Lopez, 1992; Ditto, Scepansky, Munro, Apanovitch, & Lockhart, 1998). Participants try to confirm

the least threatening possibility, that they are healthy (See also Dawson, Gilovich, & Regan, 2002; Munro & Stansbury, 2009).

4. *Frame:* Frame refers to the way in which the problem, question, or instructions are phrased to imply a particular context. The experimenter frames the information or question differently for different participant samples. This differs from decision leaning in that framed information is logically equivalent. For example, information selection behaviour differs depending on whether participants are asked to decide if an individual is an introvert or an extrovert (Zuckerman, Knee, Hodgins, & Miyake, 1995). Information selection (for a review see Evans, 2007) and interpretation (e.g. Lehman, Krosnick, West, & Li, 1992) has been found to favour the elements mentioned or implied by the question wording.

Confirmation bias can be categorised into three types based on the different types of decision options that are confirmed:

1. Confirmation of Expectation
2. Confirmation of Preference
3. Confirmation of Frame

Confirmation of Expectation refers to a bias towards confirming what one thinks is true or the decision one expects to make. This decision option is referred to as the ‘expected decision option’. Expected decision options can range in confidence from firmly held beliefs and attitudes at the high confidence end, through theories and previous choices in the middle, down to tentative hypotheses or hunches. Examples of confirmation of expectation include academics whose reviews systematically favour papers that confirm, rather than refute, current beliefs (Hergovich et al., 2010; Masnick & Zimmerman, 2009) and participants who maintain and even strengthen prior opinions and attitudes in the face of evidence against their position (Lord et al., 1979; Munro & Ditto, 1997).

Confirmation of expectation also applies to cases where no expectation was held before the experiment or demonstration. For example, confirmation processes have been observed when children are presented with a theory (Allen, 2011), pilots are presented with a hypothesised location (Gilbey & Hill, 2012), when participants test hypotheses in a new experimental environment (Mynatt et al., 1977), or investigate potential suspects in a novel criminal or military case (Lehner et al., 2008; O'Brien, 2009; Rassin, 2010; Wastell, Weeks, Wearing, & Duncan, 2012). A bias towards confirming the expected decision option has also been demonstrated in cases where the expected outcome is undesirable, such as the hostile media phenomenon, where the media is perceived as biased against one's own group (Lehman et al., 1992). In many cases, confirmation processes are observed after participants state their decision leaning, which some argue is critical to confirmation bias (for a review see Brownstein, 2003). However, confirmation processes have also been observed when participants are instructed to delay making the decision, or just memorise or comprehend the material (Simon, Pham, Le, & Holyoak, 2001). Generally, confirmation of expectation is demonstrated by comparing participants with opposing views or different decision leanings.

Confirmation of Preference refers to the tendency to accept desirable or rewarding decision options and reject undesirable or costly decision options. The most desirable or rewarding, or least undesirable or costly decision option is termed the 'preferred decision option'. There is evidence that preferences are constructed, rather than recalled (Lichtenstein & Slovic, 2006). Accordingly, confirmation of preference is usually demonstrated in areas where there is clear dominance, which is when the costs or benefits of one option or conclusion far outweigh those of other possible options or conclusions. Examples of confirmation of preference include participants who defend their positive self-concepts and health-status in the face of threatening information (Liberman & Chaiken, 1992; Munro &

Stansbury, 2009). Confirmation of preference is usually examined by observing reactions to threatening, non-threatening, or desirable information.

Finally, *Confirmation of Frame* is where individuals tend to affirm whatever decision option is implied by the information or question originally provided about the problem, which is called the framed decision option. One of the first uses of the term ‘confirmation bias’ was an example of confirmation of frame. In Wason’s (1960) original experiment, participants were provided with a set of three numbers that fit an unstated rule. Participants could present their own triplets to find out whether or not the number sequence they proposed fit the rule. The set of numbers, 2-4-6, provided a frame that elicited rules such as ‘even numbers’, ‘consecutive even numbers’, or ‘increasing by two’ (Klayman & Ha, 1989). The majority of participants ended up confirming these rules, rather than discovering the encompassing true rule, which was increasing numbers.

Confirmation of frame overlaps with phenomena known by other names, such as the focus of judgement effect (Lehman et al., 1992), and attribute framing (see Levin, Schneider, & Gaeth, 1998 for a review). The focus of judgement effect is where interpretations “are biased towards supporting any implicit assertion or hypothesis *or decision option* that is the focus of a question stem” (content in italics was not in the original Lehman et al., 1992, p. 691). In a demonstration of the focus of judgement effect, Lehman et al (1992) anchored questions on one of two rival political groups. Participants with little knowledge of the political groups tended to rate media hostility as greater towards the group mentioned in the questions. Attribute framing effects are where the description of an object or event characteristic affects the evaluation of that object or event (Levin et al., 1998). A common observation is that participants tend to provide ratings that are consistent with the valence of the attribute description. For example, ratings of beef that is 75% lean are more positive than ratings of beef that is 25% fat (Levin et al., 1998; McKenzie & Nelson, 2003).

Expected, preferred, and framed decision options are interdependent. Information frame could lead to expectation. For example, phrasing travel risk in terms of probability of negative outcomes, rather than probability of avoiding negative outcomes leads to higher expected travel risk. There is evidence that this effect is driven by information implied by the speaker's choice of frame (Weeks & Wastell, Under review). Similarly, a speaker's choice of question may convey expectations (Evett, Devine, Hirt, & Price, 1994; McKenzie, Ferreira, Mikkelsen, McDermott, & Skrable, 2001).

Frame could also influence preference. For example, participants can have a bias towards acquiescence or agreeing with assertions articulated in surveys (Bentler, Jackson, & Messick, 1971; Knowles & Condon, 1999; Krosnick, 1991). One proposed reason for this is that respondents search their memory for evidence consistent with the assertion and usually at least some consistent information can be recalled, leading to confirmation (Kahneman, 2011; Krosnick, 1991; Zuckerman et al., 1995). This behaviour could produce a true shift in preference at least momentarily due to question frame. However, when the individual is knowledgeable about the topic under scrutiny, prior knowledge may produce expectations or preferences that contradict the frame of the information. For example, Lehman et al. (1992) found that question wording influenced media-hostility ratings only in non-partisan participants with little relevant knowledge.

Confirmation of preference and expectation are often confounded because it is usually preferable to be right and have one's expectations confirmed. However, they can also contradict each other, such as when one believes that s/he left the door unlocked, the stove on, or expects it to rain on the weekend. Such events may be expected, even if they are not preferred. When preference and expectation are in opposition expectation can be more influential. For example, the hostile media phenomenon confirms the undesirable expectation that the media is biased against one's own group (Lehman et al., 1992; Vallone, Ross, &

Lepper, 1985), and confirmation processes favouring one's preferred political candidate have been found only when that candidate is also expected to win (Knobloch-Westerwick & Kleinman, 2012). However, in neither of these cases were preference and expectation manipulated independently. Therefore, the relative impact of preference and expectation cannot be assessed. For example, only one candidate was expected to win. Therefore, expectation was confounded with characteristics specific to that candidate (Knobloch-Westerwick & Kleinman, 2012). Research is required to better distinguish between the effects of expectation and preference. Empirical studies detailed in Chapters 7 and 8 address this gap.

The theoretical model to be described in Chapter 4 accommodates the three types of confirmation: Confirmation of expectation, preference, and frame. The relative importance of expected and preferred decision options on confirmation processes and outcomes is examined through experiments in Chapters 7 and 8. Although they are not mutually exclusive, the three types of confirmation have different implications for how confirmation processes may change over the course of an investigation, as detailed in Chapter 4.2.1.

1.1.2. Measurement of Confirmation Bias

There are many confirmation processes and behaviours that can lead to confirmation bias in combination or isolation. Many of these processes have been termed 'confirmation biases' by other researchers, but here the term 'confirmation bias' is reserved for the outcome where the final decision is pulled towards the original focal decision option. Use of the term 'bias' throughout this thesis is not meant in the evaluative sense of the word, but as a tendency or leaning that could be normative or non-normative.

Confirmation processes appear at every stage of decision making. Five common stages of decision making can be drawn from previous research, as shown in Table 1: Problem representation, information selection, information interpretation and quality assessment, stopping threshold, and decision.

Table 1: Decision-Making Processes Described by Theorists

Theorist	Problem Representation	Information Selection	Information interpretation and quality assessment	Stopping Rule	Decision
Klayman (1995)	Access prior beliefs and knowledge Generate Hypotheses	Search for evidence	Interpret evidence		Revise beliefs
Trope and Liberman (1996)	Hypothesis Generation	Derivation (if then) Information Gathering	Identification Inference		
O'Brien (2007)		Seek evidence	Interpret and integrate evidence		
Oswald and Grosjean (2004)	Information recollection	Information-gathering	Information interpretation		
Pyszczynski and Greenberg (1987)	Pre-existing causal theories	Generate Inference rule	Hypothesis Evaluation		

Theorist	Problem Representation	Information Selection	Information interpretation and quality assessment	Stopping Rule	Decision
	Generation of Hypotheses	Information Search	Information Evaluation		
Darley, Blankson, and Luethge (2010)	Problem Recognition	Search	Alternative evaluation		Action (Purchase)
Cronley, Posavac, Meyer, Kardes, and Kellaris (2005)	Generate Possibility	Focus on one hypothesis		Confirmation Threshold	Accept
Tschan et al. (2009)	Data Collection Generate hypotheses	Test hypothesis and exclude alternatives			
Borthwick (2011)		Information Search	Information Integration		

As displayed in Figure 1, decision making is conceptualised throughout this thesis as a multiphase process that is triggered by a problem representation (1) in reaction to a personal concern, work assignment, or disrupted goal path. This problem representation prompts information search (2) from memory and external sources where possible. As information is gathered, it is interpreted (3) particularly in regards to its implication for the decision. The information interpretation may or may not be accompanied by an assessment of the quality of information. Information search and interpretation processes are repeated until the information gathered satisfies some stopping threshold (4), at which point, information search is terminated and a decision is made (5). This model of decision making assumes a conscious, deliberate process. This thesis focuses on decision making in novel situations, like problems encountered by first time homebuyers, students, or occupational trainees. Non-conscious models of decision making (e.g. the recognition-primed decision model, Klein, 1993; Klein, 1997) are beyond the scope of this thesis, as they are less likely to apply in novel situations.

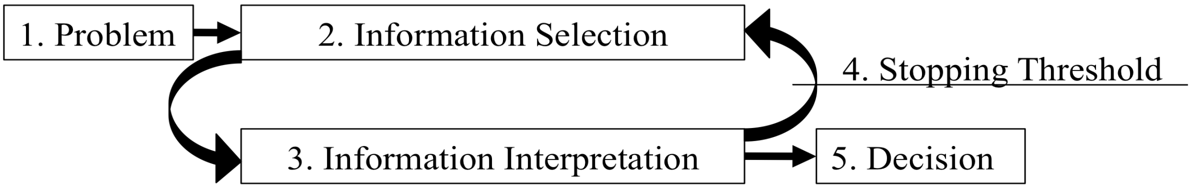


Figure 1: Depiction of the decision-making process.

1.1.2.1. Problem representation

Problem representation refers to a participants' mental depiction of the problem, decision, proposition, assessment, rule, or question that they are investigating. Problem representation encompasses the focal decision option and other problem elements that are salient to the individual. Other problem elements could include alternative decision options, associated concepts drawn from memory, and related situation assessments to be made or actions to be taken. For example, a market analyst in a software company could be asked to examine whether another software company is planning a competitive new release[2]. In this case, the focal decision option might be the possibility that the competition will release a competitive software product. The problem representation would also include alternative

[2] This market analyst scenario is used as an example throughout the introductory chapters and ties in with the scenario used in the series of experiments detailed in Chapters 5 to 8.

possibilities, such as the possibility that the competition is incapable of producing a competitive product, associated concepts, such as attributes expected if there were to be a competitive release, and associated actions, such as recommending that the market analyst's company release their product sooner than planned.

When experimenters manipulate decision leaning, threat, and frame, as discussed previously, they are attempting to influence participants' problem representation, specifically participants' focal decision option. There have also been attempts to measure problem representation. For example, Klayman and Ha (1989, p. 598) asked what participants were "testing or trying to find out" and for their "best guess", and Wastell et al. (2012) asked participants what primary and secondary murder suspects they were investigating. However, methods of capturing problem representation are limited partly by the difficulty of qualitative analysis, and partly by concerns that problem representation may be fundamentally altered by attempts to verbalise or otherwise capture it (For a discussion see Kuhberger, Schulte-Mecklenbeck, & Ranyard, 2010). The inclusion of problem representation in models of decision making and confirmation bias is important because it acts as a reminder that what participants think they are investigating does not always perfectly correspond with what the experimenter intends for them to investigate (For a review see Hilton, 1995).

1.1.2.2. Information selection

Information selection refers to the strategies one uses to gather information or evidence. The information selection processes most commonly implicated in confirmation bias are positive test strategy (PTS), pseudo-diagnostic (PD) selection, and selective exposure (SE). PTS, PD, and SE paradigms all involve investigating a question by selecting information based on titles or in some cases generating questions. Examples of instructions, questions, titles, and information for each paradigm are provided in Table 2.

Table 2: Example Content Provided in Different Information Selection Paradigms

	Positive test strategy (PTS)	Pseudo-diagnostic (PD)	Selective exposure (SE)
Example Instructions	Select cards that will show that the rule is true or false. Rule: "If there is a D on one side of any card, then there is a 3 on its other side"	Determine which of two cars your sister bought Car X or Car Y. You know *Attribute A* and *Attribute B*. 65% of Car Xs have *Attribute A*.	Decide whether health insurance should only cover traditional medical treatments or should also cover alternative healing methods.
Title type	Front of a card (back hidden)	Car by Attribute grid with covered content or statements as below	Statement of main theses
Example Titles:	"D" "3" "B" "7"	'The percentage of car Ys that have *Attribute A*' 'The percentage of car Ys that have *Attribute B*'	"The success of alternative healing methods cannot be ignored. Therefore, alternative treatments should also be paid by health insurance."
Example Information:	"3" (Card back) "K" "5" "D"	Percentage figures	An article arguing the main thesis from the title.
Reference:	Wason (1968, p. 275)	Mynatt, Doherty, and Dragan (1993)	Jonas, Schulz-Hardt, Frey, and Thelen (2001, p. 559)

Positive test strategy (PTS) was, originally, labelled a tendency to 'seek confirming evidence' by Wason (1960), but later renamed 'positive test strategy' by Klayman and Ha (1987). PTS is where participants investigate a focal decision option by preferentially asking positive questions, that is seeking information on elements that would be expected if the focal decision option were true or correct, rather than negative questions targeting elements that would not be expected if the focal decision option were true or correct, or would be expected if the focal decision option were false or incorrect (Klayman & Ha, 1987).

Positive test strategy (PTS) paradigms are where participants are asked to select from positive and negative questions that do not reveal the implication of the information for the decision. For example, Wason's (1960) original experiment asked participants to generate examples to test a hypothesised rule. Participants did not know in advance whether the response would be 'yes, that example fits the rule' or 'no, that example does not fit the rule'. Participants demonstrated PTS in that they chose predominantly examples that fit their assumed rule. For example, to test the hypothesised rule of 'consecutive *even* numbers' participants test triplets such as 2-4-6 but not 3-5-7, whereas to test the hypothesised rule of 'increasing by 2' they test 2-4-6 and 3-5-7, but not 2-5-8. Similarly, in Wason's (1968) second demonstration, when testing a rule in the form of 'if p then q' such as if there is a D on one side there is a 3 on the other, most participants selected only positive instances of the rule, D and/or 3, but not negative instances such as B or 7 (For a review see Evans & Over, 2004).

Consider a market analyst for a software company tasked with investigating whether a competitor is going to release a particular competitive product. If the competition is going to release a new product, one might expect to see (1) a scheduled media release from that organisation, and (2) evidence of increased product development activity. If the competition was not going to release a new product one might expect to find (3) barriers to product development, or (4) flaws in related products.

If the focal decision option were that the competition is going to release a new product, participants using PTS would seek information on 1 and 2 preferentially to 3 and 4. The selection of positive questions does not guarantee a consistent result. One may investigate cases of p and find not q, or look for evidence of increased product development and find no evidence of increases, evidence of decreases, or problems in product development.

Participants have been found to prefer positive to negative questions when forced to choose between them (Dawson et al., 2002; Gilbey & Hill, 2012; Munro & Stansbury, 2009; Muris et al., 2009; Wason, 1968), and to generate (Hill et al., 2008; J. M. Martin, 2001; Zuckerman et al., 1995) and select (Muris et al., 2009; O'Brien, 2009; Rassin et al., 2010) more questions that assume the focal decision option is true than false.

Pseudo-diagnostic paradigms ask participants to decide between one or more options such as used Car A or B. Attribute information is provided on one of those options, such as the petrol consumption for Car A. Participants can choose to access information on the same attribute for a different option, petrol consumption for Car B in this example, or information on another attribute for the same option, such as total kilometres travelled for Car A. Participants tend to favour more information on the original option, Car A, over information on the alternative, Car B. This is called pseudo-diagnostic (PD) selection. If one were to select information on the same attribute, petrol consumption for Car B, one may find that Car B is the same, less, or more economical than Car A. Therefore, information on the same attribute in both alternatives is required to determine which is superior (Doherty, Mynatt, Tweney, & Schiavo, 1979; Evans et al., 2002; Feeney, Evans, & Venn, 2008).

Selective exposure (SE) paradigms differ from PTS and PD paradigms because the implication of information is known from the title. In SE paradigms, participants are provided with an array of information where the argument or outcome is evident from the description. For example, in one SE paradigm participants were asked to investigate whether alternative medicines should be included in health insurance policies, and provided with titles such as "The success of alternative healing methods cannot be ignored. Therefore, alternative treatments should also be paid by health insurance” and “In the absence of an unequivocal explanation of how certain methods work, it would be irresponsible to call such a method therapeutic” (Jonas et al., 2001, p. 559). SE demonstrations show that participants often prefer to attend to, and recall, the information that is consistent, rather than inconsistent, with their focal decision option, usually the preferred or expected decision option (e.g. Cook & Smallman, 2008; Huang et al., 2012; Jonas et al., 2001; Knobloch-Westerwick & Kleinman, 2012; Schwind & Buder, 2012). A recent meta-analytic review estimated effect sizes to be medium to small (d = 0.36) for attention and small (d = 0.23) for recollection (Hart et al., 2009) of consistent information preferentially to inconsistent information. Consistent information refers to information that supports the focal decision option and inconsistent information refers to information that refutes the focal decision option. At times, a distinction is drawn between preference, expectation, and frame consistent and inconsistent information, which respectively refer to information that supports and refutes the preferred, expected, or framed decision option regardless of whether that decision option is the focus of attention.

PTS, PD, and SE differ primarily by the type of information provided. The participants’ behaviour in each is relatively similar. Participants select information more directly related to the focal decision option such as triplets that fit the rule in focus, information about the car in focus, or information related to the policy opinion in focus. Participants select less information that is related to alternative decision options such a triplets that fit alternative rules, information about the other car, or information related to an alternative policy viewpoint.

None of these selection behaviours necessarily lead to a confirmation bias outcome. In the case of PTS, confirmation bias is a possible outcome if affirmative findings are more likely or more heavily weighted than negative findings. Affirmative responses can be more likely under three conditions. Firstly, when participants answering questions tend to acquiesce. For example, Zuckerman et al. (1995) found that interviewees were more likely to respond ‘yes’ rather than ‘no’ even when the questions asked about socially undesirable characteristics such as being suspicious. In combination with the tendency of interviewers to ask questions related to the personality trait in question, such as suspiciousness, this led to a tendency to confirm the personality trait being tested. Secondly, affirmative responses are more likely than negative responses when the focal decision option is too specific and encompassed by the true situation such that all positive questions target elements that are true of the focal decision option and the actual situation. For example, in Wason’s 2-4-6 hypothesis testing task, the focal decision option of ‘increasing by 2’ is a subset of the true rule ‘ascending numbers’. Therefore, all positive tests of the focal decision option, such as 8-10-12, receive an affirmative response. Only negative tests can disprove the focal decision option if it is completely encompassed by the true situation (see Klayman & Ha, 1987 for a comprehensive discussion). Thus, the reliance on positive tests can lead to incorrect confirmation in these cases. Thirdly, affirmative responses are more likely when the information environment is such that positive questions always yields consistent results as is the case in SE paradigms (Jonas et al., 2001). Affirmative responses can be over-weighted due to a tendency to weight positive findings more highly than negative findings (the feature-positive effect; Newman, Wolff, & Hearst, 1980; Slowiaczek, Klayman, Sherman, & Skov, 1992). Even in the cases described above, confirmation bias outcomes are not guaranteed because participants could still adjust their interpretations appropriately for the biased sample of information as suggested in previous reviews of confirmation bias (Klayman, 1995; Oswald & Grosjean, 2004).

1.1.2.3. Information interpretation and quality assessment

Paradigms used to assess information interpretation include coherence shifting, information distortion, and information weighting.

Coherence Shift Paradigms ask participants to make assessments on a variety of apparently unrelated items before and after, and sometimes during, an investigative or decision task. The assessments given tend to shift by the second time point such that they are more supportive of the final decision option. For example, participants might be asked about the desirability and importance that a job was close to home and paid a high salary. If they end up choosing a job with a high salary, far from home, the ratings of desirability and importance shift up for high salary and down for close to home (Simon, Krawczyk, & Holyoak, 2004). Coherence shift paradigms have demonstrated shifts in interpretations of attitudes and facts about legal cases (O'Brien, 2009; Simon, Snow, & Read, 2004), opinions on social events (Read, Snow, & Simon, 2003) and attitudes towards job attributes (Simon, Krawczyk, et al., 2004).

Information Distortion Paradigms measure information interpretation throughout an investigation. The technical details differ but generally, participants rate the implication of information during or after an investigation and their ratings are compared to the ratings of a control group who did not have to make a decision (e.g. Russo, Carlson, Meloy, & Yong, 2008; Russo & Yong, 2011), participants with a different focal decision option (e.g. Lehner et al., 2008), or a pre-defined standard (e.g. Lehner et al., 2008). For example, participants read information on Hotels A and B, such as a description of dining options and rate how favourable the information is (Russo & Yong, 2011). Generally, participants who have to make a choice make interpretations of the attributes that are biased towards the focal decision option, such as the currently favoured Hotel, compared to the control group or standard interpretations (e.g. Russo, Medvec, & Meloy, 1996; Russo et al., 1998).

Information Weighting Paradigms ask participants to assess the quality of the information received. Generally, participants are more critical of the quality of information that opposes the focal decision option (inconsistent information), compared to that which supports it (consistent information) (e.g. Hergovich et al., 2010; Masnick & Zimmerman, 2009; O'Reilly, Northcraft, & Sabers, 1989).

All three paradigms show that the decision implication of information shifts towards supporting the focal decision option. Implication can be altered at three levels: Changes to the interpretation of what the evidence means for the decision, changes to the weight or credibility of the evidence, or changes to the beliefs or prior knowledge that impact on assessments of meaning and weight of the evidence. Although these are conceptually distinct levels, they are often harder to separate in practice where different ratings of the implication of information could be the result of different understandings, weightings, underlying beliefs, or all three.

1.1.2.4. Stopping and decision thresholds

Empirical demonstrations of confirmation bias have rarely examined the role of stopping and decision thresholds. Stopping thresholds determine the point at which an individual decides to stop seeking more information and make a decision. Decision thresholds determine what action will be taken given the individual's situation assessment.

Stopping thresholds could contribute to confirmation bias if the threshold for choosing the focal decision option is more lenient, requiring less or lower quality information than the threshold for choosing alternative decision options. If this were the case, more quantity and quality of evidence would be required to reject than to accept the focal decision option as found by Ditto and Lopez (1992). In a series of three experiments, participants who adopted the preference-inconsistent conclusion gathered more information compared to those who adopted the preference-consistent conclusion. In Experiment 1, participants needed to see more answers to an analogy test before concluding that a dislikeable student was more intelligent and, therefore, would be working with them, than participants who concluded that the dislikeable student was less intelligent, or participants who did not have a preference between students. In Experiments 2 and 3, participants took longer to decide that an ostensible medical test was complete and ran more re-tests when the result indicated ill-health than when it indicated good-health (Ditto & Lopez, 1992).

1.1.2.5. Decision outcome

The prevalence of confirmation bias has been exaggerated by the use of the term confirmation bias to refer to confirmation processes such as PTS, PD selection, and information distortion. Confirmation processes tend to have more empirical support than the decision outcome of confirmation bias itself. Even in cases where confirmation bias outcomes have been demonstrated (e.g. Slowiaczek et al., 1992), counter studies have demonstrated that results have been exaggerated by the use of abstract materials (e.g. McKenzie, 2006).

Attitude Polarisation is the main outcome-based demonstration of confirmation bias. This is where participants who start with different focal decision options end up polarising, such that their final decisions are even further apart in extremity and certainty, despite access to the same information (e.g. Hernandez & Preston, 2013; Kempf & Ruenzi, 2006; Lehman et al., 1992; Lord et al., 1979; Marsh & Hanlon, 2007).

1.1.3. Direction gained from Empirical Studies

This chapter has outlined the wide variety of paradigms and effects collated under the term confirmation bias. Confirmation processes may individually or in combination contribute to confirmation bias as recognised by previous confirmation bias theorists (Klayman, 1995; Nickerson, 1998; Oswald & Grosjean, 2004). The degree to which each process contributes to confirmation bias is an empirical question addressed in Chapters 5 to 8. Fischhoff and Beyth-Marom (1983) suggested that the term confirmation bias should be retired because it is not a unified concept. A distinction does need to be made between the behavioural confirmation processes and the final confirmation outcome. However, this thesis asserts that a unified understanding of this range of confirmation processes and confirmation bias is possible. The DHT model presented, tested, and developed throughout this thesis takes the first steps towards this goal.

1.2. Summary: An Empirical View of Confirmation Bias

An examination of the empirical investigation of confirmation bias reveals that three types of decision options are commonly confirmed. Behaviour tends to show a bias towards confirming the most desirable possibility (preferred decision option), the anticipated possibility (expected decision option), or the possibility implied by the wording or presentation of the problem or question (framed decision option). In many cases preferred, expected, and framed decision options are the same but they can also contradict each other. The focal decision option refers to whichever possibility is most salient to the decision maker at the time, and could correspond with the preferred, expected, and/or framed decision option.

The term confirmation bias has been used to refer to numerous processes and behaviours that may or may not contribute to a tendency to confirm the focal decision option in isolation. Throughout this thesis, a distinction is drawn between these confirmation processes and the outcome of confirmation bias. Confirmation processes are any human processes or behaviours that can, in isolation or in combination with other processes, produce a tendency towards accepting, rather than rejecting, the focal decision option. Confirmation bias is the outcome where one's final decision is biased towards the original focal decision option. Confirmation processes include selecting information about the focal decision option preferentially to information about alternative decision options, interpreting and assessing the quality of information such that the interpretation is swayed towards supporting the focal decision option, and use of biased stopping thresholds such that less or lower quality information is required to accept than to reject the focal decision option.

Throughout this thesis, it is argued that confirmation of frame, preference, and expectation occur when the framed, preferred, or expected decision options respectively become the focus of attention (the focal decision option). The focal decision option influences numerous confirmation processes, which can lead to confirmation bias.

2. Why and How: Theoretical Reasons and Mechanisms for Confirmation Bias (Part 1)

Numerous theories have been developed to explain the individual confirmation processes detailed in Chapter 1.1.2, a collection of these confirmation processes, or confirmation bias as a whole. As outlined in Chapter 1, confirmation bias is where the final decision is biased towards confirming the original focal decision option. The decision option in focus is commonly the preferred, expected, or framed decision option.

Some theories predominantly explain confirmation of a single type of decision option. For example, motivated reasoning theories commonly focus on confirmation of the preferred decision option (confirmation of preference, e.g. Kunda, 1990). In some theories different mechanisms explain the confirmation of preference and other types of confirmation (e.g. Pyszczynski & Greenberg, 1987). In other theories all types of confirmation can be explained using a single mechanism (e.g. Evans, 2006). No theories currently explain all types of confirmation and all confirmation processes, as outlined in Table 3.

Chapters 2 and 3 will introduce theories that are referred to throughout the thesis and the theories that the DHT model is founded upon. Influential theories are discussed within each of the five confirmation processes described in Chapter 1.1.2. Dividing theories across confirmation processes allows for a clear comparison of the mechanisms involved in each process but also means that some theories appear under multiple processes. Discussion of empirical support for each theory is largely withheld until the theoretical summary sections. This allows for an examination of empirical results that distinguish between theories. In cases where there is known evidence against the theoretical assertions, this is noted.

Table 3: Confirmation Processes Addressed by each Theory

Theory	Problem Representation (Focal Decision Options)			Information Selection	Information Interpretation	Decision and Stopping Thresholds
	Framed	Expected	Preferred			
Argumentative theory	✔ Accessibility			✔ SE (Adaptive)	✔ (E) Overweighting	✖
Associative model	✔	✖	✖	✔ SE	✖	✖
Bayesian rationality	✔	✖	✖	✔ PTS (Adaptive)	✖	✖
Biased hypothesis testing	✔ Accessibility (Active Model)		✔ (Biased Model)	✔ PTS, SE (P)	✔ Overweighting	? Vague
Cognitive consistency theories	? Focal decision option			✖	✔ Assimilation, overweighting, coherence shifts	✔
Dif con theory	Decision leaning			✔ SE	✔ Assimilation, overweighting, coherence shifts	✔ Stopping thresholds
Error avoidance	✖	✖	✔	✔ PTS (Adaptive)	✖	✖
Heuristic-analytic theory	✔ Accessibility			✔ PTS (Matching bias)	✖	✖

Theory	Problem Representation (Focal Decision Options)			Information Selection	Information Interpretation	Decision and Stopping Thresholds
	Framed	Expected	Preferred			
HyGene model	✖	✔	✖	✔ PTS (Single decision option only)	✖	✖
Information leakage model	✔	✖	✖	✖	✖	✖
Motivated reasoning	✖	✖	✔	✔ SE	✖	? Vague
Pragmatic hypothesis testing	✔ Accessibility		✔	✔ PTS (Adaptive)	✔ Assimilation	✔ Combined Thresholds
Relevance theory	✔	?	?	✔ PTS	✖	✖

Note: Shaded cells indicate multiple problem representations explained by a single mechanism

✔ = Addressed by the theory, ✖ = Not addressed by the theory, ? = Theoretical implication is unclear

PTS = Positive test strategy, SE = Selective exposure

(P) = Applies to preferred decision option only, (E) = Applies to expected decision option only

2.1. Problem Representation: Theories that Define the Focal Decision Option

As defined in Chapter 1.1.2.1, problem representation is an individual's mental depiction of the problem, decision, proposition, assessment, rule, or question that they are investigating. The focal decision option is an important part of the problem representation. Which decision option is the focus of attention and why is an important question because confirmation processes and outcomes are defined based on the decision option that they favour.

Theories take different approaches to defining which decision option becomes the focus of attention. Firstly, a number of theories suggest that the focal decision option is generated without conscious attention (e.g. heuristic-analytic theory, Evans, 2006; argumentative theory, Mercier & Sperber, 2011; and relevance theory, Sperber & Wilson, 1986; Sperber & Wilson, 2004). These theories are more specific about how the focal decision option is generated than the specific nature of the focal decision option. Secondly, motivated reasoning theories suggest that if there is a preferred decision option, this option will always become the focus of attention (e.g. motivated reasoning, Kunda, 1990; biased hypothesis testing, Pyszczynski & Greenberg, 1987; and pragmatic hypothesis testing, Trope & Liberman, 1996). Most of these theories cannot explain confirmation of the expected decision option in cases where an opposing preferred decision option exists. Thirdly, framing theories explain how context can make one decision option focal instead of others but apply only to determining the framed decision option (e.g. Associative model, Levin et al., 1998; and the information leakage model, Sher & McKenzie, 2006 of attribute framing). Finally, the HyGene model provides specific mechanisms by which the expected decision option may become the focus but provides only vague mechanisms by which other decision options may draw attention (Dougherty, Thomas, & Lange, 2010).

2.1.1. Relevance Theory (Sperber & Wilson, 1986, 2004)

Relevance theory explains reasoning as an extension of verbal comprehension and communication. Relevance theory hinges on two concepts: cognitive effect and cognitive effort. Cognitive effect refers to the degree to which new information meaningfully changes one's problem representation given the original context. Cognitive effort is the intellectual energy required to process the information (Sperber & Wilson, 1986, 2004). The central premise of relevance theory is that individuals attend to relevant information, and that relevance increases as cognitive effect increases and cognitive effort decreases. Therefore, the most relevant or attended to decision option would be the decision option that most readily comes to mind (least cognitive effort), or the decision option that, if true, would have the most impact on one's problem representation.

2.1.2. Heuristic-Analytic Theory (Evans, 2006)

The Heuristic-Analytic Theory (Evans, 2006) proposes that focal decision options are epistemic mental models that are governed by three principles:

1. Singularity: Models are generated one at a time.

2. Relevance: Models are generated pre-consciously to maximise relevance to contextual cues and current goals.

3. Satisficing: Models are accepted if they satisfy the current goals.

Epistemic mental models are states of belief or knowledge that include some measure of doubt or uncertainty around that belief. For example, the market analyst might have the epistemic mental model that a rival company will definitely, is likely to, is very unlikely to, or will definitely not release a competitive product.

Heuristic-analytic theory's principle of relevance is similar to relevance theory (Sperber & Wilson, 1986, 2004) in that both assert that relevance is judged automatically, without conscious control. However, the heuristic-analytic theory is less specific on the criteria by which the most relevant decision option is determined. Evans (2006) suggests that the focal decision option generated is relevant to current goals, which directly implies a preferred decision option. Relevance to contextual cues may also imply that framed decision options are likely to be considered relevant. Further, Evans (2006) suggests that relevant models are generally most plausible or probable, therefore implying an expected decision option. Which of these decision options is generated first would, presumably, depend on the strength and importance of goals, contextual cues, and expectation in each case.

The heuristic-analytic theory is a dual-process theory that proposes two distinct but interactive cognitive processes (for reviews and discussions of dual process theories see Evans, 2007; Evans & Stanovich, 2013; Kahneman, 2003). The defining features of the Type 1 or heuristic thinking process is that it is autonomous in that it does not require controlled attention and, therefore, does not require working memory. In contrast, the Type 2 or analytic thinking process does require working memory, and allows for mental simulation, which is representing an imaginary or hypothetical situation without confusing it with reality. Typically, heuristic processing is fast and associative whereas analytic processing is slow and rule-based (Evans & Stanovich, 2013).

Evans (2006) proposes that the heuristic process determines the focal decision option. The analytic process may then check the focal decision option if there is sufficient working memory capacity, time, and especially if the problem is abstract. If this focal decision option appears satisfactory to the analytic process, or is not checked, then it is used to form inferences and judgements as detailed under information selection.

2.1.3. Argumentative Theory (Mercier & Sperber, 2011)

Argumentative theory is another dual process theory, which proposes that human reasoning evolved for the primary purpose of constructing and evaluating arguments within a context of communication.

Mercier and Sperber (2011) propose that individuals' conclusions are formed without controlled attention by means of the Type 1 processes. These conclusions, or intuitive beliefs are input to the Type 2 process. It is the operations of Type 2 processing that Mercier and Sperber (2011) call reasoning (Mercier & Sperber, 2011 refer to Type 1 and Type 2 processes as System 1 and System 2 respectively).

According to the argumentative theory, Type 1 processes generate an intuitive belief or focal decision option that is then supported by Type 2 processes. The argumentative theory does not define which decision option Type 1 processes favour.

2.1.4. Biased Hypothesis Testing (Pyszczynski & Greenberg, 1987)

Pyszczynski and Greenberg (1987) present two models of hypothesis testing processes applied to causal attribution problems. Individuals are expected to use the 'active hypothesis testing' model (active model) when they have no preference for a particular decision, and use the 'biased hypothesis testing' model (biased model) when they have a decision preference. The biased model can be regarded as an addition to the active model, rather than a completely different set of mechanisms.

According to Pyszczynski and Greenberg (1987), the focal decision option is determined via the following process:

A. Unexpected event occurs
B. Decision options (called hypotheses by Pyszczynski and Greenberg) are generated
C. Plausible decision options are selected for testing
D. (Biased model) Undesirable decision options produce negative affect
E. (Biased model) A less threatening decision option is chosen for testing

In C, perceptions of plausibility are based on the availability heuristic (Tversky & Kahneman, 1973) in that more easily imagined causes of the event in question are considered more plausible. 'Ease of imagining' is determined by the individual's intuitive causal theories, activation of the causal theory and related information, and perceptual salience. Expected and framed decision options are likely to become the focus of attention due to their association with causal theories and perceptual salience respectively. However, if some decision options are aversive, this triggers the biased model, and if plausible decision options are undesirable, they are replaced by less undesirable options. Therefore, if there is a preferred decision option, it is likely to be given priority over an expected decision option. This assumes that the nature of preferred decision options are that there is a single preferred option and that all other decision options are aversive non-preferred decision options, or that there is a single aversive non-preferred option and all other decision options are preferred decision options by comparison.

2.1.5. Pragmatic Hypothesis Testing (Trope & Liberman, 1996)

Like Pyszczynski and Greenberg (1987), Trope and Liberman (1996) predict that individuals choose to test desirable, rather than undesirable, focal decision options. The reasons they give are that preferred decision options are more pleasant to contemplate, more cognitively accessible due to the association with the individual's goals, and seem more likely because individuals actively try to achieve them (Trope & Liberman, 1996, p. 258). Cognitive accessibility refers to the ease with which examples or concepts can be retrieved from memory, constructed, or associated (Tversky & Kahneman, 1973). If preference is not a motivating factor in focal decision option choice, hypotheses that are more accessible are used (Trope & Liberman, 1996). Assuming that frame and expectation could make decision options more accessible, the pragmatic hypothesis-testing model accommodates all three forms of confirmation bias: confirmation of frame, expectation, and preference. According to (Trope & Liberman, 1996, p. 258) the preferred decision option is chosen for testing, partly because it is also often considered more likely. Therefore, preference and expectation are predicted to coincide in many cases. When preference and expectation conflict (Trope & Liberman, 1996, p. 258) predict the preferred decision option to dominate because it is more pleasant to contemplate.

2.1.6. Framing Theories and the Framed Decision Option

Framing effects are where different linguistic descriptions of the same message produce different problem representations (Keren, 2011). For the purposes of this thesis, the framing effects of interest are those that produce different focal decision options. Of particular relevance is attribute framing, where the description of an object or event characteristic affects the evaluation of that object or event (Levin et al., 1998). Attribute framing can influence the valance of situation assessments. For example, statistics of travel risk stated in likelihood of bad outcomes produced more negative assessments of safety than the same statistics stated in likelihood of good outcomes (Weeks & Wastell, Under review). Also, labelling ground beef as 80% lean, instead of 20% fat, increased its perceived value by almost 10 cents per pound (Levin, Gaeth, Schreiber, & Lauriola, 2002). Assessments tend to shift towards the valence of the attributes mentioned, a phenomenon called valence-consistent shift (Keren, 2011; Levin et al., 1998; Sher & McKenzie, 2008). Explanations for this phenomenon include the associative model and the information-leakage model.

2.1.6.1. Associative model of attribute framing

The associative model of attribute framing effects asserts that positive and negative cognitive representations of an attribute, such as proportion of fat, cause people to attend differently to the positive or negative aspects of the evaluation dimension, such as value or taste. According to this model, the valence-consistent shift occurs via the following processes (See Levin et al., 1998):

1. Information is encoded according to descriptive valence (e.g. Fat is encoded as negative). This is similar to focusing on the valence-consistent decision option.
2. Valence-consistent associations are triggered thus spreading activation beyond the single attribute (e.g. Fat activates other negative associations such as grease, gristle, and body fat).
3. Attention is directed towards information compatible with the initial representation (e.g. Attention towards any greasy texture). Although Levin et al. (1998) focus on attention to

information from memory, they suggest that this may also extend to external information search.

4. Information is encoded and represented consistent with perceived valence in associative memory (e.g. Experience of greasy texture strengthens the initial representation). This is similar to information interpretation being biased towards supporting the original focal decision option.

In the associative model of attribute framing, the framed decision option is the decision option with the same descriptive valence as the attribute mentioned. For example, the greasy end of a rating scale draws attention if the attribute mentioned was ‘fat’.

2.1.6.2. Information leakage model of attribute framing

The information-leakage model says that the speaker’s choice of frame communicates implicit information to the listener about the speaker’s reference point. According to Sher and McKenzie (2006), frames are selected based on what element has increased. For example, 30% fat indicates more fat than a reference product, whereas 70% lean indicates more lean than a reference product.

According to this model, the valence-consistent shift occurs via the following processes:

1. The speaker chooses to describe a complementary relationship in terms of X (e.g. Fat), rather than Y (e.g. Lean)
2. The listener infers that this choice was made due to more X in this product compared to a reference product (previous product or comparison products)
3. More of a good thing is good, more of a bad thing is bad, therefore this creates a valence-consistent shift in judgment

According to the information-leakage model, the framed decision option is the decision option implied by the extra information provided by the frame. For example, use of the word ‘fat’ rather than lean implies higher fat content. Therefore, any decision option associated with high fat products, such as the greasy end of a rating scale, is the framed decision option.

2.1.7. HyGene Model (Dougherty et al., 2010)

The HyGene Model was developed primarily to explain the process of hypothesis generation based on current understanding of memory systems. For simplicity, only the implications for the focal decision option are described here without reference to all the specific memory systems (Please see Dougherty et al., 2010 for the theoretical details). The HyGene model makes important assertions about the generation of decision options:

1. Not all decision options can be given conscious attention at one time.
2. The activation of decision options in memory determines whether they receive conscious attention.
3. The decision option that is most activated, or salient, in memory becomes the focal decision option.
4. Observations, including those contained in the problem presentation, trigger associations. Associations include frequently experienced events or concepts and elements that are otherwise highly associated with the observations.
5. The strength of the link between an amalgamation of these associations, and each decision option, determines the level of activation that decision option receives.

Based on point 4, the focal decision option is likely to be one that frequently explains the observed data, which is likely to correspond with the expected decision option. The HyGene model is less specific about how framed and preferred decision options may become highly activated, though they may be otherwise highly associated with the original observations.

2.1.8. Theoretical Summary of Problem Representation

Across the theories described, there are commonalities in the depiction of problem representation and the focal decision option in particular. Firstly, theories commonly assert that people tend to focus on a single focal decision option at a time. This is explicitly incorporated into the heuristic-analytic theory as the 'singularity principle' (Evans, 2006). Based on observations in the PD paradigm (see Chapter 1.1.2.2.), Mynatt, Doherty, and Dragan (1993) also suggested that people are incapable of considering multiple hypotheses at once. Individuals need to be able to consider multiple hypotheses to selectively attend to information that distinguishes between them, called diagnostic information. The diagnosticity of information is often calculated using the Bayesian likelihood ratio, which compares the likelihood of finding this information if the focal decision option was true, to the likelihood of finding this information if the focal decision option was false (e.g. McKenzie, 2006; Slowiaczek et al., 1992). The calculation of a likelihood ratio requires a consideration of the focal decision option and alternatives. There have now been numerous demonstrations that people are able to identify diagnostic information especially when the material was learned comparatively, rather than sequentially (e.g. Klayman & Brown, 1993; McKenzie, 1998), and when more than one hypothesis is highlighted via instructions (Hodgins & Zuckerman, 1993). Therefore, it appears that, rather than being incapable of considering multiple hypotheses, people do not usually actively seek alternative hypotheses and, therefore, often focus on a single possibility.

Secondly, theorists tend to agree that the focal decision option is determined by cognitive accessibility (Dougherty et al., 2010; Evans, 2006; Pyszczynski & Greenberg, 1987; Trope & Liberman, 1996). According to Kahneman (2003), aspects that increase accessibility include attention caught by motivationally-relevant stimuli, such as a desirable or preferred decision option, and priming, physical salience or prominence, which could be increased through question wording or framing. Accessibility is also higher for elements that are more commonly encountered or thought about (Tversky & Kahneman, 1973), which may be the case for expected decision options. Therefore, accessibility in memory can explain why the focal decision option might be determined by one's frame, preference, or expectation.

Theorists have different views on whether and how accessible decision options are filtered. Common suggestions are that accessible decision options are satisfactory focal decision options if they are plausible (Evans, 2006; Pyszczynski & Greenberg, 1987; Trope & Liberman, 1996), which expected decision options are likely to be, or desirable or non-aversive (Pyszczynski & Greenberg, 1987; Trope & Liberman, 1996), which preferred decision options would be. Klayman and Ha (1989) demonstrated that participants changed their focal hypothesis when the original focal decision option was discredited. This supports the assertion that accessible decision options are dismissed if they become implausible. Evidence that individuals test the preferred decision option over others is less direct, and tends to rely on processes for testing the decision option such as evidence of PTS (e.g. Dawson et al., 2002), rather than which decision option is explicitly being tested. Theorists also disagree on whether hypotheses are filtered via affective (Pyszczynski & Greenberg, 1987; Trope & Liberman, 1996) or cognitive (Evans, 2006) mechanisms.

2.2. Information Selection

As described in Chapter 1.1.2.2, there are three main selection processes that have been associated with confirmation bias, which are summarised in Table 4.

Table 4: Type of information selected in the three main selection processes

Selection Process	Chosen information	Avoided information
PTS	Information one would expect to find if the focal decision option were true or correct	Information one would not expect to find if the focal decision option were true or correct
SE	Information that supports the focal decision option	Information that refutes the focal decision option or supports alternative decision options
PD	Information that is associated with the focal decision option	Information that is associated with alternative decision options

Note: PTS = Positive test strategy, SE = Selective exposure, PD = Pseudo diagnostic selection

Each of these three processes has a large, relatively independent body of literature. The behaviour that is commonly observed in each is relatively similar but enacted in different information conditions. In all paradigms, participants tend to select information related to the focal decision option, rather than alternatives (for reviews see Borthwick, 2011; Evans, 2007; Hart et al., 2009). The two informational differences are:

1. Whether the result of information selection for the decision option is unknown as in PTS and PD or known as in SE and
2. Whether the result of information selection provides information on only a single decision option as in PD or provides information that may help to distinguish between decision options as in PTS and SE.

Numerous theories propose to explain one or two of these selection processes, but rarely all. There are commonalities across the different theories. Firstly, motivated reasoning theories tend to suggest that PTS is a default strategy, which becomes SE in the presence of a strong preferred decision option (biased hypothesis testing, Pyszczynski & Greenberg, 1987; and pragmatic hypothesis testing, Trope & Liberman, 1996). These theories predict very few instances in which information might lead one to accept a non-preferred decision option. Secondly, numerous theories suggest that PTS is an adaptive approach to information selection for various reasons. PTS is proposed to be beneficial for error avoidance (Friedrich, 1993; Klayman & Ha, 1987; Lewicka, 1998), persuasion (argumentative theory, Mercier & Sperber, 2011), preserving cognitive resources (heuristic-analytic theory, Evans, 2006), and selecting the most relevant information in naturalistic (Bayesian rationality, Oaksford & Chater, 2007; Oaksford & Chater, 2009; pragmatic hypothesis testing, Trope & Liberman, 1996) or communicative contexts (relevance theory, Sperber & Wilson, 1986, 2004). Adaptive approaches differ on the degree to which they predict PTS behaviour to change across contexts and the specific contexts in which they expect to see PTS. Finally, the HyGene model suggests that PTS is used only in limited circumstances, when only a single decision option is being consciously considered.

2.2.1. Biased Hypothesis Testing (Pyszczynski & Greenberg, 1987)

Recall that Pyszczynski and Greenberg (1987) assert two hypothesis testing models: active or biased. Under the active model, individuals are likely to generate expected or framed focal decision options based on the accessibility of these decision options. Under the biased model, the most accessible focal decision option is filtered based on desirability, such that the preferred decision option is selected for testing. This selected decision option is then used to generate if-then statements called inference rules. Which inference rules are generated and tested is also determined by accessibility. Inference rules lead directly into information selection. When one uses if-then statements to generate elements expected if the decision option is true or correct, and tests whether these elements are or were present, this is by definition using a PTS. Pyszczynski and Greenberg (1987) propose that PTS is used to generate the type of information sought in both active and biased models. In the biased hypothesis-testing model, this process is further filtered because individuals select the positive questions expected to yield preference-consistent results preferentially to those more likely to yield preference-inconsistent results. Thus, where the environment permits, individuals with a preferred decision use SE, in that they select questions known to yield consistent information. If, despite this selection strategy, individuals receive inconsistent information they are expected to switch to a new inference rule.

Pyszczynski and Greenberg (1987) developed their theory to explain causal attribution but it is applied here to a prediction scenario. Imagine the market analyst deciding whether the competition is going to release a new language translation product within the next six months. The preferred decision option is that the competition will *not* release a new translation product within the next six months. Based on the biased hypothesis-testing model, this decision option would be selected for testing. If the competition was not going to release a new translation product within the next six months, one might expect to find evidence that the competition lacked resources, ability, speed, or inclination to produce such a product. The market analyst might elect to seek evidence of lack of ability because this seems most likely to yield evidence that the competition will not release the new product. If instead, it appears the competition does have the required ability, according to the biased model, the market analyst would quickly switch to a new inference, such as lack of resources. This process would continue through the list of accessible inferences.

2.2.2. Motivated Reasoning (Kunda, 1990)

The central premise of Kunda's (1990) motivated reasoning theory is that individuals choose different cognitive processes depending on whether they are motivated to be accurate or arrive at a certain conclusion. Specifically, Kunda (1990) proposed that individuals use more complex, effortful, and generally more appropriate strategies for accessing, constructing, and evaluating beliefs when motivated by accuracy than when motivated towards a specific conclusion.

According to Kunda, individuals motivated towards a specific conclusion search their memory for information that could justify their conclusion. If sufficient information is retrieved to persuade a dispassionate observer, the desired conclusion is chosen. This biased memory search could be likened to SE. Supporting Kunda's theory, a meta-analysis of SE paradigms reported that selective exposure to supportive information was higher when individuals were motivated to defend a particular conclusion because of high (versus low) commitment to the decision and high (versus low) topic relevance. However, when the outcome was highly relevant to the participant (versus irrelevant), presumably increasing motivation to be accurate, selective exposure to supportive information was actually larger (Hart et al., 2009). This result is contrary to Kunda's theory and suggests that individuals may use the same processes even when motivated towards accuracy.

2.2.3. Error Avoidance

Klayman and Ha (1987) proposed that PTS could be an adaptive error avoidant heuristic in many naturally occurring situations. This suggestion has since found its way into numerous theories of information selection (e.g. Friedrich, 1993; Lewicka, 1998; Poletiek & Berndsen, 2000), decision making (e.g. Haselton et al., 2009; Trope & Liberman, 1996), and confirmation bias (e.g. Klayman, 1995). Mistakes one can make when testing a rule have different consequences in different situations. If a situation assessment is accepted, when it is actually false, this is referred to as Mistaken Acceptance (MA). If a situation assessment is rejected when it is actually true, this is referred to as Mistaken Rejection (MR). Previous researchers have used different terminology for MA and MR, as evident in Table 5. Mistaken (versus correct) refers to whether or not the action was appropriate for the true situation and acceptance versus rejection refers to the decision made or the action taken. The cost of different errors is often asymmetrical. For example, for safety rules, such as 'If a potato is green, it is edible', the cost of accepting false safety (MA) is usually higher than taking unnecessary precautions (MR). In this case, eating an inedible food is usually more costly than missing out on an edible food. Alternatively, for danger rules, such as 'If the alarm rings, there is a fire', MR costs are usually higher than MA costs. In this case, staying in a burning building is more costly than leaving the building unnecessarily (Lewicka, 1998).

Table 5: Terminology used to Describe the Outcomes of Actions in Different Situations

Actual state of the world. The situation assessment is…	Action. Act as if the situation assessment is…	
	True	False
True	**Correct Acceptance (CA)** True Acceptance [a] True Positive [b] Hit [c]	**Mistaken Rejection (MR)** False Rejection [a] False Negative [b] Miss [c] Type I Error [d]
False	**Mistaken Acceptance (MA)** False Acceptance [a] False Positive [b] False Alarm [c] Type II Error [d]	**Correct Rejection (CR)** True Rejection [a] True Negative [b] Correct Rejection [c]

Note: [a] e.g. Trope and Liberman (1996), [b] e.g. Friedrich (1993), [c] e.g. Macmillan & Creelman (1991), [d] e.g. Fisher (1955)

Some information selection strategies are better at avoiding certain mistakes than others. To demonstrate a case where the agent is known but the outcome is unknown, consider the market analyst who has an identified competitor, but has to predict whether the rival company will release a competitive new product. Assume the focal decision option is that the rival company will release a competitive new product. If the market analyst looks for evidence of a new product release (PTS) and there is any evidence of a new product release, this search maximises likelihood of finding it, thus minimising the chances of mistakenly rejecting the threat. Thus, PTS potentially avoids the costly mistaken rejection error, dismissing potential competition. Alternatively, searching for evidence that the competition will not or cannot release a competitive product would maximise chances of finding such evidence, and minimise chances of a mistaken acceptance error, acting on unrealised competition. This logic is at the core of theories that present PTS as an error avoidant strategy (Friedrich, 1993; Klayman & Ha, 1987; Lewicka, 1998).

Where these theories conflict is on the extent to which individuals detect costs of potential errors in the environment and adjust their strategy accordingly. In their description of PTS, Klayman and Ha (1989) suggested that, under ideal circumstances, people would adapt their strategy use to the situation. However, they put a limitation on this by stating that under unfavourable conditions, such as abstract tasks, cognitive load, time pressure, or limited experience, people would default to PTS. Friedrich's (1993) primary error detection and minimisation (PEDMIN) hypothesis suggests a less bounded adaptability, whereby information selection is always driven by the primary error of concern.

Error avoidance theories would most directly apply to confirmation of preference because rejecting a preferred option is generally more costly than accepting it. If a preference is formed based on the preferred option having greater perceived benefits or lesser costs than alternatives, rejecting the preferred option incurs the perceived loss of more benefits and the adoption of greater costs than accepting the preferred option. However, there are cases in which PTS based on the preferred decision option is not the best strategy for avoiding error, as detailed in Chapter 5.2. Error avoidance theories may explain confirmation of frame based on the argument that the social costs of disagreement are generally higher than the costs of agreement (Friedrich, 1993). It is more difficult for error avoidance theories to explain confirmation of expectation, especially when expectation contradicts preference. These error avoidant theories are also limited to explaining PTS, not other confirmation processes.

2.2.4. Argumentative Theory (Mercier & Sperber, 2011)

Mercier and Sperber (2011) propose that PTS is not an example of reasoning but rather a Type 1 heuristic. The example given is that people look for their keys where they expect to find them. They do not carefully examine the many places they may be unless they are not in the expected location. According to argumentative theory, heuristics operate independent of an argumentative context but once an intuitive answer is presented, Type 2 reasoning is used to prepare arguments for this answer. When individuals need to construct arguments Mercier and Sperber (2011) propose that they use SE where possible to support the focal decision option generated by Type 1 processes because this generally provides the most convincing information for their position. PTS and SE based on the framed, expected, or preferred decision options could, therefore, be explained in cases where wording, expectation, or preference provides the basis for an intuitive response in Type 1 processes that is then supported by System 2 processes.

2.2.5. Heuristic-Analytic Theory (Evans, 2006)

Recall that in the heuristic-analytic theory (Evans, 2006) the focal decision option can be the preferred, expected, or framed decision. This focal decision option is then used to generate default inferences and judgements via the heuristic process, which may or may not be assessed by the analytic process as described under problem representation (this Chapter 2.1.2.). According to the satisficing principle, default inferences, including PTS, are usually accepted if they satisfy current goals.

According to the heuristic-analytic theory, framed-based PTS occurs due to a 'matching bias', which is the tendency to focus on the values explicitly named in the rule, hypothesis, or framed decision option. The analytic processing system might assess the matching elements to determine whether they would be expected to yield useful information (Evans & Ball, 2010). Evans demonstrated that p and q were preferred regardless of whether participants were testing ‘if p then q’ or ‘if p then not q’ (Evans, 1998; Evans & Lynch, 1973), demonstrating that the matching cases were chosen controlling for logic.

The heuristic-analytic theory can accommodate the three targets of confirmation and predicts PTS. It does not provide specific predictions about information interpretation or when information search stops.

2.2.6. Bayesian Rationality (Oaksford & Chater, 1994, 2009)

Bayesian rationality has also been called information gain or optimal data selection theory and is a Bayesian model of optimal data selection proposed to explain numerous phenomena in the heuristics and biases tradition including PTS (Oaksford & Chater, 1994, 2009). Bayesian rationality argues that many apparent errors in reasoning can be explained by shifting from a logical to a probabilistic mindset. Logical arguments aim to provide a conclusion that can be adopted with absolute certainty. For example, if one agrees that *all women are people* and *all people are mortal*, then one can be absolutely certain that *all women are mortal.* Bayesian rationality argues that very few things in our evolutionary history were absolutely certain and therefore, human minds are better adapted to considering probabilistic data and outcomes (Oaksford & Chater, 2009). They refer to the consideration of data and outcomes as probabilistic, rather than absolute, as a probabilistic mindset.

In regards to the PTS, particularly on the Wason (1968) selection task, Bayesian rationality argues that selection of the positive cards (those mentioned in the rule) is an effective strategy for reducing uncertainty. In other words, a PTS yields optimal information gain. This argument is predicated on the assumption that the elements mentioned in hypotheses are almost always rare (Oaksford & Chater, 2009). People tend to state, and presumably think about, hypotheses in terms of rare, rather than common, features. For example, participants were more likely to state that “If applicants have high SAT scores, then they will be accepted”, rather than “If applicants have average SAT scores, then they will be rejected" when acceptance was rare (McKenzie et al., 2001, p. 296). In these situations, positive questions ask about a relatively rare feature or event, which usually makes them better at distinguishing between decision options (more diagnostic) than questions targeting a relatively common event (McKenzie & Amin, 2002).

Suppose that one thinks that award-winning artists are usually left handed, not ambidextrous or right handed. Presumably, fewer artists win awards than those who do not, and fewer artists are left handed than right handed. Using PTS, one might select a left-handed artist to see if he or she had won an award. The result of this question has the potential to be more useful in supporting or refuting the statement than selecting a right-handed artist to see if they had won an award. Whether or not the best artists are usually left handed, one is likely to find a right-handed artist who has not won an award because the majority of the population is right handed and the majority of artists have not one awards. Therefore, the most likely result of examining a right-handed artist will not help determine whether the hypothesis is true. For a detailed discussion of the value of questions targeting rare events see McKenzie et al. (2001).

Note that this example is based on the assertion that the best artists are *usually* left handed. This is a probabilistic statement. Therefore, finding a right hander who produced an award winning artwork does not definitively disprove the statement. In Wason's selection task, rules are in the form of the best artists are *always* left handed. This is an absolute statement. Therefore, finding a right-hander who produced an award winning artwork *does* definitively disprove the statement. Oaksford and Chater (2009) assert that individuals commonly apply a probabilistic mindset even when the statement is intended to be absolute.

The role of wording, or information frame, in Bayesian rationality approaches is that it signals to the participant which events are more rare. Indeed, the evidence does suggest that participants tend to focus on the rare events, even if the framed decision option they are testing explicitly states their common counterpart (McKenzie & Amin, 2002; McKenzie & Mikkelsen, 2000; Yama, 2001). Bayesian rationality theory, therefore, predicts PTS based on the decision option implied by the frame unless other cues about rarity are available.

2.2.7. Pragmatic Hypothesis Testing (Trope & Liberman, 1996)

Trope and Liberman (1996) argue that the PTS, which they call choosing hypothesis-consistent queries, is an effective strategy in many naturalistic environments because positive questions are often better at distinguishing between alternative possibilities than negative questions. In other words, they are more diagnostic. Trope and Liberman (1996) provide two reasons why positive questions are often more diagnostic. Firstly, the hypothesis or focal decision option is often more specific than alternatives because it targets rare features or events. This is consistent with the Bayesian rationality theory that also suggests that the specificity of focal decision options is what makes the PTS informative (Oaksford & Chater, 1994, 2009).

Secondly, focal decision options are often chosen because they seem plausible or probable. Returning to the previous example, suppose one thinks that award-winning artists are usually left handed. When asking an artist whether he or she had won an award, based on the hypothesis, a positive response is more likely from a left- than a right-handed artist. The positive response, that the painter had won an award, is more diagnostic than the negative response, that the painter had not won an award, because award winning is rare. Trope and Liberman (1996) argue that, as the probability of the focal decision option increases, the likelihood of receiving the diagnostic answer to a positive question increases, and the likelihood of receiving the diagnostic answer to a negative question decreases. In our example, as the correlation between left handedness and artistic talent increases, the probability of finding a left-handed award-winning artist increases, and the likelihood of finding a right-handed award-winning artist decreases.

Therefore, according to Trope and Liberman (1996), the PTS is widely adapted because it is generally effective at distinguishing between alternative decision options. Trope and Liberman (1996) do not comment on how adaptable PTS is, in terms of whether participants deviate from PTS when the focal hypothesis does not meet the rarity and probability assumptions.

2.2.8. Relevance Theory (Sperber & Wilson, 1986, 2004)

Relevance theory draws a distinction between information available in the environment, such as the information found in a database search, and the information that is communicated, such as recommended readings for a university course. Available information is not expected to necessarily have implication for one's problem representation (i.e. have cognitive effect). If available information is associated with highly accessible information in memory, then it may be checked for cognitive effect, but otherwise discarded. Therefore, accessibility plays a large role in information selection when the information is available in the information environment. In contrast, communicated information is interpreted differently due to the 'principle of relevance'. The principle of relevance states that communication is attempted because the communicator expects the information to hold cognitive effect for the receiver worth the energy required to process the information.

Relevance theory explains the PTS based on the principle of relevance. Individuals assume that the information communicator, such as an experimenter, would provide information with at least adequate relevance given the effort required to process it. Relevance theory proposes that participants infer directly testable consequences from the rule in order of accessibility. The most accessible consequence in the case of Wason's traditional task is that finding a card with p and q on opposing sides would support the rule. Participants stop when the consequences generated are sufficiently relevant. Sperber, Cara, and Girotto (1995) assert that the traditional Wason selection task is so abstract that it takes a lot of effort to imagine consequences and the context is lacking to understand how those consequences are meaningful. Therefore, participants stop searching for consequences at the minimal level of relevance, which is met by selecting the p and q cards. Consistent with this proposition, card selection changed in the expected directions as the effort needed to process and meaningful effect of different potential consequences was manipulated (Sperber et al., 1995).

2.2.9. HyGene Model (Dougherty et al., 2010)

The most activated decision options are predicted to influence information search via four heuristic processes. Only one of these processes, memory strength, is used when only a single hypothesis is under conscious consideration. Memory strength is where the individual chooses the information associated with the focal decision option that is highest in activation value. This is effectively a PTS with the qualification that the positive information with the highest activation level is examined first. Information with the highest activation tends to be the most prevalent, or most clearly remembered in relation to the focal decision option. If more than one decision option is maintained in working memory, individuals are predicted to use heuristics to distinguish between the hypotheses in working memory.

Information gained from the search triggers further associations, which updates the activation of decision options. Therefore, according to the HyGene model, the focal decision option can change as new information is received. Further, the number of decision options under consideration can change throughout an investigation thereby altering information selection strategies.

The potential for dynamic change in the focal decision option and selection strategy is an important contribution rarely acknowledged by other theories. The prediction that the focal decision option changes throughout the course of the investigation is consistent with a number of findings. Firstly, Klayman and Ha (1989) found that participants current working hypothesis changed throughout the Wason's rule discovery task (see Chapter 1.1.2.2.) and that PTS was commonly observed based on the current working hypothesis. Secondly, Russo et al. (1998) and Simon, Snow, et al. (2004) found that a subset of participants changed their decision leaning throughout an investigation, and that these participants demonstrated information distortion and coherence shifting respectively in the direction of their current decision leaning.

2.2.10. Theoretical Summary of Information Selection

Numerous theorists assert that PTS is adaptive in many naturalistic information environments because of advantages in avoiding costly errors (Friedrich, 1993; Klayman & Ha, 1987; Lewicka, 1998), distinguishing between decision options (Trope & Liberman, 1996) and reducing uncertainty (Oaksford & Chater, 1994, 2009). Theorists differ in the degree to which they predict individuals will change their selection strategy in response to the environment and whether the cues for strategy change are the rarity of decision options (Oaksford & Chater, 1994, 2009; Trope & Liberman, 1996), the likelihood of decision options (Trope & Liberman, 1996), or the potential costs associated with decision options (Friedrich, 1993; Klayman & Ha, 1987; Lewicka, 1998). Further, Dougherty et al. (2010) suggests that PTS it is limited to situations where only a single decision option is under consideration and a number of theorists suggest that PTS is a default strategy (Klayman & Ha, 1987; Mercier & Sperber, 2011; Pyszczynski & Greenberg, 1987).

All of these theories propose conditions under which frame-based PTS will not occur. Frame-based PTS is where participants preferentially seek information on concepts that are mentioned in or implied by the question wording (frame-consistent titles), rather than the inverse of those concepts (frame-inconsistent titles). For example, when asked to find out whether an individual was an extrovert, selecting questions that ask about extroverted traits preferentially to questions about introverted traits would be considered frame-based PTS. Some of the predictions regarding when frame-based PTS will not be observed appear to contradict each other. For example, Pyszczynski and Greenberg (1987), suggest that participants will attend to information related to the preferred decision option, whereas error avoidant approaches (e.g. Friedrich, 1993; Lewicka, 1998) suggest that participants will attend to information related to the greatest potential threat, which, presumably, would not be the preferred decision option in most cases. Despite contradictions such as this, there is evidence that frame-based PTS selection is reduced in cases where the framed elements are undesirable (Dawson et al., 2002; George, 1991) as per Pyszczynski and Greenberg (1987), non-threatening (Smeets, de Jong, & Mayer, 2000) as per error avoidant approaches (e.g. Friedrich, 1993; Lewicka, 1998), common rather than rare (Oaksford & Moussakowski, 2004; Yama, 2001) as per Bayesian rationality (Oaksford & Chater, 1994, 2007), and when more than one decision option is salient (e.g. McDonald, 1990) as per the HyGene model (Dougherty et al., 2010). The model proposed in Chapter 4 accommodates this variety of findings by proposing that PTS can be based on the framed, preferred, or expected decision option depending on salience. The particular conflict between motivated and error-avoidant approaches is explored further in Chapters 5 and 6.

Theories diverge on whether and when individuals are predicted to seek confirmation of their focal decision option via selective exposure to consistent information. Biased hypothesis testing (Pyszczynski & Greenberg, 1987) and motivated reasoning theories (Kunda, 1990) both predict selective exposure only when an individual has a preference for a particular decision option. Argument theory (Mercier & Sperber, 2011) predicts selective exposure whenever one is in an argumentative context where one expects to need to communicate and rationalise their decision.

2.3. Information Interpretation: Theories that Address Information Weighting, Distortion, and Coherence Shifting

As detailed in Chapter 1.1.2.3 and displayed in Table 6, coherence shifting, overweighting, and distortion all result in greater support for the focal decision option than for alternative decision options, but each process impacts a different element of information interpretation: the foundational attitudes, perceived quality, or implication for the focal decision option respectively. Foundational attitudes refer to attitudes or beliefs that inform quality and interpretation assessments, such as attitudes about the reliability of different forms of evidence. For example, Simon, Snow, et al. (2004) assessed attitudes towards the reliability of witness testimonies before and after participants were asked to read and decide on a criminal case. One item of evidence in the criminal case was a witness testimony. The asserted reliability of witness testimonies and other such attitudes shifted pre to post decision such that they favoured the final decision made. Although coherence shifting, overweighting, and distortion are conceptually distinct, they can be hard to distinguish empirically. For example, distortion of information interpretation in favour of the focal decision option could be an outcome of considering consistent information to be of greater quality than inconsistent information (overweighting), or shifts in the judgements and attitudes on which interpretation is based on (coherence shifting).

Table 6: Distinctions Between, and Definitions of, Three Interpretation Effects

Interpretation Effect	Element Impacted	Definition
Coherence shift [a]	Foundational attitudes or beliefs	Where assessments of attitudes, opinions, or facts tend to shift from pre-decision to post-decision such that they are more supportive of the final decision option.
Information weighting [b]	Information quality	Where the perceived quality of consistent information is greater than the perceived quality of inconsistent information
Information distortion [c]	Information implication	Where interpretations of attributes or information are biased towards the focal decision option

Note: For examples see [a] Simon et al. (2001), [b] Hergovich et al. (2010), [c] Russo and Yong (2011)

Numerous theories address overweighting of information but suggest that overweighting is especially strong for preference-consistent information (biased hypothesis testing model, Pyszczynski & Greenberg, 1987), or limited to expectation-consistent information (argumentative theory, Mercier & Sperber, 2011). Of these theories, only the argumentative theory provides a mechanism to explain coherence shift phenomena. The pragmatic hypothesis testing theory (Trope & Liberman, 1996) suggests that distortion occurs primarily for ambiguous information because the focal decision option is given the benefit of the doubt. Differentiation consolidation theory (Svenson, 2006) uses different processes to account each of the three interpretation findings: coherence shifting, overweighting, and distortion. Only the parallel constraint satisfaction (PCS) theories provide a single mechanism that can easily explain all three interpretation findings (e.g. Holyoak & Thagard, 1989; Monroe & Read, 2008). Finally, the belief-adjustment model (Hogarth & Einhorn, 1992) provides a description of information interpretation and belief updating processes that have implications for the degree of impact that interpretation processes are expected to have on the decision outcome.

2.3.1. Biased Hypothesis Testing (Pyszczynski & Greenberg, 1987)

According to Pyszczynski and Greenberg (1987), information interpretation occurs via the following steps:

1. Information accessed is immediately interpreted in terms of its implication for the focal decision option
2. Individuals are generally better at using consistent than inconsistent information leading to an asymmetry in information weighting
3. Information quality is evaluated when:
    a. The individual feels a strong need for accuracy
    b. When the information is unexpected
    c. (Biased Model) When the information is preference-inconsistent
4. Quality assessments generally result in the underweighting of the information compared to information that is accepted without a quality assessment due to:
    a. The extra processing time and effort
    b. (Biased model) Asserted attempts to refute preference-inconsistent information due to negative affect

In combination, the active and biased models produce a number of predictions:

A. Information consistent with any focal decision option is overweighted compared to inconsistent information due to ease of use (Steps 1 and 2).

B. Expectation-consistent information is overweighted compared to expectation-inconsistent information because expectation-inconsistent information is subject to greater scrutiny (Steps 3b and 4a).

C. Preference-consistent information is overweighted compared to preference-inconsistent information because preference-inconsistent information is subject to greater scrutiny and asserted efforts to refute it (Steps 3b and c, 4a and b).

D. Overweighting for preference-consistent information is greater than for expectation-consistent information due to asserted efforts to refute the information. Overweighting for expectation-consistent information is greater than for purely frame-consistent information because of the quality assessment process.

E. Overweighting effects are reduced by high need for accuracy, which promotes quality assessment of all information (Step 3a).

Together, the active and biased models account for overweighting effects for any focal decision option, and make assertions about the relative strength of overweighting depending on whether the focal decision option is the preferred, expected, or framed decision option. These overweighting effects could contribute to information distortion findings because quality assessments might impact interpretation ratings. However, overweighting cannot as easily explain coherence shift effects. The active and biased models also use quite a complex sequence of conditional steps to explain overweighting effects.

2.3.2. Argumentative Theory (Mercier & Sperber, 2011)

When individuals need to evaluate arguments, Mercier and Sperber (2011) argue that they go through a process of coherence checking and trust calibration. Coherence checking is where new information is compared with previously held beliefs. Trust calibration is where individuals assess the trust they put in the speaker based on perceived competence and intent. When there is an inconsistency between old and new information, there are two possible responses:

1. Reject the new information (if trust in the source is high, this option requires a revision of trust)
2. Revise beliefs

These mechanisms could explain coherence shifting, information weighting, and information distortion but only in response to the expected decision option. When information is consistent with current beliefs (expectation-consistent information), it can be incorporated to strengthen current beliefs without prompting trust-collaboration processes. In contrast, expectation-inconsistent information prompts trust-collaboration processes. This is analogous to the assertion made by Pyszczynski and Greenberg (1987) that quality assessment occurs for expectation-inconsistent information but not expectation-consistent information. However, argumentative theory assumes that quality assessment occurs in such a way that both foundational beliefs and information quality might be impacted. Expectation-inconsistent information is likely to be underweighted compared to expectation-consistent information just because some inconsistent information is likely to be rejected, whereas consistent information is always accepted. In addition, when inconsistent information from a high trust source is rejected, the trust in that source is revised downwards, explaining coherence shifts in fundamental beliefs. These coherence shift and overweighting effects could explain distortion observations (e.g. DeKay et al., 2011; Russo & Yong, 2011).

2.3.3. Pragmatic Hypothesis Testing (Trope & Liberman, 1996)

Trope and Liberman (1996) propose that coherence shifting and distortion occur because individuals interpret ambiguous information in terms of the focal decision option, which leads to assimilation. Assimilation is when the implication of new information is interpreted in such a way that it is consistent with the focal decision option. According to the inclusion/exclusion model (Bless & Schwarz, 2010), assimilation occurs when accessible information, such as the focal decision option, is used in the judgement of new information.

2.3.4. Differentiation Consolidation (Dif Con) Theory (Svenson, 1992, 2006)

Dif con theory proposes that individuals strive for sufficient differentiation between decision options to guard against post-decisional regret. Differentiation can be achieved via a number of processes: holistic, process, or structural, as summarised in Table 7. Structural processes account for coherence shifting via the reinterpretation of facts. A reinterpretation of facts can also occur via questioning the quality of information leading to overweighting. Finally, distortion can occur via all structural processes suggested and summarised in Table 7 Row 4. Dif con theory's explanatory power resides in the overarching purpose of all processes: to increase differentiation between decision options, and the collation of multiple processes.

Table 7: Differentiation Processes Proposed in the Dif Con theory

Differentiation Process	Type of Problem	Description
Holistic	Familiar	Prototypical or affective cues favour a decision option
Process	Trade-offs	Multiple decision rules are employed, many of which may favour a single decision option
Structural	Trade-offs and problem definition	Reassess attractiveness or importance of attributes, reinterpret facts, redefine the problem

2.3.5. Cognitive Consistency Theories and Parallel Constraint Satisfaction (PCS) (Holyoak & Simon, 1999; Simon, Snow, et al., 2004)

In contrast to the dif con theory that explains information interpretation via numerous processes, parallel constraint satisfaction explains option differentiation via a single process. Cognitive consistency theories are built on the assumption that the interactions between items of psychological knowledge are fundamental to human cognition. These theories are based on four Gestaltian principles (Simon, Snow, et al., 2004):

1. Cognitive states are best understood by the relationships between cognitive elements as well as the elements themselves.
2. Cognitive structure is dynamic. Some cognitive elements are related by cohesive relationships driving them to cluster, other cognitive elements conflict driving them to disperse. These relationships determine the stability of the structure and potential for change.
3. Cognitive structures are homeostatic such that they settle in a state of optimal constraint satisfaction whereby the drives of the individual elements to cohere or disperse are optimally satisfied.
4. To satisfy structural requirements, cognitive elements can change.

A concrete analogy for these principles is trying to organise seating for a wedding. The guests represent cognitive elements. Couples have strong relationships and are generally seated together. Divorced couples may repel and are generally seated apart. There are clusters of people such as work friends but within those some individuals may want to be seated together and others may not. Constraint satisfaction is the process of trying to satisfy all these constraints simultaneously. To understand the seating arrangement or cognitive structure, the relationships between people or elements is at least as important as the individual people or cognitive elements themselves. The seating or structure can be very stable, as when everyone gets along or all cognitive elements cohere. In this case, if an individual declines or a cognitive element was discredited, there would be minimal change in structure. Alternatively, the seating or structure could also be optimally settled, such that the majority of constraints are satisfied with only weak preferences neglected, but still be unstable. For example, if the individual who pulled out had a strong negative relationship with a colleague, the removal of this relationship may allow individuals to sit together who had previously been separated due to their relationships with the separated individuals. As anyone who has organised a wedding knows, it is not always possible to satisfy all constraints, so on the day, individuals may need to change to accept the distance from a friend or proximity to a bore, just as cognitive elements may shift to account for discrepancies between bodies of knowledge as asserted in cognitive consistency theories (see Simon, Snow, et al., 2004 for a review and demonstration).

Cognitive consistency theories have regained popularity since the advent of connectionist theories and PCS mechanisms (Simon, Snow, et al., 2004). The relevance to confirmation processes is derived from two important elements of PCS models: 1. The decision elements such as guilty or not, new product release or not are represented as cognitive elements. 2. Elements are connected via bi-directional relationships. Implications of these relationships are that when the focal decision option is activated, this activation spreads to information that is consistent with the focal decision option but inhibits alternative possibilities and information inconsistent with the focal decision option. Some of the activation of the consistent elements returns to further activate the focal decision option. Activation determines cognitive accessibility.

Based on this model, consistent information is overweighted due to recursive bidirectional activation between the decision option and consistent information, but inhibitory links between the decision option and inconsistent information. This results in greater cognitive accessibility of consistent information compared to inconsistent information. These bidirectional links extend from information to related attitudes. Therefore, the activation of consistent information also strengthens associated attitudes, and weakens conflicting attitudes, producing coherence shifts.

2.3.6. The Belief-Adjustment Model (Hogarth & Einhorn, 1992)

The belief-adjustment model is a descriptive model of belief updating. Although it does not specifically address coherence shifting, overweighting and distortion phenomena, it examines in what situations final beliefs will be most influenced by information received early (primacy effects) or late (recency effects) in the decision making process and has implications for confirmation processes and outcomes.

Hogarth and Einhorn (1992) propose a sequential anchoring-and-adjustment process that is qualified by three sub-processes, as shown in Table 8.

Table 8: The Three Sub-Processes and Modes of the Anchoring and Adjustment Model

Sub-Process	Component Mode	Definition
Encoding	Evaluation mode	The implicative valence and strength is *added* to the current assessed likelihood of the focal decision option.
	Estimation mode	The implication is *averaged* with the current assessed likelihood of the focal decision option.
Processing	Step by step	Adjustments are made after each new item of information.
	End of sequence	A single adjustment is made based on an aggregate assessment of all information received.
Adjustment		The size of adjustment depends on the position of the anchor.

The encoding sub-process refers to how information interpretation is used to update situation assessments or decision leanings. Participants may encode information via evaluation or estimation modes. In both evaluation and estimation modes, information is interpreted in terms of its implication for the focal decision option. The difference between the modes is whether implication is compared to an absolute (evaluation) or moving (estimation) anchor.

Imagine that the market analyst finds an item of information. The information is assessed as indicating 75% likelihood of a competitive software release from a rival company.

In the evaluation mode, this information is consistent with a software release. Therefore, the perceived probability of release increases. In the estimation mode the direction of adjustment depends on the market analyst's previous estimation of release probability. If the market analyst's original estimation of release probability were 80%, receiving information that places release probability at only 75% draws the release probability down.

Information distortion occurs, presumably, before the information encoding processes that Hogarth and Einhorn (1992) describe because it affects the initial information interpretation. The typical information distortion finding is that information is interpreted as more consistent with the favoured decision leaning or situation assessment compared to interpretations made by a no-choice control group (e.g. Russo & Yong, 2011). Information distortion would be theoretically expected to produce exaggerated support for the focal decision option in either encoding mode, but the exaggeration may be smaller in the estimation compared to encoding mode.

To expand on the example above, say 75% is a distorted figure, and a more correct estimate of the information is that the information indicated a 60% likelihood of a competitive software release from a rival company. Assume again that the original estimation of release probability was 80%. In the evaluation mode, release probability will be increased more by the distorted interpretation than it would be by an unbiased interpretation. In the estimation mode, release probability will still be decreased, though less than it would have been by the unbiased interpretation. Hogarth and Einhorn (1992) suggest that estimation modes are more frequently used than evaluation modes. Therefore, information distortion may not have as large an impact on final decisions as implied by additive models, which assume the implication of new information is added to one's prior assessment (e.g. Bayesian models, Fischhoff & Beyth-Marom, 1983).

The processing sub-process includes step-by-step and end-of-sequence modes. Step-by-step processing is where adjustments are made after each new item of information. End-of-sequence processing is where a single adjustment is made based on an aggregate assessment of all information received. Hogarth and Einhorn (1992) suggest that step-by-step processing is forced when participants are asked to report updated situation assessments after each item of information, and chosen when the information is too complex or the sequence is too long for end-of-sequence processing. Generally, step-by-step processing is more susceptible to recency effects, whereas end-of-process processing is more prone to primacy effects (Hogarth & Einhorn, 1992). Traditionally, confirmation bias outcomes involve a tendency to confirm the original focal decision option, which is sometimes manipulated using early information (e.g. Mendel et al., 2011; O'Brien, 2009). Therefore, confirmation bias outcomes are more similar to the primacy effects observed in end-of-sequence processing, than the recency effects observed in step-by-step processing.

Finally, the adjustment sub process acknowledges ceiling and floor effects on adjustment. Estimations that are approaching the top of the scale have less room for adjustment up, than adjustment down. Conversely, estimations that are approaching the bottom of the scale have less room for adjustment down, than for adjustment up. Therefore, Hogarth and Einhorn (1992) suggest that the size of adjustment also depends on the position of the anchor.

2.3.7. Theoretical Summary of Information Interpretation

Numerous theorists predict that consistent information will be overweighted compared to inconsistent information. However, they disagree on why this occurs and for which decision options. Suggestions are that consistent information is more easily processed (Pyszczynski & Greenberg, 1987), inconsistent information is more critically processed (Ditto & Lopez, 1992; Ditto et al., 1998; Mercier & Sperber, 2011; Pyszczynski & Greenberg, 1987), or information interpretation and decision options influence each other via bi-directional links (Simon, Krawczyk, et al., 2004). These suggestions are not mutually exclusive and all have empirical support. There is evidence that expectation-consistent information is faster to process than expectation-inconsistent evidence (Feeney, Coley, & Crisp, 2010), supporting the ease of processing suggestion, that preference-inconsistent information is more critically processed than preference-consistent information (Ditto & Lopez, 1992; Ditto et al., 1998), supporting the quality of processing suggestion, and that decision leanings influence, and are influenced by, information interpretation, supporting the bi-directional link suggestion (e.g. DeKay et al., 2011; Russo & Yong, 2011; Simon, Krawczyk, et al., 2004).

Preference and expectation are often confounded in research designs, making it hard to test whether the influence on information interpretation originates from the preference, expectation, or both. For example, distortion and coherence shift paradigms often measure shifts in interpretations based on a decision leaning towards one of two products or decision options (e.g. DeKay et al., 2011; Russo et al., 1998; Simon, Krawczyk, et al., 2004). This decision leaning could be considered the current preference or the option the individual currently expects to dominate.

2.4. Summary: Theoretical Gaps in Problem Representation, Information Selection, and Interpretation

Problem representation: A number of theories can explain how framed, preferred, and expected decision options can become the focus of attention. The mechanism commonly cited is accessibility of framed, expected, and preferred decision options. However, theories often lack specificity around the nature of the focal decision option. It is also common for theories to focus on a single type of decision option, such as the preferred decision option to the exclusion of others.

Information selection: Few theories attempt to explain PTS, SE, and PD findings in combination. Of the information selection theories reviewed, only the HyGene model explicitly acknowledges that the focal decision option may change as a result of new information, and that information selection strategies may be altered accordingly.

Information interpretation: Only parallel constraint satisfaction models could provide a single mechanism to explain coherence shifting, overweighting, and distortion phenomena for the focal decision option. Theories differ in whether they predict expected or preferred decision options to have the most influence on information interpretation. Unfortunately, expectation and preference are often confounded in the empirical literature.

3. Why and How: Theoretical Reasons and Mechanisms for Confirmation Bias (Part 2)

3.1. Stopping and Decision Thresholds

Stopping thresholds and decision thresholds are conceptually distinct but often theoretically combined (e.g. Busemeyer & Townsend, 1993; Pleskac & Busemeyer, 2010; Ratcliff & McKoon, 2007; Trope & Liberman, 1996). Recall that stopping thresholds determine *when* a search stops and often a decision is made and decision thresholds determine *which* decision is made. If stopping and decision thresholds do interact, then they could potentially exacerbate confirmation outcomes resulting from processes outlined in Chapters 1 and 2. To understand why, an examination of decision threshold theories is required.

Theories that address decision thresholds take different approaches to answering the same problem: How to define the point at which an individual will switch from rejecting to accepting a decision option. Expected utility theory (see Mongin, 1997), and prospect theory, (Kahneman & Tversky, 1979, 1990; Tversky & Kahneman, 1992) approach this question by trying to calculate and compare the perceived value of decision options, whereas signal detection theory (Green & Swets, 1966) attempts to determine the point at which individuals switch actions. Both approaches incorporate costs, benefits, and probabilities of different potential outcomes to determine whether a decision option is accepted or rejected.

These models assume that the decision outcome depends on the situation. Take the market analyst example. If the market analyst accepts the threat of a competitive product release and recommends defensive action, this may lead to praise if the threat comes to pass (correct acceptance), but criticism if the threat does not eventuate (mistaken acceptance). The converse could be true for rejecting the threat and recommending no defensive action. The perceived and actual value of these different outcomes might differ. The theories above all conclude that the perceived value of different outcomes influences the level of certainty in the situation, referred to as the situation assessment level, at which an individual will switch from acting as if the situation was false, to acting as if it was true. The situation assessment level is the perceived probability of the situation, such as the perceived probability of a threatening event occurring.

A decision threshold can be placed on the probabilistic situation assessment. The exact location of the decision threshold is contested due to debates over whether perceived costs and benefits are relative or absolute, and whether they receive the same weighting (Kahneman, 2011). However, theories consistently suggest that, as the costs of mistaken acceptance increase and benefits of correct acceptance decrease, the perceived probability of the situation at which one will switch from acting as if the situation were false to acting as if the situation were true increases.

Perceived costs and benefits of different outcomes influence the formation of preference (Kahneman, 2011). If decision and stopping thresholds were combined, this would have implications for confirmation of preference. As preference for Decision Option A increases (potential benefits increase, potential costs decrease), the decision threshold for Decision Option A decreases, such that the individual will accept Decision Option A under a greater range of situation assessment levels. If the decision threshold were also the stopping threshold, less information and time would be required to choose the preference-consistent decision option than the preference-inconsistent decision option.

A number of theories propose that decision thresholds and stopping thresholds are the same, including the pragmatic hypothesis testing (Trope & Liberman, 1996), random walk and diffusion models (e.g. Busemeyer & Townsend, 1993; Pleskac & Busemeyer, 2010; Ratcliff & McKoon, 2007). There are thresholds at either end of whatever decision option is being assessed and until the confidence in a decision option reaches one of these thresholds information search continues. When a threshold is reached determines the point at which information search stops (making it a stopping threshold), and the threshold that is reached first determines whether that decision option is accepted or rejected (making it a decision threshold).

Consistent with the impact of preference on stopping thresholds, participants who reach personally threatening or undesirable conclusions have been found to require more, better quality information, and more decision-time than participants who reach more desirable, less threatening conclusions (Ditto & Lopez, 1992). Different theories suggest different mechanisms for why this could occur. Suggestions are that preferences influence the initial anchor point, such that it is closer to the preferred conclusion (Busemeyer & Townsend, 1993; Pleskac & Busemeyer, 2010; Roe, Busemeyer, & Townsend, 2001), preferences alter the thresholds such that the preferred decision has a lowered threshold for acceptance (Trope & Liberman, 1996), or that preferences alter the interpretation of information such that preference-consistent information is given more weight and, therefore, reaches the threshold faster than preference-inconsistent information (Ditto & Lopez, 1992; Ditto et al., 1998).

There is reason to suspect that preference influences stopping rules only where motives are strong enough to arouse emotion, and may not be as influential in more cognitive, less emotive decisions. When instructed to stop when they have enough information to make a decision or form an impression, participants stopped information search earlier when induced with a positive, rather than negative, mood (L. L. Martin, Ward, Achee, & Wyer, 1993). Similarly participants stopped information search earlier when induced with a feeling of rightness by creating a match, rather than a mismatch, between the participant's natural goal orientation and the task goal (Vaughn, Malik, Schwartz, Petkova, & Trudeau, 2006). Preferred decision options that evoke emotive reactions are likely to trigger positive mood and feelings of rightness when considered, which may contribute to lower stopping thresholds. Preferences formed based on the weighing up of relatively affect-neutral costs and benefits may evoke less emotion and therefore have less effect on stopping thresholds.

3.1.1. Theoretical Summary of Stopping and Decision Thresholds

A number of theories propose that decision thresholds, which determine what decision option is chosen, are heavily influenced by preference, especially preference formed based on the costs and benefits of possible decision outcomes (Green & Swets, 1966; Kahneman & Tversky, 1979, 1990; Mongin, 1997; Tversky & Kahneman, 1992). A number of theories propose that decision and stopping thresholds are the same, such that when an individual reaches a decision threshold for a specific decision option, information search stops (Busemeyer & Townsend, 1993; Pleskac & Busemeyer, 2010; Ratcliff & McKoon, 2007; Trope & Liberman, 1996). These theories suggest that preferred decision options would effectively have lower decision and stopping thresholds than non-preferred decision options. Therefore, less or lower quality information would be required to accept than to reject a preferred decision option. This has obvious implications for confirmation of preference.

3.2. Confirmation Outcomes: How Does Confirmation Bias Occur?

Confirmation bias theorists tend to agree that confirmation bias is an outcome of a combination of processes (Klayman, 1995; Nickerson, 1998; Oswald & Grosjean, 2004; Pyszczynski & Greenberg, 1987). There have been a number of influential reviews of the confirmation bias phenomenon. Major contributions of each will be highlighted, along with ways in which the theoretical and empirical discussion on confirmation bias has since progressed and where there are opportunities for further advancement.

3.2.1. Varieties of Confirmation Bias (Klayman, 1995)

Klayman (1995) produced one of the first reviews of the confirmation bias phenomenon. This review made a number of significant contributions to the field. Firstly, it clarified the narrow range of circumstances in which confirmation processes could lead to confirmation outcomes. This was an important step towards clearing the confusion created by calling all confirmation processes and outcomes ‘confirmation bias’.

Secondly, Klayman (1995) specified and defined a range of confirmation processes and how they could combine to create confirmation bias outcomes. One such combination was the association between extremity preference and insensitivity to answer diagnosticity. Extremity preference is where individuals prefer information on extremely likely or extremely unlikely features given the focal decision option, rather than moderately likely or unlikely features. Diagnosticity is the ability of information to distinguish between two or more decision options. Diagnosticity is highest when data would definitely be found if decision option A were true and would definitely not be found if option B were true or the other way around. In combination, extremity preference and insensitivity to answer diagnosticity can lead to confirmation outcomes because elements that are extremely likely or unlikely under the focal decision option yield asymmetrically diagnostic answers. Specifically, responses that are consistent with the focal decision option are less diagnostic than responses that are inconsistent. Insensitivity to this difference results in overweighting of the consistent response. Slowiaczek et al. (1992) provided a mathematical explanation of this based on the likelihood ratio of each of two possible answers. Extremity preference and insensitivity to answer diagnosticity has been found to result in confirmation bias (Slowiaczek et al., 1992). However, a subsequent study has shown that this effect disappears when using familiar materials and consequently suggested that the situations in which final decisions are meaningfully swayed by confirmation processes may be limited (McKenzie, 2006).

Finally, Klayman (1995) made an important contribution to the discussion of why confirmation bias might occur. Klayman (1995) suggested that cognitive limitations and motivated reasoning may play a role in some confirmation processes, but that the reason that such a diverse range of behaviours tend to favour confirmation is that they are learned.

Confirmation is often rewarded because of the feeling that ones ideas are validated and because it breeds confidence, which is intrinsically and socially rewarded. Guarding against confirmation bias is often punished because it is cognitively costly to revise current ideas and seek new ideas and disconfirmation of ideas can lead to doubt, which can be intrinsically and socially costly. This immediate feedback is rarely counteracted because rewards and punishments for correct or incorrect conclusions are often delayed or absent and incorrect conclusions are particularly unlikely to be corrected due to the social norm against delivering bad news (Klayman, 1995). Consistent with the learning explanation, studies have demonstrated that the way in which materials are learned can improve coherence to normative Bayesian behaviour and reduce the single decision option focus observed in confirmation processes (Klayman & Brown, 1993; McKenzie, 1998).

3.2.2. Confirmation Bias: A Ubiquitous Phenomenon in Many Guises (Nickerson, 1998)

Although Nickerson's (1998) review lacked the clarity that Klayman (1995) brought to the distinction between confirmation processes and outcomes, it made a number of important contributions. Firstly, this review popularised the confirmation bias phenomenon by applying it to numerous historical and practical situations such as witch hunting, medicine, the judicial system, and science.

Secondly, Nickerson (1998) contributed to the discussion on motivated and unmotivated contributions to confirmation bias. A common question throughout the confirmation bias literature is whether confirmation bias is initiated by an individual's goal or desire to defend beliefs, or whether confirmation bias also occurs in the defence of decision options in which the individual has no obvious personal interest. Nickerson (1998) suggests that these are different forms of confirmation bias and calls them motivated and unmotivated confirmation bias respectively. Unmotivated confirmation bias is often attributed to 'cognitive factors', such as ease of processing and cognitive constraints (e.g. Nickerson, 1998; Oswald & Grosjean, 2004).

Nickerson (1998) suggested, based on the evidence, that confirmation bias is observed when strong motivation towards a single decision option is both present and absent. Therefore, a comprehensive explanation of confirmation bias needs to explore both motivated and unmotivated mechanisms for confirmation bias. Nickerson's (1998) view was that motivated and unmotivated mechanisms probably interacted to produce confirmation bias.

Thirdly, this review drew on practical examples to demonstrate cases in which confirmation bias could be beneficial. For example, as a motivating force in science that drives researchers to persist in attempts to support their own theory and disprove competing theories. Finally, Nickerson (1998) expanded on Klayman's (1995) suggestion that confirmation processes and outcomes are learned by pointing to the effect of education. Nickerson (1998) suggested that, in the Western schooling and social system, well-justified uni-directional arguments are rewarded. Possibly as a result, participants have been found to consider one-sided arguments to be of better quality than two-sided arguments (Baron, 1995).

3.2.3. Confirmation Bias (Oswald & Grosjean, 2004)

Oswald and Grosgean's (2004) review addressed a number of important questions in relation to confirmation bias. Firstly, the differences between PTS and confirmation bias outcomes were clarified again. Oswald and Grosjean (2004) suggested that PTS leads to confirmation bias outcomes in three situations

1. When the correct decision option is more general than the focal decision option such that all evidence supporting the focal decision option also supports the correct decision option (Klayman & Ha, 1987)
2. When positive questions are not diagnostic and likely to be answered in the affirmative

3. When the mode of questions elicits affirmative responses, such as when social norms favour positive responses

This list helped to reduce the confusion between PTS and confirmation bias, but was missing situations in which affirmative responses were overweighted compared to negative responses, which was included in Klayman's (1995) review.

Secondly, Oswald and Grosjean (2004) clarified conditions under which confirmation of the preferred decision option, rather than the non-preferred decision options might occur and under what situations this may be reversed. Based on the pragmatic hypothesis testing theory (Trope & Liberman, 1996), Oswald and Grosjean (2004) suggested that people generally avoid confirming undesirable decision options, except when this could lead to greater negative consequences. For example, individuals may more readily confirm their competence than incompetence, except when assuming false competence could lead to danger.

Finally, Oswald and Grosjean (2004) continued the discussion of motivated versus unmotivated phenomena based on empirical studies. Oswald and Grosjean (2004) called unmotivated phenomena 'cognitive phenomena'. Motivated and unmotivated phenomena may be a better distinction, given that the majority of motivated reasoning theories propose cognitive mechanisms by which motivation influences confirmation bias (e.g. Kunda, 1990; Pyszczynski & Greenberg, 1987; Trope & Liberman, 1996). Therefore, the fact that cognition plays a role in confirmation bias, whether motivated or unmotivated, is not really contested. Observations were divided into information selection, interpretation, and recall contexts. In the information selection and interpretation contexts, Oswald and Grosjean (2004) suggest that there must be an unmotivated component in at least some cases. This is based on the observation that, in selective exposure (SE) environments, consistent information had been selected preferentially to inconsistent information in the absence of any clear reason to prefer support for the focal decision option (Betsch, Haberstroh, Glöckner, Haar, & Fiedler, 2001). Similarly, overweighting of consistent over inconsistent information has been observed with both emotionally charged and emotionally neutral focal decision options (e.g. Slowiaczek et al., 1992).

In recall contexts, Oswald and Grosjean (2004) observed that both selective recall for consistent information and selective recall for inconsistent information had been observed (Stangor & McMillan, 1992), and that consistent information appeared to be favoured when there was an established focal decision option, decision options referred to social groups not individuals, and when there was a time delay between information processing and the recall or judgment task. Oswald and Grosjean (2004) conclude that selective recall for consistent information is motivationally driven. This was based on a series of studies by Sanitioso, Kunda, and Fong (1990) that manipulated whether introversion or extroversion was considered a more advantageous trait generally or specifically for police officers. Student participants more easily recalled autobiographical memories consistent with the favoured trait only when it was generally advantageous, not when it was specifically advantageous for police officers. A caveat to this study was that generally or specifically advantageous conditions were run as separate studies, rather than a properly controlled crossed design. This allows for the possibility that the effect was not replicated in the specifically advantageous condition due to spurious or random factors, rather than the manipulation.

Since Oswald and Grosgean's (2004) review, theoretical discussions of the unmotivated versus motivated mechanisms have evolved. More recently, the question has changed from whether unmotivated or motivated mechanisms are implicated to how they interact. For example, theories have begun to examine how affect influences cognition (Clore & Huntsinger, 2007; Slovic & Peters, 2006), and how traditionally emotional Type 1 processing and traditionally analytic or cognitive Type 2 processing interact (Evans &

Stanovich, 2013) or may, in fact, be integrated in a single processing system (Kruglanski & Gigerenzer, 2011; Osman, 2004; Wastell, 2014). Therefore, a better empirical focus may be the extent to which motivated elements, such as preference, and unmotivated elements, such as expectation, sway decisions, and the effect on decisions when preference and expectation conflict.

3.2.4. The Forensic Confirmation Bias: Problems, Perspectives, and Proposed Solutions (Kassin, Dror, & Kukucka, 2013)

Kassin, Dror, and Kukucka's (2013) review applied the phenomena of confirmation bias to the forensic profession. As well as the field-specific application, Kassin et al. (2013) made a number of important theoretical contributions. Whereas Klayman (1995) and Oswald and Grosjean (2004) examined confirmation of the focal decision option, Kassin et al. (2013) emphasised the confirmation of the expected decision option. Kassin et al. (2013) also acknowledged all three sources of bias identified in Chapter 1.1.1 in the definition of forensic confirmation bias. Forensic confirmation bias is defined as "the class of effects through which an individual's pre-existing beliefs, expectations, motives, and situational context influence the collection, perception, and interpretation of evidence during the course of a criminal case" (Kassin et al., 2013, p. 45). Expectations are directly cited, motives could be considered preferences, and situational context encompasses the effect of the problem frame.

Finally, Kassin et al. (2013) suggested that ambiguity moderates confirmation bias, such that confirmation bias can be greater in highly ambiguous contexts and judgements, but minimal or non-existent in unambiguous contexts and judgements. Although ambiguity was mentioned in previous reviews, Kassin et al. (2013) acknowledged clearly that ambiguity varies in degrees and that the degree of ambiguity influences the impact of confirmation bias.

3.2.5. Theoretical Direction for Confirmation Outcomes

The reviews described have made significant contributions to the understanding of confirmation bias but there are still a number of theoretical gaps that require attention. Firstly, with one exception (Kassin et al., 2013), most reviews did not discuss the elements that determine the focal decision option. Klayman (1995) and Oswald and Grosjean (2004) both discuss how confirmation of the focal decision option might occur, with little discussion of what determines the focal decision option. Nickerson (1998) discusses examples of confirmation of expectation, preference, and frame, but does not discuss how these phenomena may differ or interact. None of the previous reviews explore what might happen if, for example, preference and expectation conflict.

Finally, the reviews and theories examined rarely discuss the possibility that the decision option in focus may change throughout the course of the investigation (for an exception see Dougherty et al., 2010). This is an important consideration because the focal decision option has been observed to change throughout investigations, and information selection (Klayman & Ha, 1989) and interpretation (Russo et al., 1998; Simon, Snow, et al., 2004) have been observed to shift accordingly.

3.3. Why Does Confirmation Bias Occur?

Drawing from the theories explained in Chapters 2 and 3, explanations for confirmation bias outcomes and processes fit into three levels of explanation: transient motives, learned behaviour, and evolved behaviour. Transient motives are defined as goals that are present to varying degrees across individuals or situations. These include individual differences, and individual and situational preferences (Kunda, 1990; Pyszczynski & Greenberg, 1987). Implications of transient-motive theories are that confirmation processes and bias should be greater in individuals with certain characteristics or with a desired conclusion compared with individuals without these factors. Transient-motive theories are generally best suited to explain confirmation of preference. Transient-motive theories that explain confirmation of expectation and frame usually do so by proposing a different decision process that operates when one does not have a preferred decision option (e.g. Pyszczynski & Greenberg, 1987).

The level of analysis for transient motives is the individual. The level of analysis for confirmation as learned behaviour is the environment within which individuals interact. Confirmation bias may be a learned behaviour if confirmation processes and outcomes are frequently reinforced and consequently adopted as a behavioural strategy (e.g. Klayman, 1995).

At the highest level, confirmation processes and outcomes may have evolved as part of the human cognitive condition because of fitness advantages. Assertions that confirmation bias has evolved generally rest on the assumption that reasoning is not primarily adapted for truth-finding, but for some other purpose, such as avoiding costly errors (Friedrich, 1993; Lewicka, 1998; Trope & Liberman, 1996), producing and evaluating arguments (Mercier & Sperber, 2011), or maintaining coherent representations and separating decision options (Russo et al., 2008; Simon, Krawczyk, et al., 2004; Simon, Snow, et al., 2004). Alternatively, confirmation processes may be products of bounded rationality; labour saving strategies necessitated by processing constraints (Evans, 2006).

3.4. Overview and Critique of Theories

The theories described in Chapters 2 and 3 approach confirmation bias from a breadth of perspectives including social, evolutionary, and cognitive psychology. Theories also target different levels of explanation from why confirmation bias might have evolved, how it might be learned, the underlying motives, to the processes, and the sub-processes involved. However, as shown in Table 3 in Chapter 2, no single theory explains the range of confirmation processes as well as providing explanations for confirmation of frame, preference, and expectation.

The biased hypothesis testing and pragmatic hypothesis testing models come closest to explaining the range of confirmation biases. However, these models are not without fault. The biased hypothesis testing model suggests a very strong tendency to reach the desired conclusion. Pyszczynski and Greenberg (1987) suggest that if evidence for the non-preferred decision option is overwhelming, individuals will only accept the non-preferred decision option if there is high need for accuracy. Otherwise, individuals might abandon the hypothesis testing process and accept the preferred decision option without evidence or divert their attention from the issue altogether. Observations of confirmation bias tend to be less extreme and show quantitative shifts towards the focal conclusion. Lord, Ross, and Lepper's (1979) original demonstration of attitude polarisation is an example. Arguments for capital punishment swayed attitudes towards capital punishments, regardless of the initial attitude. Arguments against capital punishment swayed attitudes away from capital punishments, regardless of the initial attitude. Attitude polarisation occurred because the degree to which attitudes were swayed by different arguments differed. In this case, the amount of pro and anti capital punishment material was balanced. If there was overwhelming information in one direction, attitude polarisation findings would suggest that individuals may undergo attitude change, but to a lesser degree than those who originally held the supported position. Empirical Chapters 7 and 8 explore this possibility.

Both the biased and pragmatic hypothesis-testing models assert that where there is a preference, this dominates the decision-making processes beyond the influences of expectation and frame. In the biased hypothesis-testing model, this is due to the addition of affect. In the pragmatic hypothesis-testing model, preference contributes to expectation, affect, and accessibility. These assertions conflict with evidence cited in Chapter 1.1.1 that when preference and expectation oppose each other confirmation of expectation processes sometimes prevail (Knobloch-Westerwick & Kleinman, 2012; Lehman et al., 1992; Vallone et al., 1985).

The pragmatic hypothesis-testing model is largely a collection of processes previously observed and theorised. The major original contribution is the suggestion that there are two decision thresholds, one for acceptance and one for rejection of each decision option. Preference for a decision option shifts the acceptance and rejection thresholds down such that the threshold for acceptance is closer to the midpoint and the threshold for rejection is further from the midpoint. Trope and Liberman (1996) call these thresholds 'confidence thresholds' and describe them as the amount of certainty required to make the associated decision. This suggests that preferred or safe conclusions should require a lower level of confidence than non-preferred or risky conclusions. Trope and Liberman (1996) state that they do not predict lower levels of confidence for acceptance versus rejection of preferred decision options because confidence for accepting the preferred decision option is expected to substantially exceed the threshold, whereas confidence for rejecting the preferred decision option is expected to fall close to threshold. This suggestion seems contrary to the operation of a threshold, which, by definition, triggers an action when crossed. In this case, crossing the acceptance or rejection thresholds should trigger a stop in information search.

3.5. Summary: A Theoretical View of Confirmation Bias

Decision and stopping thresholds: Decision thresholds determine which decision option is chosen whereas stopping thresholds determine when information search stops. Stopping and decision thresholds are combined in many theories such that each decision option has an acceptance threshold, and when enough information supports a decision option, information search stops and that decision option is chosen. If decision and stopping thresholds are combined in this way, it could contribute to confirmation of preference. There is uncertainty over whether decision and stopping thresholds always interact, or whether decision and stopping thresholds are separate but both influenced by affect-laden preferences.

Confirmation outcomes – Reviews: The understanding of confirmation bias has been greatly advanced by reviews of the phenomenon. Contributions include the recognition that confirmation processes in isolation do not necessarily result in confirmation outcomes but that confirmation outcomes are more likely to result from the combination of confirmation processes. Some areas have thus far been given insufficient attention. Outstanding questions include

1. What elements influence the focal decision option?
2. What happens when these elements conflict, such as when expectation and preference are in opposition?
3. Does the focal decision option change? How does this impact confirmation processes and outcomes?

4. A New Model: Dynamic Hypothesis Testing (DHT)

The Dynamic Hypothesis Testing (DHT) Model integrates empirical (Chapter 1) and theoretical (Chapters 2 and 3) accounts of confirmation bias. The focus is on explanations of *how* confirmation bias occurs because an understanding of mechanisms behind confirmation bias may help to clarify how it might be counteracted when appropriate. Chapter 9.2 expands the DHT Model to encompass why confirmation bias occurs.

4.1. Mechanisms of the DHT Model: How Does Confirmation Bias Occur?

The DHT model proposes that when an individual encounters a situation that will require a decision, they proceed through 6 processes, as shown by the grey, numbered boxes in Figure 2. The processes are not strictly linear. They are likely to interact, operate simultaneously in some cases, and some processes, such as information selection and interpretation, may be skipped. The processes are summarised below:

1. *Accessible characteristics:* The situation triggers accessible characteristics including salient goals (preferences), expectations, and contextual cues (frame).
2. *Problem representation:* The individual forms a representation of the problem; including a representation of the various decision options, one of which may be given more attention than others.
3. *Information selection:* The individual selects information associated with the salient decision option or decision options because associated information is most easily processed.
4. *Information interpretation:* The interpretation of information is influenced by two factors: the actual content of the information selected (represented by the arrow from 3 to 4 in Figure 2), and the salient decision option or options (represented by the bidirectional arrow between 2 and 4 in Figure 2). The

interpretation of the information may produce changes in the problem representation (2 in Figure 2) in terms of the salience of decision options, and accessible characteristics of the situation (1 in Figure 2).

5. *Stopping and decision threshold:* Decision thresholds and stopping thresholds are interdependent as detailed below.
6. *Decision:* A decision is made. Usually this will be the most activated or salient decision option at the time.

The DHT model is based on a connectionist framework, where activation spreads autonomously across associated cognitive concepts, most of which do not enter the individual's explicit awareness. Activation refers to the amount of energy, salience, and cognitive accessibility associated with a cognitive concept, which is the product of the number, strength, and valence of connections to that concept that are also receiving activation. Therefore, the DHT model assumes that many of these processes occur without controlled attention, especially accessible characteristics, problem representation, stopping threshold, and many of the interactions between processes. As a result, an individual is unlikely to be able to remember or iterate all 6 processes and processes may operate simultaneously.

The DHT model asserts that a focal decision option can form based on accessible characteristics, including preferences, expectations, and the frame or context of the information provided. The degree to which attention is focused on the focal decision option to the exclusion of alternative decision options determines the degree to which the focal decision option influences information selection and interpretation processes. It is predominantly these information selection and interpretation processes that contribute to a confirmation bias outcome.

The DHT model incorporates the concept of bi-directional reasoning from Parallel Constraint Satisfaction (PCS) models (represented by the bidirectional link between 2 and 4 in Figure 2). Bidirectional reasoning is where "evidence influences the conclusions and, at the same time, the emerging conclusion affects the evaluation of the evidence" (Simon, Snow, et al., 2004, p. 814). The DHT model extends PCS models in two ways. Firstly, PCS models have traditionally focused on a single decision with two or more options such as guilty or not (e.g. Simon, Snow, et al., 2004), Job A or B (Simon, Krawczyk, et al., 2004). The DHT model explicitly applies to cases in which two interdependent decisions need to be made. This is the case when individuals need to choose actions based on a situation assessment. For example, when pilots need to decide whether to maintain course or deviate based on the predicted severity and movement of a storm, market analysts need to recommend strategy based on their assessments of the competition, or individuals need to decide whether to buy a house based on their assessment of the property market. Secondly, PCS models focus primarily on how the preliminary decision, or decision leaning, influences information interpretation (e.g. Holyoak & Simon, 1999). The DHT model extends to predictions about information selection, decision, and stopping thresholds.

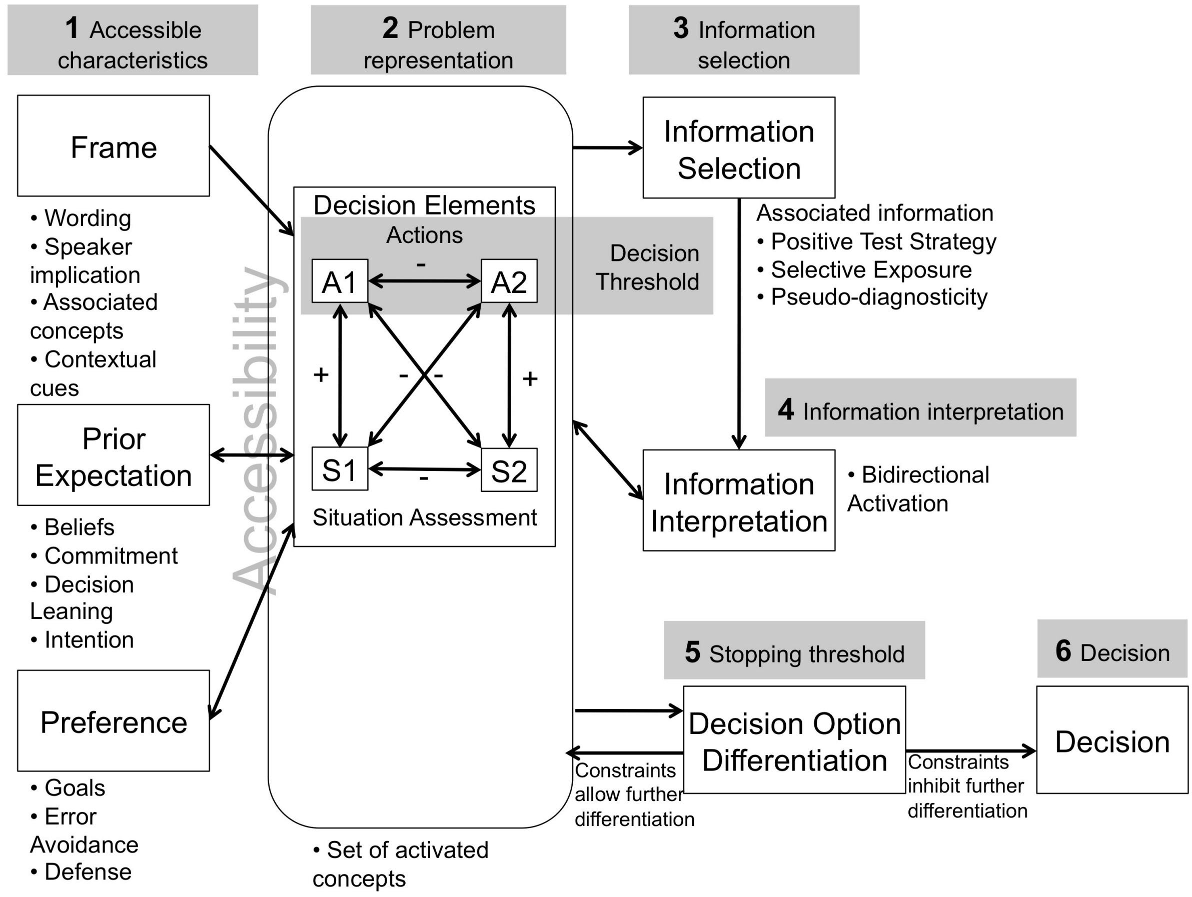


Figure 2: The Dynamic Hypothesis Testing (DHT) model.

4.2. Detailed DHT Model

4.2.1. Problem Representation

At the centre of the DHT model shown in Figure 2 are the interdependent decision options. Like numerous connectionist models (see Doumas & Hummel, 2012 for a review; and Monroe & Read, 2008 for a related example), the DHT model asserts that related concepts are connected. Concepts can be activated when they are mentioned or implied in the problem frame, when they correspond to a salient preference or goal, or when they are expected events. The activated concept further activates positively related concepts that commonly co-occur but inhibits negatively related concepts that are expected not to co-occur. Consistent with PCS associative mechanisms, competing actions and competing situation assessments inhibit each other and compatible actions and situation assessments activate each other as indicated by the minus and plus signs respectively.

Preference, frame, and expectation can independently add activation to any or multiple of the decision elements. For example, an individual may prefer a certain action, such as a pilot who would prefer to maintain course for shorter flight duration. Alternatively, an individual could prefer a particular situation assessment such as concluding that property will increase in value, thus producing capital gain. These preferences may align with or contradict expectations. Which decision elements end up most powerfully activated would depend on the relative strength and salience of the input from frame, preference, and expectation.

As per PCS models (e.g. Monroe & Read, 2008) and connectionist models generally, (Doumas & Hummel, 2012) elements that are more powerfully activated are more accessible. Accessible elements form the focal decision option and problem representation. Recall that the focal decision option is the action or situation assessment that is most salient to the decision maker at the time. Based on the DHT model, the focal decision option is the most activated action or situation assessment based on excitatory and inhibitory input from preference, expectation, and frame. The problem representation incorporates the broader network of associated actions, situation assessments, and concepts that are accessible to the individual. The DHT model is consistent with the theories discussed in Chapter 2.1 in that accessibility determines the focal decision option but also expands on these theories by pointing to characteristics that are likely to increase accessibility: frame, preference, and expectation.

The framed, expected, and preferred decision options are determined in different ways but may represent the same decision option. The framed decision option is the decision option that is implied or mentioned in the problem or task description. A decision option is mentioned if the problem description is anchored on a single event or action. A classic example is asking participants to decide whether an individual is an introvert (Snyder & Swann, 1978). The framed decision option is that the individual is an introvert because this trait is mentioned. Competing decision options are activated if both traits are mentioned in the question, for example, if the participant is asked to decide whether an individual is an introvert or an extrovert. If the market analyst is told that a rival company is suspected of preparing a competitive release, the focal decision option is that the rival will produce a competitive release, rather than alternative decision options that are not stated, such as the rival will release a non-competitive product, or will not release a new product. Alternatively, the framed decision option can be implied by the valence of the attributes mentioned as observed in valence-consistent shifts in attribute framing (see Chapter 2.1.6 and Levin et al., 1998).

The expected decision option is the decision option that one considers will be true or best given their goals. For example, the market analyst might expect that the rival company will produce a competitive release and therefore, taking action to counteract this threat would be best. In this case, a situation assessment that a competitive release is likely and the associated action are the expected decision options.

Preferred decision options are determined by the anticipated costs and benefits of different situation assessments or actions. There is evidence that preference is constructed, rather than recalled (Lichtenstein & Slovic, 2006). Therefore, a preferred decision option is only predicted to arise if there is clear dominance of one decision option over the other given the individual's goals, or if the individual is also required to state, and therefore form, a preference. A decision option is dominant if it has clearly higher benefits or lower costs compared to other decision options.

The DHT model also predicts the three accessible characteristics to differ in terms of the amount of influence they assert over the problem representation at different stages of investigation. Throughout an investigation, the impact of frame is predicted to rapidly decrease. The impact of preference and expectation may gradually increase, or stay relatively static, depending on the nature of the information available during the investigation. Participants are expected to rely on the framing of the task only when other contextual influences are lacking. Therefore, frame is expected to exert the most influence over one's problem representation before, and in the early stages of information search. As more information is received, the effect of frame weakens because new information provides further context and can fuel expectations and preferences that conflict with the frame. Consistent with this view, framing effects have been observed to weaken after an opportunity to select and read further information (Weeks & Wastell, Under review). There is evidence that framing effects can increase after longer processing times in the absence of new information (Igou & Bless, 2007; Svenson & Benson, 1993), suggesting that it is the additional information, not the elapsed time, that weakens the impact of frame. Further, Lehman et al. (1992) found that question wording influenced responses only for participants with little relevant knowledge. Participants who could incorporate additional context from their knowledge and memory, showed no effect of question frame.

Whether the influence of preference or expectation is predicted to increase throughout the investigation depends on whether the information available pertains to the object of preference or expectation. An increasing influence over the problem representation is predicted for the accessible characteristic that the information pertains to. To illustrate, if the information pertains to costs and benefits of competing actions or assessments, the influence of preference over problem representation would be predicted to increase as more information is obtained. Alternatively, if the information pertains to the likelihood of actions being beneficial or the likelihood of situations occurring, the influence of expectation over problem representation would be predicted to increase as more information is obtained. Increasing influence is predicted based on research into parallel constraint satisfaction processes, which demonstrate that certainty in ones decision increases over the course of an investigation despite ambiguous information environments that support two decision options equally (e.g. Simon & Holyoak, 2002; Simon, Krawczyk, et al., 2004). Further, certainty is observed to increase with more information disproportionately to gains in accuracy (Tsai, Klayman, & Hastie, 2008). Based on the DHT model, increasing decision certainty is analogous to increasing differentiation between the decision options, resulting in a stronger focal decision option and greater influence of the focal decision option over information selection and interpretation. Therefore, as information is accumulated, and certainty in the preferred, or expected, decision option increases, the strength of influence over the problem representation, information selection, and information interpretation is predicted to increase. Consistent with this suggestion, research into information distortion shows that preferences evolve as preference-relevant information is received and creates an increasing pattern of information distortion favouring the preferred decision option (e.g. DeKay et al., 2011; Russo et al., 1996; Russo & Yong, 2011). For example brand preference, and its effect on information distortion, has been found to strengthen as new information is revealed about each brand (Russo et al., 1998).

As indicated by the bidirectional arrows between preference and problem representation, and expectation and problem representation, some influence from the focal decision option is expected to flow back to influence preference and expectation. This is based on findings that preferences have been observed to shift throughout an investigation in accordance with changes in the focal decision option, even when the information does not relate directly to those preferences (e.g. Simon, Krawczyk, et al., 2004). Therefore, even if the information pertains directly to the expectation, not to the preference, some small shifts in preference are expected. However, these shifts are predicted to be small in comparison to changes produced by new information, and therefore have a lesser, if any, impact on the focal decision option throughout the investigation.

Due to the weakening impact of frame over the course of an investigation, frame is predicted to exert a lesser effect over final assessments and actions than preference and expectation when further information is available beyond the problem frame. The degree of influence of preference and expectation over the focal decision option is predicted to depend on their relative strengths at that point in the investigation. As outlined in Chapter 1.1.1, there is evidence from the hostile media phenomena (Lehman et al., 1992; Vallone et al., 1985) that when preference and expectation conflict, perceptions can be biased towards supporting the expectation of hostile media bias, rather than the preference, assuming that individuals do not want the media to be biased against them. Similarly, participants selectively chose information supportive of their preferred political candidate only when that candidate was also expected to win the election (Knobloch-Westerwick & Kleinman, 2012). In both of these cases expectation seemed to exert a stronger influence over confirmation processes and outcomes than preference. However, Ditto and Lopez (1992) observed that participants required less information to reach a preferred conclusion, than a non-preferred conclusion, even though the preferred conclusion was considered more surprising and, therefore, contrary to expectation. The differences in comparative strength of expectation and preference may explain why both have been observed to dominate in different situations. Unfortunately, empirical examinations of information distortion and coherence shifting commonly confound preference and expectation, by anchoring shifts in interpretation on a decision leaning (e.g. DeKay et al., 2011; Russo & Yong, 2011; Simon, Krawczyk, et al., 2004). The decision leaning is usually interpreted as a preference, but could also be influenced by an expectation that the currently favoured decision option will be best. Experiments 3 and 4 independently manipulate preference and expectation to address this gap.

Central mechanisms defining problem representation are as follows:

A) Related decision options are positively associated such that if one is activated, some of this activation spreads to the other. In the market analyst example, the situation assessment of a competitive release activates the action concept of 'speeding up' release plans to beat the competition to the market.

B) Opposing decision options are negatively associated, such that if one is activated it inhibits the other. For example, the situation assessment of a competitive release inhibits the action concept of maintaining release plans.

C) The most activated *action* decision option guides the selection and interpretation of information regarding possible actions.

D) The most activated *situation assessment* decision option guides the selection and interpretation of information regarding the situation.

A and B are consistent with evidence of associative processes in memory (Doumas & Hummel, 2012). C and D are consistent with evidence of information distortion (e.g. DeKay et al., 2011; Russo & Yong, 2011). In cases where preference, expectation, and frame strongly favour one set of associated decision options over competing decision options, the favoured set of decision options has a large influence over information selection and interpretation. In cases where preference, expectation, and frame diverge, implying opposing decision options, activation is spread more evenly across competing decision options. In these cases, participants may engage in attempts to distinguish between competing decision options such that information selection and interpretation is more balanced. This is consistent with the HyGene model (Dougherty et al., 2010) as detailed in Chapter 2.2.9 and with findings that participants display more PTS when testing a unidirectional possibility, such as whether an individual is extroverted, than when testing a bidirectional possibility, such as whether an individual is extroverted or introverted (Hodgins & Zuckerman, 1993; Zuckerman et al., 1995). Further, PTS has been observed in problems with a single salient decision option, whereas more diagnostic testing strategies have been observed in problems with two alternatives (McDonald, 1990).

4.2.2. Information Selection

The DHT model asserts that the same processes in different information environments result in Positive Test Strategy (PTS), Selective Exposure (SE), and Pseudo-Diagnostic (PD) testing. Decision options have positive associations with information that is prototypical of that action or assessment. As observed by Trope and Liberman (1996), prototypical information is often that which would be expected if that assessment were true or that action was taken. Take the example of a market analyst who has to decide whether or not the competition will release a competitive new product. The ‘release’ situation assessment option would have positive associations with concepts such as capability, intention, and resources, but negative associations with concepts associated with ‘no release’ such as faults, incapable, and loss of resources. In effect, if ‘release’ were more activated than ‘no release’, information about capability, intention, and resources would be more accessible than information about faults, incapability, and loss of resources. Recall that accessibility refers to the ease with which examples or concepts can be retrieved, constructed, or associated (Tversky & Kahneman, 1973). Based on this definition, accessible concepts would be more likely to be retrieved for inclusion in generated questions about the situation and processed more easily than less accessible concepts. In cases where information is provided for an investigation, information that is more easily processed may be considered more relevant. This is consistent with relevance theory, which proposes that information that produces the greatest cognitive effect with the *least cognitive effort* is considered most relevant (Sperber & Wilson, 1986, 2004). Consistent with the impact of ease of processing on perceived relevance, Sperber et al. (1995) found that statements that made the p and not q elements of the Wason selection task accessible increased the selection, and presumably perceived relevance, of these cards. Similarly, Fischer, Jonas, Frey, and Schulz-Hardt (2005) found that focal-decision consistent items were expected to be of higher quality than focal-decision inconsistent items based only on the titles in a SE task.

In summary, according to the DHT model, PTS, SE, and PD selection occur because concepts associated with the focal decision option are highly activated due to their association in memory, whereas concepts associated with alternative decision options are not. Activated concepts are more accessible and, therefore, are more likely to be included in requests for information, and are perceived as more relevant to the investigation.

The selection of information associated with the focal decision option, as defined by the DHT model, can explain observed changes in selection strategy that may otherwise appear contradictory. For example, participants select the threatening outcome as per error-avoidant theories in some cases, but select the safe or preferred outcome as per motivated reasoning theories in other cases. This apparent conflict is explored in Chapter 5, and can be explained by whether preference applies to an action decision option, such as avoiding threat, or a situation assessment decision option, such as the perception of safety. Chapter 5 details the conditions under which the action or situation assessment decision option would be activated by preference.

4.2.3. Information Interpretation

The DHT model proposes a bidirectional link between the problem representation and the cognitive representation of new information. When the focal decision option and new information are consistent, activation flows between the two concepts and, in effect, increases the salience and perceived impact of the new information. In contrast, when new information contradicts the focal decision option, it inhibits, and is inhibited by the focal decision option. Although the new information may effectively reduce the activation of the focal decision option, its impact is weaker compared to consistent information due to the inhibitory effect of the focal decision option, and the fact that inhibition does not occur recursively, whereas activation can cycle back and forth between positively associated concepts. This is consistent with PCS models that explain information distortion and coherence shifting as the result of bi-directional associations between the decision leaning and information (e.g. Monroe & Read, 2008; Simon, Snow, et al., 2004), and findings that information supportive of the focal decision option is overweighted compared to information that contradicts the focal decision option (e.g. Ditto & Lopez, 1992; Russo & Yong, 2011; Simon, Krawczyk, et al., 2004; Trope & Liberman, 1996).

Bidirectional reasoning can also explain why ambiguous information is often perceived as supportive of the focal decision option (e.g. O'Brien, 2009; Shafir, 1993). Information can be ambiguous for a number of reasons: 1) there are contradictory elements, 2) elements could have different meanings or implications depending on the context, or 3) critical contextual elements are missing. In the first case, the focal decision option activates elements of the new information that are consistent with it, and inhibits elements that are inconsistent. Therefore, the consistent elements of ambiguous information are more accessible, and perceived as more relevant, than inconsistent elements. A meta-analysis of recall for expectation-consistent and –inconsistent social information demonstrated that expectation-consistent information was more easily recalled, suggesting greater accessibility, when only a single decision option was mentioned, and when the expectation was stronger (Stangor & McMillan, 1992). This is in line with the DHT prediction that information consistent with the focal decision option will be more accessible than inconsistent information when the difference in activation between the focal decision option and alternatives is greater. In the second and third cases, the problem representation provides the context in which new information is interpreted. Given that the focal decision option is more activated than alternative decision options, information is interpreted in terms of its potential implication for the focal decision option, with less regard for the implications for alternative decisions. Consideration of the relationship between the information and focal decision option, without regard for the relationship with alternative hypotheses has been well documented (Evans, 1989; Fischhoff & Beyth-Marom, 1983; Klayman & Ha, 1987). To give an example, if the market analyst is focused on the situation assessment that competitors will release a rival product, and discovers that the competition has scheduled a media release, the market analyst might expect a rival product announcement, thereby perceiving the new information as release-consistent. If the market analyst was focused on alternatives, for example, that the competition is focused on other non-rival products, a scheduled press release might be expected to reveal new non-rival products. Thus, in this case, the same information may be perceived as unimportant and potentially irrelevant.

4.2.4. Stopping and Decision Threshold

The DHT model makes a distinction rarely made in the literature, between decision thresholds and stopping thresholds (for an exception see Gigerenzer & Gaissmaier, 2011). Decision thresholds refer to the perceived probability of a situation at which the action chosen will change. For example, a market analyst might decide to maintain product release plans as long as a competitive release from a competing company is considered to be lower than 50% likelihood, but speed up product release plans if the likelihood of competitive release rises above 50%. In this case, 50% would be the decision threshold. This example is meant to demonstrate how the analyst will behave given different situation assessments. The DHT model does not propose that individuals think about their decisions in this way as detailed later in this Chapter 4.2.4. Decision thresholds determine what action will be taken given the individual’s situation assessment. Stopping thresholds determine the point at which an individual decides to stop seeking more information and make a decision. The separation of decision and stopping thresholds allows for more refined predictions.

In the DHT model, the mechanism for decision thresholds is based on the action decision elements, represented by A1 and A2 in Figure 2. Perceived costs and benefits of actions inhibit and activate the representation of those actions respectively. This forms an action preference. The strength of action preference is represented by the inequality of activation between the preferred action and other actions. In the market analyst example, if the potential costs of defensive action are high, and the benefits of inaction are high, the inaction decision option receives greater activation than the action decision option and becomes the focus of attention. The inaction decision option will be selected unless other factors activate the action decision option sufficiently to counteract the influence of preference. One way that this could happen is if expectation or frame strongly activates the situation assessment associated with action, in this case a competitive release. This results in the same predictions associated with economic and statistical theories detailed in Chapter 3.1, that a higher situation assessment will be required to select action over inaction when costs and benefits favour inaction. However, the theories discussed in Chapter 3.1 all assume that the situation assessment acts as an unbiased input to the decision threshold. In contrast, the DHT model suggests that when preference activates inaction, the associated situation assessment also receives some referred activation. Therefore, the situation assessment is influenced by the decision threshold, as well as acting as input to the decision threshold.

In relation to stopping thresholds, the DHT model proposes that individuals seek to differentiate decision options before they make their decision and that this occurs in the context of PCS mechanisms. Ideally, one decision option is highly activated and alternatives have no activation, but few circumstances allow for this. Individuals seek optimal decision option differentiation within individual, situational, and informational constraints. Examples of constraints on ability to differentiate decision options might be an individual's cognitive capacity, the situational time constraint, or the ambiguity of the information available. High option differentiation should be positively associated with high decision confidence or certainty, and low information seeking behaviour. There are a number of empirical observations consistent with optimal differentiation assumptions. Firstly, participant confidence in decisions was lower under time pressure than no time pressure (Verplanken, 1993), supporting the suggestion that time pressure constrains option differentiation. Secondly, participants sought more information if the information received was conflicting (Heslin, Blake, & Rotton, 1972), supporting the assertion that higher ambiguity constrains option differentiation prompting further information search behaviour.

One implication of optimal differentiation within constraints is that decision thresholds can influence stopping thresholds, when they are not inhibited by other constraints. If preference, frame, and expectation all activate the same decision option, the differentiation between decision options is greater compared to situations in which two or more of these influences conflict. Assuming that other constraints apply equal pressure towards stopping or continuing information search in both conditions, participants with lower differentiation between decision options should persist with an information search for longer than participants with greater differentiation. Consistent with this assertion, Druckman, Fein, and Leeper (2011) observed that participants in conditions that produced higher decision certainty, and participants with higher reported decision certainty, were less likely to request further information. A second implication is that the stopping threshold is likely to change over time as constraints change, for example, as fatigue increases, the amount of relevant information diminishes, and as ambiguity increases due to the receipt of conflicting information.

Differentiation consolidation (dif con) theory also proposes that individuals attempt to differentiate decision options (Svenson, 1992, 2006). The dif con theory suggests that there is a criterion for acceptable differentiation, which individuals may move up or down. The DHT theory draws on PCS processes to explain how this criterion might be influenced.

By proposing that the decision threshold is one factor that influences stopping rules, the DHT model coheres with models that combine decision and stopping rules (Busemeyer & Townsend, 1993; Pleskac & Busemeyer, 2010; Ratcliff & McKoon, 2007; Trope & Liberman, 1996), while acknowledging that stopping thresholds may be influenced by other factors also. In addition, the suggestion that action preferences can influence situation assessments, as well as the other way around, the DHT model may account for deviations in behaviour from models that consider situation assessments to be input independent of the decision threshold (Rieskamp, 2008). Finally, the incorporation of PCS mechanisms provides an explanation of how stopping and decision thresholds might be incorporated into a connectionist framework.

4.2.5. Decision Outcome

Consistent with attitude polarisation observations detailed in Chapter 1.1.2.5 and confirmation bias predictions, preference, expectation, and frame are expected to influence final assessments. The DHT model extends general 'confirmation bias' observations in a number of ways. Firstly, the DHT model predicts that a preference for a certain *action* will influence a related situation assessment. This is interesting, as situations rarely change because a particular action has been chosen. For example, a market analyst's recommendation to speed up release plans would not usually change the likelihood of competition. For a pilot, deciding to deviate does not change the severity of the storm. Confirmation bias demonstrations typically manipulate preference for, expectation, or framing of the target decision directly, rather than a related decision (for exceptions see DeKay, Patino-Echeverri, & Fischbeck, 2009; DeKay, Patiño-Echeverri, & Fischbeck, 2009). Secondly, the DHT model predicts that the effects of preference, expectation, and frame on final situation assessments will be mediated by selection and interpretation confirmation processes. Thirdly, the DHT model predicts that the effect of frame, preference, and initial expectation on selection and interpretations processes is mediated by the focal decision elements. Finally, the DHT model acknowledges the dynamic nature of problem representations, and predicts changes in the focal decision option during an investigation, as the influence of frame decreases, and the influence of expectation and/or preference increases. Therefore, the DHT model can account for cases in which individuals switch decision options (e.g. Russo et al., 1998; Simon, Snow, et al., 2004) or confirm the expected decision option despite a conflicting preference (e.g. Knobloch-Westerwick & Kleinman, 2012; Lehman et al., 1992).

4.3. Summary: An Integrated View of Confirmation Bias

The Dynamic Hypothesis Testing (DHT) model incorporates the three types of confirmation bias. Frame, preference, and expectation influence the problem representation, and specifically, the decision option that is most salient to the individual. This focal decision option then guides major confirmation processes: information selection, interpretation, decision and stopping thresholds, and final decision. Information that is associated with the focal decision option is selected due to its perceived relevance. Consistent information is given more weighting than inconsistent information due to bi-directional recursive activation. The relationships between associated decision options means that preferred decision options can require slightly less quality and quantity of information to make. As a result of these confirmation processes, situation assessments can be swayed towards supporting the focal decision option, thus producing confirmation of frame, preference, or expectation outcomes.

The DHT model is a step towards the unification of the ‘multiple guises’ of confirmation bias (Nickerson, 1998). It provides a foundation for understanding differences in results by differentiating confirmation of frame, preference, and expectation. The integration of the different types of confirmation processes and outcomes provide a testable model from which we can advance a more comprehensive understanding of the mechanics of confirmation bias. As suggested by the name, the DHT model is dynamic in that it predicts changes to problem representation, individual and situational constraints, and associated processes throughout an investigation. Although this can produce the traditional confirmation bias outcome where the final decision is swayed towards the original focal decision option, it also acknowledges and allows for changes in the focal decision option over time.

5. Experiment 1: Effects of Frame and Preference on Information Selection in a Complex Information Environment

5.1. Overview of Experiments

The empirical component of this thesis was designed to provide a test of the DHT model in an information environment that places similar cognitive demands on the decision maker to many personal and organisational decisions. A central component of the DHT model is the differential influence of preference and expectation on the focal decision options and other decision making processes. In many experiments to date preference and expectation are confounded by either anchoring confirmation processes or outcomes on a decision leaning, which could be influenced by either or both expectation and preference (e.g. Russo & Yong, 2011), or using a decision that evokes strong prior beliefs (e.g. Lord et al., 1979), which people are likely to expect to be true but also prefer to maintain due to the level of integration with personal values, attitudes and other beliefs (see Monroe & Read, 2008 for a discussion of coherence within attitude structure). In both cases the information available pertains directly to the decision leaning or belief. This is referred to as a direct preference-information case because preference or decision leaning is directed towards the same action or situation assessment that the available information pertains to.

In many organisational and personal decisions, preference and expectation can diverge such as when a pilot would prefer a direct flight but suspects there may be a severe storm in the path that will require diversion, when a market analyst would prefer to maintain current plans but anticipates a threat that may warrant a change in plans, or when an individual would prefer to buy a house now but anticipates a downward turn in the market. In many cases, action and situation are interdependent such that the action recommendation depends on the assessment of the situation. For example, whether diversion is recommended for a pilot depends on an assessment of whether there is a severe storm in the path. Preferences can apply to an action such as maintaining course that depend on the situation assessment such as no threat. This is referred to as an indirect preference-information case because preference is directed towards an action that is separate from the situation to which the information pertains. It is important to study confirmation bias in indirect preference-information cases because it is common for analysts to investigate situations to present action recommendations or decide on actions themselves. Use of an indirect preference-information case is one way to separate preference from expectation. Understanding whether and how individual action preferences influence the situation assessment in these cases could also inform task and job design, training, and procedural measures to counteract these effects where appropriate. The DHT model predicts that confirmation of preference outcomes should occur with greater strength in direct preference-information situations, but still be observed in indirect preference-information situations due to the bidirectional link between associated action and situation assessment decision options. A second measure taken to separate expectation from preference is the use of an information environment that was novel to the university student participants. The use of a novel scenario limits the amount of strong beliefs participants can apply to the scenario. A novel scenario also lends itself to studying reasoning among employees relatively new to a role or decision makers faced with a novel decision problem.

The DHT model proposes that positive test strategy (PTS), selective exposure (SE), and pseudo-diagnostic (PD) selection occur via the same mechanism. Titles that are most closely associated with the focal decision option are most activated and, therefore, most accessible and perceived to be most relevant. Most database searches, such as Google searches, reveal a series of titles but the implication of the information for the decision is not always clear until one has selected that title to examine the information in more detail. In this way, database searches are more similar to PTS than SE paradigms. The difference between SE and PTS paradigms is whether the title reveals the implication of the content for the decision. In PTS paradigms, only an antecedent such as “vitamin x” or “other vitamin” or a consequent such as “resisting infections” or “getting infections” is presented in the title, and only once content is revealed can an antecedent be matched to a consequent (George, 1991, p. 467). In SE paradigms, the title presents evidence or an argument with a clear implication. For example, Jonas et al. (2001, p. 559) asked participants to investigate whether alternative medicines should be included in health insurance policies, and participants chose from titles such as “The success of alternative healing methods cannot be ignored. Therefore, alternative treatments should also be paid by health insurance”.

This thesis expands on findings from both PTS and SE paradigms by using titles similar to SE paradigms in that the potential decision implication is apparent from the title but participants are required to select titles to reveal whether that potential decision implication was found to be affirmed or contradicted. Using titles in the style of SE paradigms but with unknown outcomes as in PTS paradigms allows for a test of whether SE findings are a result of the title wording as proposed by the DHT model or expected decision implications.

Finally, the DHT model takes a PCS approach to the mechanisms of confirmation bias. A couple of important constraints in many organisational and personal decision contexts are cognitive load and ambiguity. These constraints are incorporated through the use of a complex, ambiguous information environment similar to the kind of information drawn upon by analysts, managers, and forecasters. According to Omodei and Wearing (1995, p. 303), “naturally occurring decision situations typically involve (1) a large number of inter-related variables; (2) ambiguity… and uncertainty in the values of key variables; and (3) multiple decision alternatives”. These elements were incorporated into the design of the scenario and information space.

Four main experiments (Experiments 1 to 4), and one replication experiment (Experiment 5), were conducted to test assertions of the DHT model. As represented by the grey sections in Table 9, Experiments 1 and 2 focus on the effect of preference on information selection holding frame constant. Specifically, Experiment 1 tests the DHT model assertion that PTS behaviour can be observed in complex, ambiguous, cue-based environments by observing selection behaviour in an expanded version of the Wason selection task that includes 36 titles rather than 4.

Experiments 1 and 2 test the DHT model assertion that frame-based PTS is observed only in the absence of new information, which provides additional context. This is examined by comparing the selection of frame-consistent and frame-inconsistent titles (frame-based PTS) in Experiment 1, where participants do not receive information beyond the frame and titles to select from (simultaneous information search), to Experiment 2, where participants receive the information requested after each title selection (sequential information search).

All of the four main experiments test the DHT model assertion that participants select information associated with the preferred decision option. This is examined by comparing the level of frame-based PTS across manipulated preference conditions, where costs and benefits of different actions are emphasised to produce one action that is more desirable than the other.

Experiments 2, 3, and 4 test the DHT assertion that preference for an action can exaggerate final situation assessments such that they favour the preferred action. This is examined by manipulating action preference and requesting final situation assessments.

Experiments 3 and 4 test predictions about the effect of preference and expectation on information selection, decision, and stopping thresholds holding frame constant. Specifically, a test of the assertion that participants select information associated with the expected decision option is conducted by comparing the level of frame-based PTS across manipulated expectation conditions. Expectation is manipulated via the information content available for examination throughout the investigation.

The DHT model predicts that decision thresholds are based on the relative activation of opposing action decision options. To test this, the situation assessment at which participants report that they would change action is compared across action preference conditions. The DHT model also predicts that less differentiation between options leads to more information seeking behaviour, assuming constraints are equal. According to the DHT model, option differentiation is lower when there is conflict between competing decision options, indicated by exceeding a high decision threshold, or passing below a low decision threshold. This is examined by comparing the relationship between decision threshold and quantity of information search across participants who chose each action as detailed in Chapters 7 and 8.

Experiment 4 incorporates information interpretation and confirmation of expectation outcomes. Specifically, Experiment 4 compares interpretation ratings of the same information between treatment participants, asked to make a decision, and control participants, not expecting to make a decision. In addition, process tracing methodology is incorporated to measure information interpretation, expectations, and preliminary action decisions (action leanings) throughout the investigation. Preference and expectation manipulations are maintained. This allows for a more comprehensive test of the DHT model including the following assertions:

1. Situation assessments are biased towards supporting the preferred action.
2. Participants select information consistent with, rather than inconsistent with, the previous focal situation assessment.
3. Information interpretation will be biased towards the previous focal situation assessment.
4. Final situation assessments will be biased towards the expectation built up through the information available in the treatment, compared to the control, group.

5. Final situation assessments will be biased towards supporting the preferred action in the treatment, compared to the no-preference control, group.
6. Situation assessments and favoured action decision options will exert bi-directional influence over each other.

Table 9: DHT Model Assertions Examined in Each Thesis Experiment

DHT Model Relationship Tested			Examined in
IV	Med/Mod Variable	DV	Experiment(s)
	Problem representation		
Action preference (M)	Action leaning (Med)	Situation assessment	4
	Information selection		
Simultaneous versus sequential information search (M)		Frame-based PTS	1 - 2, 4 - 5
Action preference (M)		Frame-based PTS	1 - 4
Expectation (M)		Frame-based PTS	3, 4
Action preference (M) and Expectation (M)	Previous situation assessment (Med)	Frame-based PTS	4
	Information interpretation		4
Action preference (M) and Expectation (M)	Previous situation assessment (Med)	Information interpretation	4
	Decision threshold		3, 4
Action preference (M)		Decision threshold	3, 4
	Stopping threshold		3, 4
Decision threshold	Action decision (Mod)	Quantity of information search	3, 4

	Decision outcome		
Action preference (M)		Final situation assessment	3, 4
Action preference (M) and Expectation (M)	Average information interpretation (Med) Control versus Treatment group (Mod)	Final situation assessment	4

Note: IV = Independent Variable, Med/Mod Variable = Mediator or Moderator Variable, DV = Dependent Variable, (M) = Manipulated IV, (Med) = Mediator, (Mod) = Moderator

5.2. Experiment 1

The increasing availability of information means that organisations will gain strategic advantage through the ability to integrate data to communicate clear, effective advice based on accurate situation assessments, rather than through superior access to information. It is, therefore, very important to understand how individuals go about searching and integrating information to form decisions. One strategy for selecting information is PTS. Recall that PTS is where participants investigate a focal decision option by asking positive questions, regarding elements that would be expected if the focal decision option were true or correct, rather than negative questions, targeting elements that would not be expected if the focal decision option were true or correct or would be expected if the focal decision option were false or incorrect (Klayman & Ha, 1987).

PTS has traditionally been studied using variants of one of three research paradigms: Wason's (1960) 2-4-6 hypothesis testing task, Wason's (1968) selection task, and Snyder and Swann's (1978) social hypothesis testing task. In Wason's (1960) 2-4-6 hypothesis testing (see also Chapter 1.1.2.2), participants are told that the three numbers, 2-4-6, conform to a simple rule. Their task is to determine that rule by asking whether other number triplets also conform to the rule and receiving a yes or no response. Participants tend to display PTS in that they select more triplets that conform to their hypothesised rule than triplets that would not be expected under their hypothesised rule. In Wason's (1960) original experiment, 79% of participants proposed the wrong rule initially and displayed, on average, four times more positive than negative tests prior to making their first guess. The other 21% of participants proposed the correct rule initially and generated, on average, almost twice as many negative than positive tests prior to making their guess. In Wason's (1960) 2-4-6 hypothesis testing task, participants are led to think of a rule that is more specific than, and completely encompassed by, the true rule. For example, all triplets that fit the hypothesised rule of 'increasing by two' also fit the true rule of 'ascending numbers'. As observed by Klayman and Ha (1987), this is the only relationship between the hypothesised and true rule in which PTS consistently leads to confirmation. In situations where the participant's rule is too general or where rules overlap rather than encompassing each other, PTS can lead to disconfirmation of the hypothesised rule. Klayman and Ha (1989) demonstrated that when the relationship between the hypothesised and true rule was varied, participants still predominantly used PTS and that this led to overly narrow hypotheses but did not produce a bias towards the original hypothesis unless the original hypothesis was encompassed by the true rule.

In Wason's (1968) selection task, participants were given a sentence in the form 'if p then q' such as "If there is a D on one side of a card, then there is a 3 on its other side" (Wason, 1968, p. 275). Participants were presented with four cards with a number on one side and letter on the other. The sides displayed were D (p), 3 (q), B (not p), and 7 (not q). Participants were asked to select only those cards that would help them to find out if the rule was true or false. Participants displayed PTS in that they selected the cards showing a D and 3 both of which would be expected to conform to the rule if it were true, but neglect the 7 card, which would disprove the rule if it had a D on the opposite side. In the original experiment, only 28% of participants chose the 'not q' (7) and the q (3) card, 50% chose the q (3) card as their only consequent card, and 22% chose no consequent card at all.

In Snyder and Swann's (1978) social hypothesis testing task, half the participants were asked to select questions to test whether the interviewee was a prototypical extrovert, the other half were asked to select questions to test whether the interviewee was a prototypical introvert. The questions they could choose from consisted of questions that assumed extroversion such as "What would you do if you wanted to liven things up at a party?" or assumed introversion such as "What factors make it hard for you to really open up to people?" and neutral questions such as "What kinds of charities do you like to contribute to?" (Snyder & Swann, 1978, p. 1204). Participants tended to display PTS in that they selected more questions assuming the personality profile they were testing than questions assuming the opposite personality profile, regardless of prior certainty that this profile was correct. In the original experiment, on average, participants selected almost 3 times more positive than negative tests. However, in the original experiment, all questions were non-diagnostic, in that they were poor at distinguishing introverts from extroverts. It has since been shown that diagnostic selection, which is selecting questions best at differentiating competing hypotheses, is preferred to PTS where the two strategies conflict (Bassok & Trope, 1984; Skov & Sherman, 1986; Slowiaczek et al., 1992; Trope & Bassok, 1982, 1983).

Frame-based PTS is where participants preferentially seek information on concepts that are mentioned in or implied by the question wording (frame-consistent titles), rather than the inverse of those concepts (frame-inconsistent titles). For example, when asked to find out whether an individual was an extrovert, selecting questions that ask about extroverted traits preferentially to questions about introverted traits would be considered frame-based PTS.

Participants do tend to focus on information that is mentioned in the rule or hypothesis, such as p and q in the Wason selection task (Beattie & Baron, 1988; Evans & Ball, 2010; Wason, 1968), and the trait mentioned in the social hypothesis testing task (Snyder & Swann, 1978). Exceptions to these findings are explored in more detail in discussions on preference- and expectation-based PTS.

The DHT model suggests that the frame of the information is one characteristic that can influence information selection. According to the DHT model, the framing of instructions and questions makes certain decision options more salient than others. The focal decision option triggers associations with related concepts. Frame-consistent titles are activated by the focal decision option and require less cognitive effort to process, are seen as more relevant, and are more frequently chosen than frame-inconsistent titles that are inhibited by the focal decision option. In this way the DHT model is very similar to relevance theory. The DHT model further proposes that three things determine the decision options most salient to the individual: the frame of the information including which elements are explicitly stated, the individual's preference, and expectation.

Information framing is also asserted to play a central role in producing PTS in a number of other theories including the heuristic-analytic theory (Evans, 2006; Evans & Ball, 2010), relevance theory (Wilson & Sperber, 2004), and Bayesian rationality theory (Oaksford & Chater, 1994, 2009), as summarised in Table 10 and detailed in Chapter 2.2.

Table 10: How Theories Explain the Preferential Selection of Titles Associated with the Framed Decision Option

Theory	Source of Advantage of Framed Decision Option	Why Associated Concepts are Selected	Exceptions
Heuristic-analytic	Type 1 process based on accessibility.	PTS based on focal decision option.	Type 2 process intervention.
Relevance	Context makes decision option and related concepts salient.	Greater perceived relevance due to lower cognitive effort requirements.	The framed decision option has low anticipated cognitive effect, or alternative decision options have high anticipated cognitive effect.
Bayesian rationality	Assumed rarity.	Assumed to be more diagnostic.	The framed decision option is known to be common.
DHT	Frame activates decision option. Activation spreads to related concepts.	Greater accessibility leads to generation and processing advantages.	Other accessible characteristics activate competing decision options and concepts.

In Wason's selection tasks, the information environment perfectly matches the prediction. That is, for the prediction if p then q there are p and q cards, or cards that fit neatly into categories p and q. For example, in the original task when the rule was if there is a D on one side there is a 3 on the other, 'D' and '3' cards were provided (Wason, 1968). In the pilot study for Wason's (1968) experiment, the rule was that if there is a vowel on one side, there is an even number on the other, and a vowel such as 'A' and an even number such as '2' were provided to choose from. In more complex information environments, the decision maker is presented with a set of cues that are more loosely related to the prediction. Consider the example of a market analyst presented with the prediction that their competitors will release a rival product in the next 6 months. The market analyst is unlikely to have the opportunity to directly observe a competitive product, but will rather have to rely on cues that may indicate a competitive product such as media releases or evidence of development activity. It would be valuable to know whether findings and theories on PTS apply to these more complex, cue-based environments.

To demonstrate the predictions of the DHT model more concretely, consider a market analyst asked to investigate the possibility that “the rival company, DCC, will release a competitive product in the next 6 months”. This is the framed decision option. The analyst conducts a Google search on DCC that yields a series of titles that can be clicked for more information. The DHT model, and other theories, predicts which titles the analyst will select. When conducting an information search, according to frame-based approaches, the market analyst would select titles expected if a release was immanent such as “DCC schedules a media release” (release-consistent titles) preferentially to titles not expected if a release was immanent such as “DCC encounters barriers to product development” (release-inconsistent titles).

The DHT model asserts that the focal decision option, such as a competitive release, activates related concepts, such as a media release. These concepts are then accessible. Titles with more accessible concepts are more salient and, therefore, more likely to be selected than titles with less activated concepts. The DHT model expands on previous theories by explicitly embedding the association and activation of concepts within a connectionist network. Therefore, the focal decision option such as a competitive release can also activate related actions such as defensive action, making concepts associated with defensive action more accessible also.

The first aim of Experiment 1 is to assess the DHT model’s assertion that frame-based PTS extends to the selection of complex, ambiguous information, similar to the kind of information drawn upon by analysts, managers, and forecasters. The DHT model suggests that because PTS is based on the associations between the focal decision option and information titles, frame-based PTS should be observed a) when the frame influences the focal decision option, b) whether or not the outcome of information selection is known a priori, and c) whether titles are loosely or categorically associated with the decision options.

Hypothesis 1 Frame-Based Selection: *Participants will display frame-based selection in that they will select more release-consistent than release-inconsistent titles.*

There is also theoretical and empirical reason to suspect that PTS may be used to examine the preferred decision option. Preference-based PTS is where participants select more preference-consistent titles than preference-inconsistent titles. Preference-consistent titles are those that support the preferred conclusion, preference-inconsistent titles are those that refute the preferred conclusion. For example, if the market analyst would prefer that the competition were not about to release a rival product, the title “DCC encounters barriers to product development” would be preference-consistent, whereas the title “DCC scheduled media release” would be preference-inconsistent. Researchers have approached preference-based PTS from two angles, error avoidance and motivated reasoning. Error avoidance approaches assume that individuals select information that minimises the possibility of committing costly errors (Friedrich, 1993; Klayman & Ha, 1987; Lewicka, 1998). This involves biasing decision processes towards accepting threatening possibilities such as the presence of a snake to take precautionary action but questioning safety assumptions such as edibility of mushrooms to avoid exposing oneself to danger. Support for error-avoidance predictions come from experiments where Wason’s selection task is conducted with a threat-rule such as “If mushrooms have brown stems, then they are poisonous” or a safety-rule such as “If mushrooms have brown stems, then they are edible” (Smeets et al., 2000, p. 768). Frame-based theories would predict that, in the threat-rule case, mushrooms with brown stems and poisonous mushrooms would be examined whereas, in the safety-rule case, mushrooms with brown stems and edible mushrooms would be examined. However, in both cases, participants tended to ask people who ate poisonous mushrooms whether the mushrooms they ate had brown stems, rather than asking people who ate edible mushrooms. The error avoidant advantage of this strategy is apparent. Asking people who ate poisonous mushrooms whether stems were brown, helps in identifying and avoiding poisonous mushrooms. These responses are consistent with frame-based PTS in the threat-rule, but not in the safety-rule conditions.

In contrast to error-avoidance approaches, motivated reasoning approaches predict that participants will be *defensive* to threatening possibilities, seek desired possibilities and, therefore, selectively attend to preference-consistent titles. For example, Kunda (1990) suggests that preference-related information is selectively recalled, where Pyszczynski and Greenberg (1987) and Trope and Liberman (1996) suggest that the preferred hypothesis is chosen for testing, and PTS is used to test this hypothesis. Support for this view has also been found using variants of the Wason selection task. In their first experiment, Dawson et al. (2002) asked participants to identify themselves as high or low in emotional lability, then presented them with the hypothesis that "everyone in the [separate] study who was low (high) in emotional lability, without exception, experienced an early death" (Dawson et al., 2002, p. 1382). Participants could choose to examine a person with high or low emotional lability and a person who died early or late. When the hypothesis was threatening for the participant due to their emotional lability status, they were more likely to select the preference-consistent outcome, the person who died late, compared to participants who were not threatened by the hypothesis. The second experiment showed the same results, except that participants were more likely to select the preference-consistent outcome that was contrary to the negative stereotype if they identified with the stereotyped group compared to those who did not identify with the stereotype. These responses are consistent with frame-based PTS when the rule posed no threat to the individual (safety-rule), but not when the rule posed a threat to the individual (threat-rule), which is opposite to the error-avoidant observations described above.

George (1991) presented participants with a selection task, such as choosing a favourable car, school, or vitamin. They were presented with an assertion like "If one buys a K-make car, one is always satisfied" (George, 1991, p. 466). The outcome was manipulated to be positive, such as satisfied, or negative, such as unsatisfied. Participants tended to select the positive outcome more frequently, regardless of whether the positive or negative outcome was mentioned in the assertion. These responses are consistent with frame-based PTS when the rule mentioned a positive outcome, but not when it mentioned a negative outcome.

Using the same paradigm, Smeets et al. (2000) demonstrated a general preference for threatening or negative outcomes, whereas Dawson et al. (2002) and George (1991) demonstrated a general preference for safe or positive outcomes. The difference in these results can be explained by two factors: control over the outcomes and approach versus avoidance goals. Threat-related information was preferred to safety-related information when action could be taken to avoid any identified danger. For example, in Smeets et al's (2000) experiments, if brown-stemmed mushrooms were found to be poisonous, they could presumably be avoided. Safety-related information was preferred to threat-related information when the threat was based on group membership as was the case in Dawson's (2002) experiments, and therefore, could not be changed whether the threat was accepted or not.

Rules provided in both Smeets et al's (2000) and Dawson et al's (2002) experiments facilitated a danger-avoidance goal through reference to threatening outcomes and stereotypes. George (1991) explicitly stated benefit-approach goals such as "Your goal is to buy a car" and "Your goal is to choose a school" and when this goal statement was removed, participants no longer showed the same preference for the positive-outcome card. Differences in attention based on approach versus avoidance goals have been found in other areas too. For example, participants attend to positive features when asked to choose an option, whereas they attend to negative features when asked to exclude an option (Meloy & Russo, 2004; Shafir, 1993).

The DHT model integrates the previous findings by proposing that preferences can influence the focal decision option via two pathways. One may have a preference for an action decision option, such as taking precautionary action against a threat, or for a situation assessment option, such as concluding that one will live a long life. In cases where situation assessment and action decision options are associated, they activate each other. For example, a defensive action would be associated with the threatening situation. The rules used by Smeets et al. (2000) would be expected to create preferences for precautionary action. The focus on the precautionary action would activate the associated danger, in this case poison, resulting in a focus on threatening outcomes and preventative action. In cases like this, where actions are possible and expected to prevent or minimise threat, or achieve or maximise gains, the action preference would be expected to dominate. In cases where actions are impossible, highly aversive, or not expected to be effective in the avoidance or approach goal, preference for the most favourable situation assessment would be expected to dominate.

The DHT model proposes that frame and preference can pull attention towards the same or competing decision options. Therefore, frame-based PTS would be stronger when the framed and preferred decision options are the same. In the market analyst scenario the framed decision option of a competitive release is strengthened by the analyst's preference for action, or fear of inaction, because both framed and preferred decision options favour a competitive release requiring action. Conversely, the framed decision option is weakened by the analyst's preference for inaction, or fear of action, because the preferred decision option now favours no competitive release, which supports inaction.

The DHT model extends on previous explanations of PTS by proposing that actions and associated situation assessments activate each other. Therefore, action preferences can influence the focal situation assessment and related information selection. This is consistent with results found by Smeets et al. (2000). The DHT interpretation of these results is that participants preferred to identify and, therefore, avoid any food that could be poisonous or inedible, which led to a focus on testing situations of poisoning to find out what was eaten. However, these results are inconclusive on the effect of action preference given that this was not manipulated by Smeets et al. (2000). The second aim of Experiment 1 is to examine whether action preferences lead to preferential selection of information about the associated situation assessment. To examine the influence of action preference on information selection holding frame constant, preference for taking preventative action (Prefer-Action condition) or not taking preventative action (Prefer-Inaction condition) was manipulated.

Hypothesis 2a Preference-based selection: *Participants will select more release-consistent than release-inconsistent titles in the Prefer-Action but not in the Prefer-Inaction condition.*

Hypothesis 2b. *The degree of difference between the number of release-consistent and release-inconsistent titles selected should be positively related to the strength of the preference for action and negatively related to the strength of the preference for inaction.*

5.3. Methods

5.3.1. Participants

Participants in this experiment and the three subsequent experiments were paid for their time and recruited via a range of advertising methods at Macquarie University. University students were considered an appropriate population for the following reasons: a) these experiments aim to examine whether confirmation processes and outcomes are observed in the absence of strong prior preferences or expectations, novice participants were considered unlikely to have strong prior convictions, and b) PTS was first demonstrated with, and has since been replicated with, university student samples (Handley, Feeney, & Harper, 2002; Wason, 1960, 1968).

Participants from a range of disciplines participated on campus and were paid AU$15 for one hour of their time. Of 85 participants, 64% were female, 56% were in their first or second year of university, and 44% were in higher undergraduate or postgraduate years. Participants ranged from 18 to 62 years of age with an average age of 23.21 (*SD* = 8.85).

5.3.2. Design

The scenario was designed to keep a number of important variables constant and manipulate only preference. This allowed for an examination of preference, an important component in the DHT model. Firstly, the frame was designed to highlight the possibility of a competitive product release, rather than other possibilities such as a non-competitive product release or no product release. Therefore, release-consistent titles were frame-consistent titles and release-inconsistent titles were frame-inconsistent titles.

Secondly, the scenario was designed to be an avoidance scenario where participants were asked to avoid possible negative outcomes and warned of threats, rather than an approach scenario where participants had the opportunity to seek rewards. Thirdly, an element of control was emphasised by providing a choice of actions proposed to mitigate the threats faced. Based on the literature cited, these conditions should lead to the selection of threat-related titles.

Preference was manipulated to form three preference conditions summarised in Table 11. The Prefer-Action condition emphasised the costs of inaction if a competitive release was present. In this condition release-consistent titles were threat-related because the greatest threat was inaction when the threat of competitive release was present. Release-consistent titles were also preferred, because they supported the preference for action. The Prefer-

Inaction condition emphasised the costs of action if a competitive release were absent. In this condition, release-inconsistent titles were threat-related because the greatest threat was a false alarm: action when the threat of competitive release was absent. Release-inconsistent titles were also preferred because they supported the preference for inaction. Finally, the No-Preference condition did not emphasise any costs. This acted as a control group to examine how participants with explicitly manipulated preferences differed from a baseline given only the scenario. The primary dependent variables of interest were the number of release-consistent and release-inconsistent titles selected.

Table 11: Characteristics of Manipulated Preference Conditions

Condition	n	Costs emphasised	Preference-consistent titles
Prefer-Action	29	Inaction when release present	Release-consistent
Prefer-Inaction	28	Action when release absent	Release-inconsistent
No-Preference	28	None	Baseline

5.3.3. Apparatus and Materials

5.3.3.1. Scenario

The scenario asked participants to imagine being a market analyst for a software company. A rival organisation, DCC was suspected of planning a competitive product release, specifically a real-time translation device (Appendix B). Participants were told that their task was to investigate this possibility and make a recommendation to their company from four possible responses ranging from minimal action (maintaining release plans, or monitoring DCC) to counter action (speeding up release plans to release sooner than intended, or as soon as possible). Taking action (speeding up release plans) was recommended if DCC was very likely to release a competitive product. Inaction (maintaining release plans) was recommended if DCC was very unlikely to release a competitive product.

In addition to the standard control group scenario, risks of speeding up release plans were highlighted for participants in the Prefer-Inaction condition and risks of maintaining release plans were highlighted for participants in the Prefer-Action condition, as detailed in Appendix B.

5.3.3.2. Information environment

An information space was designed for investigation of the scenario above. A pilot study was conducted to select titles that were related to a competitive release (release-consistent titles), titles that were related to no competitive release (release-inconsistent titles), and neutral titles from an original pool of 44 titles. Release-consistent or inconsistent titles that were also diagnostic were selected. Titles are positive (in PTS terms) if they are expected when the focal decision option is true. Positive titles are not necessarily diagnostic, because the same title may also be expected if the focal decision option is false, therefore providing little information about which decision option is true. To identify diagnostic release-consistent and inconsistent titles, participants were asked to what degree a competitive release would be expected or not expected if each title was true. This helped to identify positive (release-consistent) and negative (release-inconsistent) titles that were also perceived as diagnostic of a competitive release.

Titles consisted of statements about the competitor's actions such as "Scheduled press release", products such as "Recent problems in language translation", or characteristics such as "Regular release pattern". Forty-five participants were asked to rate each title on how indicative it was of a competitive real-time translation software release where 0% indicates the DCC is definitely NOT planning this new competitive product release, 50% does not indicate either way, and 100% indicates the DCC IS definitely planning this new competitive product release. The 15 titles rated as most indicative of a new competitive product release were chosen as release-consistent titles ("Transferred staff to research" $M = 65.82$, $SD = 16.77$ to "Increased alliance with potential consumers" $M = 74.49$, $SD = 13.24$). The 15 titles rated as most indicative of no new competitive product release were chosen as release-inconsistent titles ("Audio headset source bankrupt" $M = 36.82$, $SD = 18.88$ to "Recent problems in language translation" $M = 49.84$, $SD = 18.22$). Finally, 6 neutral titles were selected from between the two extremes ("Price reduction on all products" $M = 52.82$, $SD = 19.33$ to "Target market" $M = 63.64$, $SD = 14.99$).

The resulting titles were arranged in a grid of information that participants could select from. Titles were arranged in an alternating pattern such that if participants selected consecutive titles vertically or horizontally they would select an even number of release-consistent and release-inconsistent titles.

Experiments 1 to 3 used a 6 by 6 grid with 15 release-consistent, 15 release-inconsistent, and 6 neutral titles, as shown in Figure 3. Display order was counter-balanced such that half the participants saw the information grid displayed in Figure 3, and half the participants saw the same information grid flipped diagonally such that "Social events" was in the top left position.

Target market	Translation expert quit	Contracted software testers	Audio headset source bankrupt	Increased development activity	Annual report
Slow release pattern	Translation expert hired	Product list	Bulk production of audio headsets	Barriers to development	Key software engineer hired
Scheduled press release	Speech recognition expert quit	Recent advances on speech recognition	Current speech recognition faults	Transferred staff to research	Key software engineer quit
Cancelled press release	Speech recognition expert hired	Recent problems in speech recognition	Share price	Audio headsets poor language translation	Audio expert hired
Price reduction on current translation software	Current language translation faults	Recent advances on language translation	Faults in audio production	Increased alliance with potential consumers	Audio expert quit
Price reduction on all products	Branding strategy	Recent problems in language translation	Improvements in audio production	Lost loyalty of potential consumers	Social events

Neutral Title	Release-Inconsistent Title	Release-Consistent Title

Note: Colour coding was not included in the participants' display.

Figure 3: Representation of the information grid that participants selected titles from in Experiments 1 to 3.

5.3.3.3. Self-report measures

The preference manipulation check used was anticipatory affect measured as per Peters et al. (2009). Participants were asked to rate how attractive each action option was to them, and how good or bad choosing that option would make them feel on 7-point scales

(Extremely unattractive – Extremely attractive; Very bad – Very good). These scales request affective responses to decision options without explicitly alluding to risk and were shown in a pilot study to differentiate between the preference conditions. There was a ceiling effect for the second option (monitoring DCC), with 95% of participants attracted to this option. Therefore, the average rating of attraction and feeling questions for only the first action (maintaining current release plans) was used to form an ***inaction attraction*** score representing the attraction towards maintaining release plans (Cronbach's alpha for Experiment 1 = .90 and Experiment 2 = .89). Mean ratings for the attraction and feeling questions for both the 3rd and 4th actions (speeding up release plans) were averaged to form an ***action attraction*** score representing the attraction towards speeding up release plans (Cronbach's alpha Experiment 1 = .92 and Experiment 2 = .83). Scales ranged from 1 to 7 with high scores indicating greater attraction, 4 indicating neither aversion nor attraction, and low scores indicating aversion to that action.

Title Perception was measured for each title selected. After making their selection of titles, participants were asked to rate the information titles to determine whether they were perceived as release-consistent or release-inconsistent as per the a-priori categorisation described in the previous section. Participants were asked to "Imagine that you found that the DCC did have the following characteristics and had taken the following actions. For each of the statements please rate how indicative it would be of these new competitive product release plans. Please rate each item individually, irrespective of other items. This information indicates that an imminent competitive release is..." They responded using a 9-point scale from impossible to definite. High scores indicate that the title, if found to be true, is perceived as indicating a high likelihood of competitive release. Low scores indicate that the title, if found to be true, is perceived as indicating a low likelihood of competitive release.

A full list of instructions and questions is provided in Appendix C.

5.3.3.4. Behavioural measures

Selected titles is the number of titles that each participant selected for investigation out of a possible 36 titles.

Release-consistent title selection is the number of release-consistent titles that each participant selected for investigation out of a possible 15 titles.

Release-inconsistent title selection is the number of release-inconsistent titles that each participant selected for investigation out of a possible 15 titles.

5.3.4. Procedure

Upon arrival, participants read and signed information and consent forms and were seated at individual computers. All subsequent instructions were computer-administered. Participants were randomly allocated to one of the three conditions electronically. The computer provided a definition of "real-time translation software" that was "software that converts the meaning of spoken language into a different language with minimal delay". Participants were then presented with the scenario and condition-specific manipulation. To ensure that the scenarios were understood and considered, each scenario was followed by true/false questions that participants were asked to answer and mark their own answers using the scenario. To cement the manipulations, participants were asked to generate risks associated with a particular decision (preference conditions) or key points from the scenario (control condition). Participants then answered manipulation check questions before progressing to the main selection task.

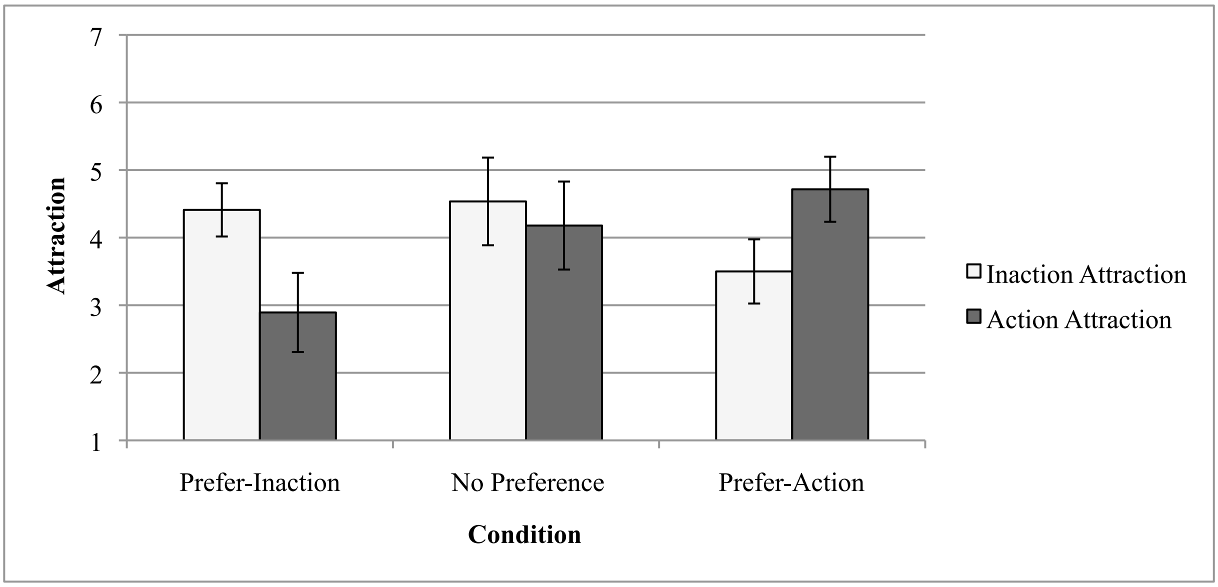
The participants were told that the information titles referred to the their competitor, DCC's, characteristics and actions and may contain information indicating that the characteristic or action was present or absent. The example was given that the cell titled "Manager on leave" may reveal that the manager is actually working, he is not on leave. They were also told that information about DCC was randomly selected for display, so some information may not be related to the task. This was stated to remove the assumption of relevance applied to communicated information (Chapter 2.2.8) with two main aims: 1. To make the selection of information available appear more like a database search than a personal communication from the experimenter and 2. To remove the assumption that participants were expected to select all of the information. Participants answered questions on these instructions to confirm that they understood. The instructions for information selection requested that participants select only the information required to make an informed decision. Participants could then select any number of titles from the 6 by 6 information grid (Figure 3). After selecting titles and clicking 'next', participants were asked for their perceptions of the titles they selected as described in Chapter 5.3.3.3. Participants then completed a series of individual difference questionnaires described in Appendix C.

5.4. Results

All dependent variables were examined for relationships with age and selected titles and for differences across gender and display order. When statistically significant relationships were found, those variables were controlled for in all analyses involving that dependent variable. Assumptions of normality were met for all dependent variables used in parametric analyses.

5.4.1. Manipulation Checks

Two manipulation checks were conducted in Experiment 1 and all subsequent experiments. Firstly, the effect of the preference manipulation on attraction and feeling towards the various possible actions was examined (statistical details are provided in Appendix D). As shown in Figure 4, action and inaction attraction were significantly different between conditions. Action attraction was significantly higher for participants in the Prefer-Action and No-Preference conditions compared to the Prefer-Inaction condition. Inaction attraction was significantly higher for participants in the Prefer-Inaction and No-Preference conditions compared to the Prefer-Action condition. The difference between the Prefer-Action and Prefer-Inaction condition explained 23% of the variance in action attraction and 6% of the variance in inaction attraction. Therefore, preference manipulations had a significant impact on attraction and positive feelings towards action and inaction decision options as intended.



Note: A score of 4 is the midpoint of the 1 to 7 attraction scale.

Figure 4: Attraction to action was higher in the Prefer-Action (n = 29) condition and lower in the Prefer-Inaction (n = 28), compared to attraction to inaction. The No-Preference (n = 28) condition showed no difference between inaction and action attraction. Error bars represent 95% CI.

Secondly, the perceived difference between release-consistent and -inconsistent titles in their implication for a competitive release was examined. On average, participants rated release-consistent titles as indicating that a competitive release was likely, and release-inconsistent titles as indicating that a competitive release was somewhat unlikely. The difference in title perception across title type (release-consistent, neutral, release-inconsistent) was statistically significant, as detailed in Appendix D. Average title perception was also greater, or more consistent with release, for participants who selected fewer titles.

The results for the impact of preference conditions on action and inaction attraction and for the perceived difference between release-consistent and -inconsistent titles held across all five experiments, as shown in Appendix D. Only large changes in effect size or qualifying interactions are mentioned in future chapters.

5.4.2. Information Selection

Hypothesis 1 Frame-Based Selection: *Participants will display frame-based PTS in that they will select more release-consistent than release-inconsistent titles.*

A repeated measures GLM analysis with release-consistent and release-inconsistent title selection as the within participants variable provided support for Hypothesis 1. Participant age was controlled for due to a significant relationship with release-inconsistent title selection. On average, participants selected almost three (M =2.77, SE = 0.50, 95% CI 1.77, 3.76) more release-consistent (M = 8.68, SD = 4.14) than release-inconsistent titles (M = 5.92, SD = 4.14) Wilks' Lambda = 0.80, F (1,83) = 21.33, p < .0005 accounting for 20% of the variance in title selection. The title selection by age interaction was also statistically significant Wilks' Lambda = 0.91, F (1,83) = 8.10, p = .006 explaining 9% of the variance. For every 10-year increase in age, the number of release-inconsistent titles selected increased by 1, there was no significant effect of age on release-consistent title selection.

Hypothesis 2a Preference-based selection: *Participants will select more release-consistent than release-inconsistent titles in the Prefer-Action but not in the Prefer-Inaction condition.*

A repeated measures GLM analysis with release-consistent and release-inconsistent title selection as the within participants variable and preference condition as the between participants variable, controlling for age did not support Hypothesis 2a. The difference between release-consistent and release-inconsistent titles selected was slightly greater in the Prefer-Action condition than in the Prefer-Inaction condition. However, the effect of preference condition explained only 3% of the variance in title selection and was not statistically significant. Age was still a statistically significant predictor of title selection $F(1,81) = 9.23$, $p = .003$, explaining 10% of the variance in title selection.

Hypothesis 2b. *The degree of difference between the number of release-consistent and release-inconsistent titles selected should be positively related to the strength of the preference for action and negatively related to the strength of the preference for inaction.*

A repeated measures GLM analysis with release-consistent and release-inconsistent title selection as the within participants variable and action attraction and inaction attraction as covariates, controlling for age, partially supported Hypothesis 2b. The difference between release-consistent and release-inconsistent title selection was greater for participants with higher action attraction Wilks' Lambda = 0.95, $F(1,81) = 4.26$, $p = .042$, explaining 5% of the variance, but there was no effect of inaction attraction, which explained only 0.2% of the variance. For every 1 unit increase on the 7-point action attraction scale, the number of release-consistent titles selected increased by 0.07, and the number of release-inconsistent titles selected decreased by 0.69. Therefore, the difference was predominantly driven by a reduction in the number of release-inconsistent titles selected by participants with high action attraction.

5.5. Discussion

Hypothesis 1 was supported. Consistent with the DHT model, frame-based PTS was observed even in this complex information environment. This finding was also replicated in Experiment 5 (Appendix E) with a smaller information grid of 4 by 4 titles. This result occurred even though 86% of participants answered "true" to the question "The title 'manager on leave' could contain information that the manager is working, not on leave". Therefore, it is unlikely that information selection was driven by a desire for release-consistent information.

In regards to the impact of preference, the preference conditions did produce differences in action attraction and inaction attraction, and higher action attraction was associated with the selection of fewer release-inconsistent titles. This is consistent with attraction to action activating the concept of release, inhibiting the concept of no release and, therefore, reducing the accessibility and perceived relevance of release-inconsistent titles relative to release-consistent titles as predicted by the DHT model. However, contrary to predictions, only action attraction, not inaction attraction was associated with information selection, and there was no significant impact of preference manipulations on information selection. The impact of preference on information selection is examined again in Experiment 2. Therefore, the implications of these findings are discussed in Chapter 6.3.

Experiment 1 found some evidence of frame-based PTS in a complex information environment. Like most demonstrations of PTS, the information environment was static, that is no new information or context was revealed during information selection. This is typical of Wason's (1968) selection task and variants, as well as the social hypothesis testing task (Snyder & Swann, 1978). Wason's (1960) 2-4-6 hypothesis testing task is an exception that reveals minimal information in the form of a yes or no response after each new sequence is proposed. The DHT model proposes that the introduction of new information and context throughout the information selection process is relevant because it can impact the individual's problem representation and the relative importance of accessible elements can change. Consistent with this prediction, participants were found to change their focal decision option throughout a variant of the 2-4-6 hypothesis-testing task and tended to use PTS based on the most recent focal decision option (Klayman & Ha, 1989). In personal and organisational decision making contexts, it would be rare to select all of the information required, based on titles, prior to viewing any content. In most cases information received is also likely to be more extensive than a yes or no response. The DHT model predicts the original frame to be less influential in these circumstances as other factors begin to exert influence over problem representation. Experiments 2 to 4 examine whether frame-based PTS remains when participants are allowed to read the information from the first title selection prior to making the second title selection.

5.6. Summary of Results from Experiment 1

Frame-based selection: Participants displayed frame-based PTS, in that they selected more frame-consistent than frame-inconsistent titles. This result was replicated with a smaller 4 by 4 (rather than 6 by 6) information grid, as detailed in Appendix E.

Preference-based selection: Preference conditions did not significantly influence information selection.

6. Experiment 2: Effects of Frame and Preference on Information Selection under Sequential Information Search Conditions

Experiment 1 showed that when asked to select information, frame-based PTS is evident even in complex information environments. This is consistent with decades of research on the Wason selection task (for a review see Evans, 2007) and the social hypothesis testing task (for a review see Trope & Liberman, 1996). In practice, this is similar to conducting a database search and selecting all the titles of interest before reading any of the content. Jonas, Shulz-Hardt, Frey, and Thelen's (2001) call this simultaneous information search. Sequential information search is also common, where individuals conduct a database search, select a title of interest, read the content, and then return to the search to select another title. As detailed below, there are theoretical reasons to expect that search strategies may differ in sequential compared to simultaneous information search conditions. It is important to understand information search processes under different conditions to better inform practice.

The DHT model proposes that the original frame of the problem influences the focal decision option, as do preference and expectation. The original problem frame would be expected to have the most influence immediately after the framed information is received from the problem description. In simultaneous information search conditions such as in Experiment 1, the effect of the original frame would be expected to influence the entire selection phase because no new information is provided to alter the originally framed context. However, in sequential information search conditions, the original problem frame could be diluted by subsequent information that may alter the focal decision option. The altered focal decision option would then guide further information search, reducing the overall impact of the original frame on information selection. Therefore, based on the DHT model, the effect of the original frame would be lesser in sequential information search conditions compared to simultaneous information search conditions.

***Hypothesis 1 Frame-based PTS selection** will be greater in simultaneous information search compared to sequential information search conditions*

The DHT model assumes that positive test strategy (PTS) and selective exposure (SE) are effectively the same strategy in different information environments as detailed in Chapter 4.2.2. Therefore, Hypothesis 1 appears to contradict the results reported by Jonas et al. (2001), who found that whether information search was simultaneous or sequential, participants displayed the same degree of SE. The apparent contradiction between these empirical findings and the theoretical prediction can be explained by the difference between the framed decision-option and the expected decision-option. According to the DHT model, the original framed decision option has the most influence over the focal decision option immediately after the context is described and can potentially be diluted by subsequent information, which provides further context. In contrast, the expected decision option is constantly revised and strengthened as new information is received and, therefore, exerts an increasing influence over the focal decision option throughout the investigation. This assumes that the available information is relevant to the expectation, which it was in the study by Jonas et al. (2001). The DHT model predicts the same level of PTS or SE behaviour in simultaneous and sequential information search conditions assuming that the expectation is not altered by the information received. This assumption is upheld in SE paradigms where expectation-consistent titles always yield expectation-consistent information, but not in PTS paradigms where expectation-consistent titles can yield expectation-inconsistent information. Jonas et al. (2001) used a SE paradigm, whereas Experiment 2 uses a PTS paradigm.

Note that there is a difference between consistent and inconsistent *titles* and *information.* Titles provide a heading alerting the reader to the topic of the content, which may be an agent, outcome, or characteristic, for example. Titles are considered consistent if the topic would be expected if the focal decision option were true and inconsistent if that topic would not be expected if the focal decision option were true. The information is the content received after selecting the title. Information is considered consistent if it supports the focal decision option and inconsistent if it argues against the focal decision option or for an alternative decision option.

Selective exposure paradigms tend to provide longer titles such that the implication of the information for the decision is apparent from the title. Therefore, in selective exposure paradigms, titles and information always share implication in that consistent titles contain consistent information and inconsistent titles always contain inconsistent information. In PTS paradigms, titles provide only a topic without revealing the implication of the content for the focal decision option. Therefore, in PTS paradigms, titles and information can have different implications for the focal decision option. For example, in a Wason selection task where the rule is “If there is a D on one side of any card, then there is a 3 on its other side” (Wason, 1968, p. 275), D and 3 would both be expected if the rule were true, making them consistent. However, one will not necessarily find a card with a D on one side and a 3 on the other. The information, what is on the card’s other side, therefore, may be consistent or inconsistent with the rule.

Whether information is searched for simultaneously as in Experiment 1, or sequentially as in Experiment 2 is expected to impact the effect of frame on information selection but not the impact of preference. According to the DHT model, preference should continue to exert pressure on the focal assessment throughout the information search and interpretation process. Therefore, Hypotheses 2a and 2b would be expected to hold with similar effect sizes to those found in the simultaneous information search conditions of Experiment 1. Preferences were manipulated as in Experiment 1 to create a Prefer-Action and Prefer-Inaction condition. The strength of frame-based PTS was measured by the number of release-consistent titles selected relative to the number of release-inconsistent titles selected.

Recall that release-consistent and -inconsistent titles pertain to actions or characteristics that are, respectively, expected or not expected if a release is immanent. Release-consistent titles are also frame-consistent, and preference-consistent in the Prefer-Action condition.

Hypothesis 2a Preference-based selection: *Frame-based PTS will be stronger for participants in the Prefer-Action compared to those in the Prefer-Inaction condition.*

Hypothesis 2b. *The degree of difference between the number of release-consistent and release-inconsistent titles selected should be positively related to the strength of the preference for action and negatively related to the strength of the preference for inaction.*

Experiment 2 expands on Experiment 1 by examining behaviour in a sequential information search condition in which participants are provided with the information contained under each title immediately after selecting it. Participants are also asked to make a final situation assessment and action decision. This allows for a test of confirmation outcomes. Traditionally, confirmation bias is where decisions are biased towards confirming the original focal decision option, as held at the very start of the investigation (see Chapter 1). Experiments 2, 3, and 4 test for confirmation of preference, and Experiments 3 and 4 test for confirmation of expectation.

Confirmation of preference is the tendency to confirm the preferred decision option. According to the DHT model, preference for a certain action should spread focus to the associated situation assessment making it the focal situation assessment. For example, participants who prefer to speed up release plans should focus more on the possibility of release. Participants who prefer to maintain release plans should focus more on impediments to early release. The focal situation assessment is predicted to influence information selection and interpretation such that the final situation assessment is swayed towards the situation assessment associated with the preferred action.

Hypothesis 3 Confirmation of Preference: *Participants will tend to confirm the situation assessment associated with the preferred action. Participants in the Prefer-Action condition will rate the probability of release higher than participants in the Prefer-Inaction condition.*

6.1. Methods

6.1.1. Participants

A total of 114 university students from a range of disciplines participated on campus and were paid AU$15 for one hour of their time. Of these participants, two cases had to be removed due a computer malfunction causing unreliable data, and one case was removed due to only spending 42 seconds on the information grid page, and not selecting any titles. Of the remaining 111 participants, 69% were female, 39% were in their first or second year of university, and 61% were in higher undergraduate or postgraduate years. Participants ranged from 18 to 54 years of age with an average age of 22.83 (SD = 6.64).

6.1.2. Design

Experiment design was the same as Experiment 1. Participants were randomly allocated to the same three conditions: Prefer-Inaction (n = 38), Prefer-Action (n = 35), and No-Preference (n = 38). The main difference was that sequential information search was required in that participants had to select a single title and were presented with the information contained before closing the information and selecting the next title. This is in contrast to Experiment 1 where participants selected all titles prior to ostensibly receiving the information (simultaneous information search).

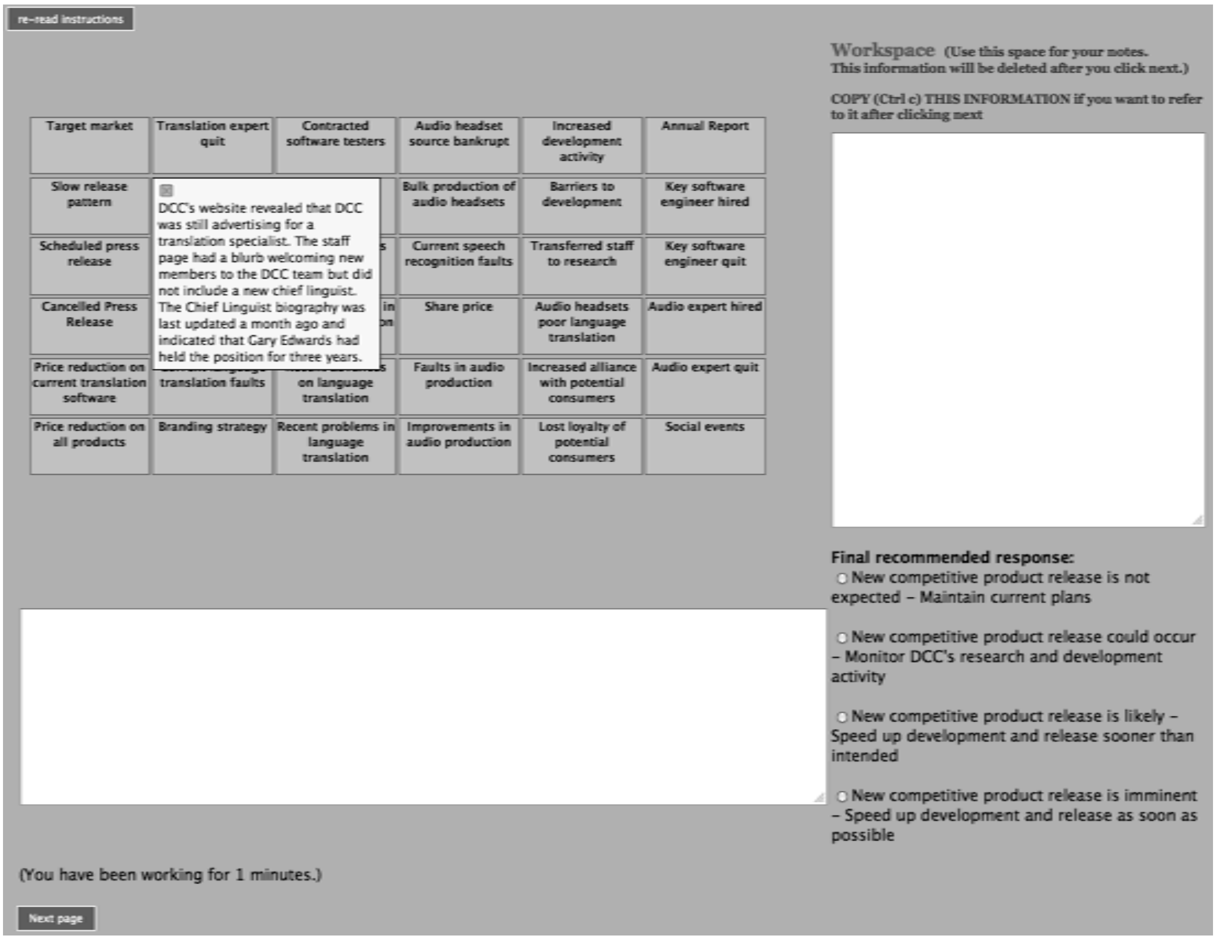
6.1.3. Apparatus and Materials

6.1.3.1. Scenario

The business scenario was identical to Experiment 1 and the same procedure was used to present the scenario, manipulations, and instructions.

6.1.3.2. *Information environment*

The information grid was the same as in Experiment 1. The only difference was that participants could click on cell titles to reveal 40 to 60 words of information on that action or characteristic (see Figure 5), within the ASP program (Analysis Simulation Project – SINTELLA, Wastell, Weeks, & Duncan, 2009; Weeks, Wastell, Taylor, Wearing, & Duncan, 2012). Each cell had to be closed prior to selecting the next title.



Note: Opened cell is titled "Translation expert hired"

Figure 5: Interactive information grid that allows participants to open and close cells.

When cells were opened, the content could indicate that the characteristic or action from the title was found for the rival organisation DCC (affirmatory), or not found for DCC (contradictory), or mixed (ambiguous). For example, the open cell in Figure 5, "Translation expert hired" could reveal evidence that a translation expert had not been hired (contradictory), as in Figure 5. Alternatively, it could reveal that a translation expert had been hired (affirmatory). There was no ambiguous version of this information. An example of ambiguous information was that the title “Price reduction on current translation software” yielded the following information: “Historically, just prior to new software updates, DCC discounts the old version by 20 to 50 percent depending on the magnitude and popularity of the update. However, at this time of year, they would also usually run a stocktake sale reducing all items by 10 to 30 percent. The current translation software has been discounted by 30%.”

Twelve of the fifteen release-consistent and release-inconsistent titles had affirmatory and contradictory versions of the content. The other three titles had only ambiguous content. Two independent coders, drawn from the same population as the participants, rated two different versions of the content as affirmatory, contradictory, or ambiguous. Kappa values ranged from good (.76) to very good (.85) with observed agreements ranging from 84 to 91%. Where coding did not match the intended implication, the content was discussed by the coders and altered accordingly.

Information grid display order and content were counterbalanced such that the top left title in Information Grid A corresponded to the bottom right title in Information Grid B, and titles with affirmatory results in Content A yielded contradictory results in Content B and visa versa to ensure that cell-selection results were not peculiar to display or content.

For any one participant, of the 15 release-consistent and 15 release-inconsistent titles available, 6 affirmed the presence of the indicated action or characteristic, 6 contradicted it, and 3 provided ambiguous information. Therefore, 6 of the release-consistent titles revealed release-consistent information (affirmatory), 6 revealed release-inconsistent information (contradictory), and 3 revealed ambiguous information. Similarly, 6 of the release-inconsistent titles revealed release-inconsistent information (affirmatory), 6 revealed release-consistent information (contradictory), and 3 revealed ambiguous information.

6.1.3.3. Self-report measures

Self-report measures were the same as in Experiment 2 with the following exceptions:

***Release probability*:** Once participants had made their choice they were presented with the following questions: "Given the information you just read...

1. How likely is it that the DCC is <u>planning</u> a competitive product release? Please enter a number between 0 and 100, where 0 = Impossible and 100 = Definite.

2. How likely is it that the DCC is <u>capable</u> of a competitive product release? Please enter a number between 0 and 100, where 0 = Impossible and 100 = Definite.

These two questions were separated because pilot tests showed that participants were hesitant to provide an estimate of intention in absence of capability because they felt they were both important. These measures were averaged to produce a *release probability* score with reasonable internal reliability (Cronbach's alpha = .65). High *release probability* scores indicate high perceived likelihood of a competitive release and low *release probability* scores indicate low perceived likelihood of a competitive release.

6.1.3.4. Behavioural measures

ASP (Analysis Simulation Project – SINTELLA, Wastell et al., 2009; Weeks et al., 2012) is a process tracing program (for a review see Kuhberger et al., 2010) that provides an interactive information grid and records a wide range of behavioural variables from the sequence of titles selected, to the number of repeat cell openings, to the time spent in cells. Only the behavioural measures of interest to hypotheses are detailed.

Selected titles, ***release-consistent titles***, and ***release-inconsistent titles*** were measured as in Experiment 1. Participants could select a single title multiple times in Experiment 2, but only the first selection was counted, thereby retaining consistency with Experiment 1 and traditional PTS tasks that do not allow repeat selection. The DHT model proposes that PTS and SE phenomena both occur due to the association between the focal decision option and titles. Therefore, the first selection is also of most theoretical interest in this case, because it represents information selection behaviour based on the interpretation of the title, not memory of the information content.

Action decision is the final decision made in regards to whether to maintain release plans (inaction), monitor the situation (inaction), or speed up plans to release sooner than intended (action), or ASAP (action).

6.1.4. Procedure

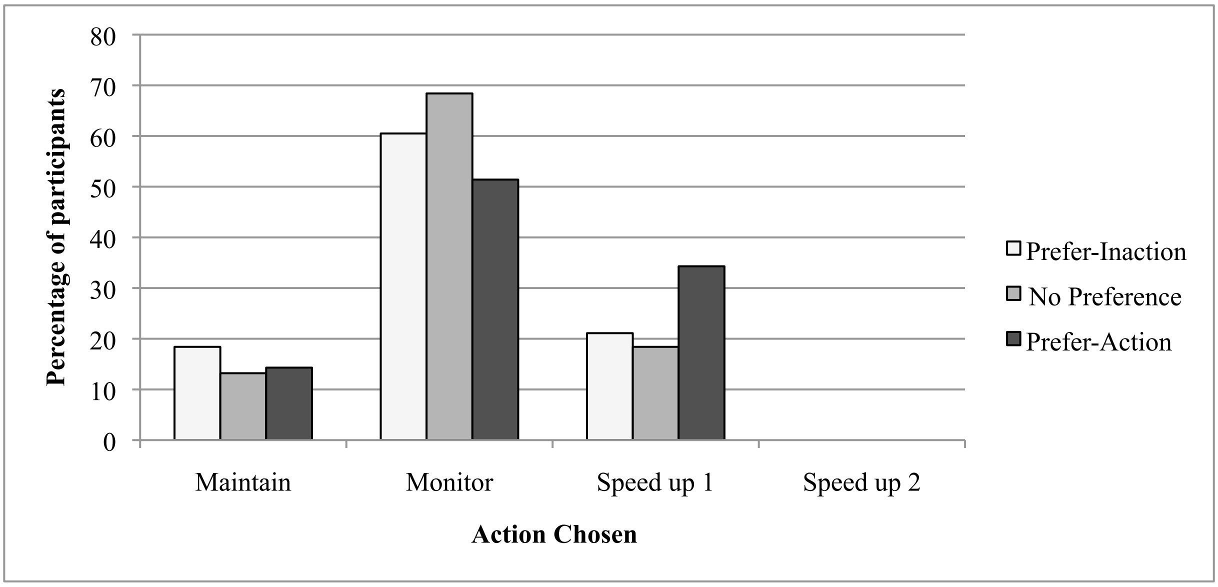
After arriving and signing the information consent form, participants were led through the same scenario and condition manipulation, manipulation check, and instructions on the nature of the content as described in Experiment 1. They were then provided with instructions on how to use the information database and told that they would have only five minutes to gather information on the DCC and decide on an action. Before beginning, they were given time (minimum 40 seconds) to examine the titles available and 'plan what information to examine'. They were then transferred to a final instruction page, which repeated the scenario and instructions on database use and that could be referred back to during the task. After clicking next, the 5-minute timer began and participants were presented with the interactive, six by six information grid. Participants could open any or all titles to read the information and had to select one of the four actions before continuing. Pop-up messages after four and five minutes respectively, told them when they had one minute left and asked them to choose and move on. After choosing an action, participants were asked to answer a series of task-related questionnaires, as described in Experiment 1, and individual difference questionnaires, as described in Appendix C.

6.2. Results

All dependent variables were examined for relationships with age and selected titles and for differences across gender, display order, and content. When statistically significant relationships were found, those variables were controlled for in all analyses involving that dependent variable. Assumptions of normality were met for all dependent variables used in parametric analyses.

6.2.1. Manipulation Checks

In addition to the preference condition manipulation check detailed in Chapter 5.4.1 and Appendix D, preference condition should impact action decisions such that more participants in the Prefer-Action condition should choose the action options of speeding up release plans than participants in the Prefer-Inaction condition. As shown in Figure 6, there is a small, but not statistically significant trend in the expected direction $\chi^2(4, N = 111) = 3.39$, $p = .495$. The majority of participants (60%) chose the second option: maintaining release plans while continuing to monitor DCC's behaviour (See Appendix D for a comparison across Experiments). Therefore, preference manipulations did not have a significant impact on final action decisions.



Note: No participants chose "Speed up 2".

Figure 6: The percentage of participants who chose each of the four actions did not differ significantly across the Prefer-Inaction (n = 28), No-Preference (n = 28), and Prefer-Action (n = 25) conditions.

In addition to the observed difference in title perception detailed in Chapter 5.4.1 and Appendix D, average title perception was greater, or more consistent with release, for participants who selected fewer titles.

6.2.2. Information Selection

Hypothesis 1, Frame-based PTS *will be greater in simultaneous information search compared to sequential information search conditions*

To test Hypothesis 1, a repeated measures GLM analysis was used to compare the number of release-consistent and release-inconsistent titles selected within participants across Experiments 1 and 2. Participant age was controlled for due to a significant relationship with release-inconsistent title selection. As predicted, participants in the simultaneous information search experiment demonstrated frame-based PTS in that they selected more release-consistent than release-inconsistent titles, but this difference disappeared in the sequential information search experiment, as evidenced in Figure 7. The difference between the differences was statistically significant Wilks' Lambda = 0.92, F (1,192) = 15.70, $p < .0005$ and explained 8% of the variance in title selection. Age was a statistically significant predictor of the difference between release-consistent and release-inconsistent title selection only in Experiment 1 as described in Chapter 5.4.2.

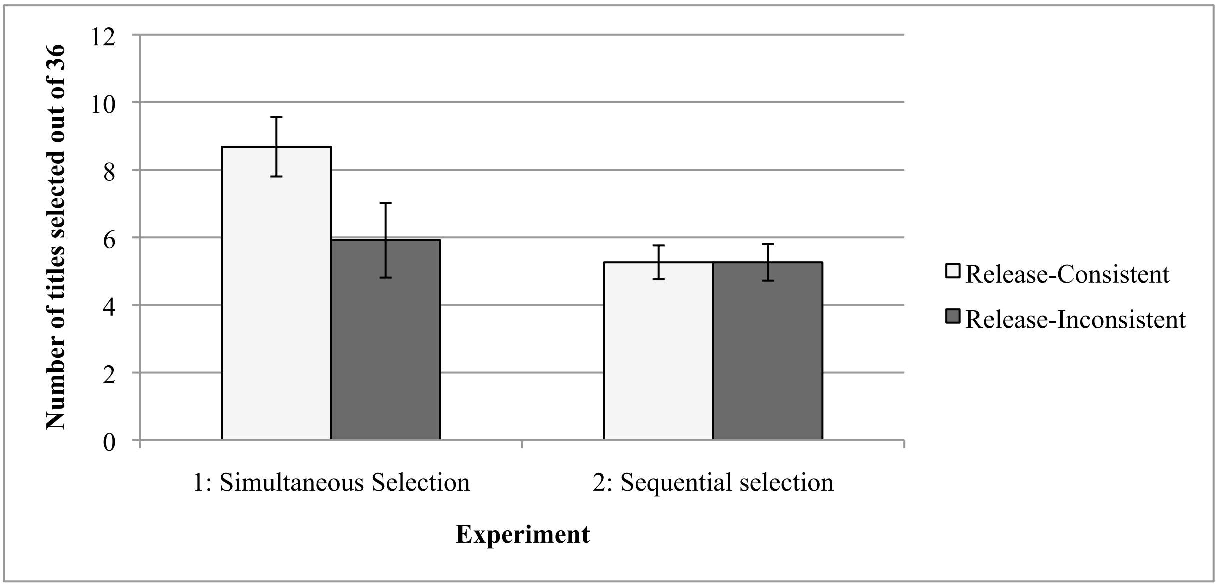


Figure 7: Participants selected more release-consistent than release-inconsistent titles in the simultaneous (N = 85) but not sequential (N = 111) information search experiment. Error bars represent 95% CI.

Hypothesis 2a Preference-based selection: *Participants will select more release-consistent than release-inconsistent titles in the Prefer-Action but not in the Prefer-Inaction condition.*

A repeated measures GLM analysis with release-consistent and release-inconsistent title selection as the within participants variable and preference condition as the between participants variable did not support Hypothesis 2a. Participants selected slightly more release-consistent than release-inconsistent titles in the Prefer-Action condition, whereas the opposite was true in the Prefer-Inaction condition. However, the effect of preference condition explained only 1% of the variance in title selection and was not statistically significant, Wilks' Lambda = 0.99, F (2,108) = 0.76, p = .472.

Hypothesis 2b. *The degree of difference between the number of release-consistent and release-inconsistent titles selected should be positively related to the strength of the preference for action and negatively related to the strength of the preference for inaction.*

A repeated measures GLM analysis with release-consistent and release-inconsistent title selection as the within participants variable and action attraction and inaction attraction as covariates partially supported Hypothesis 2b. The difference between release-consistent and release-inconsistent title selection was greater for participants with higher action attraction Wilks' Lambda = 0.94, F (1,108) = 7.45, p = .007, explaining 6% of the variance in title selection, but there was no effect of inaction attraction, which explained only 0.1% of the variance. For every 1 unit increase on the 7-point action attraction scale the number of release-consistent titles selected increased by 0.11, and the number of release-inconsistent titles selected decreased by 0.40. Therefore, the difference was again predominantly driven by a reduction in the number of release-inconsistent titles selected by participants with high action attraction.

6.2.3. Confirmation Outcomes

Hypothesis 3 Confirmation of Preference: *Participants will tend to confirm the situation assessment associated with the preferred action. Participants in the Prefer-Action condition will rate the probability of release higher than participants in the Prefer-Inaction condition.*

Differences in release probability between conditions were minimal. There is no evidence of confirmation of preference in this experiment.

6.3. Discussion

Hypothesis 1 was supported. PTS disappeared when information search was sequential, rather than simultaneous. According to the DHT model, this is because release-consistent titles sometimes revealed release-inconsistent information. This affected expectations such that a competitive product release was seen as less likely, which altered subsequent information selection. Consistent with this evidence, Klayman and Ha (1987) and Tweeney et al (1980) found that, when testing rules, participants would test alternative decision options using PTS, especially when their original decision option was refuted by the results.

There could be alternative explanations for the difference in PTS across simultaneous and sequential information search conditions. Firstly, it is possible that PTS disappeared because people misunderstood what kind of results the titles would reveal in Experiment 1, and when this became apparent in Experiment 2 they altered their strategy. Although content was counterbalanced, both content conditions provided affirmatory and contradictory results for release-consistent and –inconsistent titles. Participants may have expected all titles to yield affirmatory results. If this were the case, release-consistent titles would always be expected to yield release-consistent information and release-inconsistent titles would always be expected to yield release-inconsistent information. The results from Experiment 1 could, therefore, be interpreted as a preference for release-consistent information, which disappeared in Experiment 2 when participants found out that titles did not indicate release-implication. This seems unlikely given that the majority of participants in Experiment 1 acknowledged that release-consistent titles did not necessarily contain release-consistent information and those who did not were corrected prior to selecting information.

A second possibility is that participants selected fewer titles in Experiment 2, which resulted in lower levels of PTS. Perhaps the time constraint altered their approach or prevented them from selecting some titles that they otherwise would have investigated. However, further examination of the data refutes this possibility. The results from Experiments 1 and 2 suggest that participants who selected fewer titles displayed *more* PTS, not less. This effect was small but statistically significant and supports the DHT model's suggestion that frame-based PTS is weakened as more information is selected. Experiment 3 further tests the DHT prediction by manipulating expectations and removing the time limit.

Preference-based Hypotheses 2a and 3 were not supported. However, both Experiments 1 and 2 found that preference manipulations did affect attraction to action and inaction, and action attraction had a small, statistically significant relationship with PTS. It is possible that preference manipulations were just not strong enough to produce the predicted effects. This is likely given that manipulations intended to produce action preferences had no significant influence on the action chosen. There could be a number of reasons for the ineffectiveness of manipulations. Firstly, manipulations required participants to understand and engage with the imaginary role they were taking. There was no impact of their decision for them personally. This is altered in Experiments 3 and 4 by threatening pay reductions for costly incorrect decisions.

Secondly, the popularity of the second action, monitoring DCC's behaviour, was not anticipated. In hindsight, this effectively mitigates the risks of maintaining or speeding up release plans by allowing participants to avoid committing to either. This may explain why preference manipulations did not significantly impact action decisions. It also may have reduced the effects of preference by focusing individuals on the monitoring decision option, rather than maintaining or speeding up release plans. Experiments 3 and 4 include only two actions to choose from.

Finally, it was evident in Experiment 1 that preference manipulations produced an aversion to the potentially costly action, but not attraction to the other actions. Although there was some evidence of attraction to the least costly actions in Experiment 2, effect sizes were still greater for aversion to costly actions. Therefore, Experiments 3 and 4 include a statement about the minimal costs associated with the alternative action.

6.4. Summary of Results from Experiments 1 and 2

1. **Frame-based selection:** Participants display frame-based PTS, in that they select more frame-consistent than frame-inconsistent titles, under simultaneous but not sequential information search conditions.

2. **Preference-based selection and decisions:** There was no evidence that preference conditions influenced information selection or final decisions. However, given that trends were in the expected directions and preference manipulations had no significant effect on action, it is possible that preference manipulations were not strong enough to produce the expected effects.

7. Experiment 3: Effects of Preference and Expectation on Information Selection, Decision and Stopping Thresholds, and Final Decisions

Recall a central tenet of the DHT model is that the focal decision option, which attracted the most attention, is influenced by the problem context or frame and the individual's preferences and expectations. Frame, preference, and expectation may strengthen the same decision option, or opposing decision options, and the balance of these influences determines the focal decision option at that point in time. The focal decision option guides information search and interpretation.

Experiments 1 and 2 examined the impact of frame and preference on information selection under different information search conditions. Expectation was not examined in the first two experiments. Experiments 3 and 4 focus predominantly on the effects of expectation and preference and broaden the range of confirmation processes under examination.

7.1.1. Information Selection

In Experiments 1 and 2, there was no effect of preference on information selection, specifically on Positive Test Strategy (PTS). As explained in Chapter 6.3 there is reason to suspect that the preference manipulations were not strong enough. Preference manipulations are strengthened in Experiments 3 and 4. In Experiments 1 and 2 preferences were manipulated via a business scenario that would have no direct impact on the participants. Previous research on preference-based information selection has used manipulations where participants anticipate some personal impact of their decision, such as expecting to have to work with the student chosen (Ditto & Lopez, 1992). Personal impact in the form of performance and choice-based payment was implemented in Experiments 3 and 4. Preference-related hypotheses were retained as follows.

Hypothesis 1a Preference-based selection: *Participants will select more release-consistent than release-inconsistent titles in the Prefer-Action but not in the Prefer-Inaction condition.*

Hypothesis 1b. *The degree of difference between release-consistent and release-inconsistent titles selected should be positively related to the strength of the preference for action and negatively related to the strength of the preference for inaction.*

The DHT model predicts that frame, preference, and expectation have different patterns of influence on the focal decision option throughout an investigation. The impact of frame is predicted to weaken rapidly as information is accumulated. There is evidence of this from Experiments 1 and 2, where the impact of frame on information selection disappeared under sequential search conditions. Preference is predicted to have a consistent strength of influence throughout investigation because, in this case, the information does not directly pertain to the costs and benefits of different actions. In contrast, the strength and impact of expectation is predicted to increase throughout the investigation as new information, relevant to the expected situation, is received and integrated. Therefore, throughout an investigation pertaining to the likelihood of a situation, the focal decision option is expected to reflect a weakening influence of frame, a relatively consistent influence of preference, and an increasing influence of expectation.

Take the example of the market analyst. The information frame received is that “the rival company, DCC, will release a competitive product in the next 6 months”. At this point, the focal decision option is the framed decision option, that DCC will release a competitive product within 6 months. The market analyst selects frame-consistent titles, such as “Increased development activity”, and “Translation expert hired”. The information is frame-inconsistent, there is no evidence of increased development activity and it appears that a translation expert has not been hired. The market analyst begins to expect that there will be no competitive release. The decision option of no competitive release is activated and may become the focus of attention. The market analyst then begins to attend to frame-inconsistent, but expectation-consistent, titles such as “Recent problems in speech recognition” and “Barriers to development”. If the market analyst has a preference to act on the threat of a competitive release, this would constantly redirect attention towards the possibility of release thus, to some degree, counteracting the effect of expectation in this case.

Experiments 1 and 2 found that the problem frame influenced information selection, specifically Positive Test Strategy (PTS), in simultaneous but not sequential information search conditions. This difference was observed in displays of identical titles. The DHT theory predicted this because the effect of frame on the focal decision option and, therefore, information selection, was expected to weaken as more information was received in the sequential information search task. At the same time the participant’s expectation was predicted to exert increasing influence over the focal decision option. Given that frame-consistent titles may yield frame-inconsistent information, the expected decision option could easily be opposed to the framed decision option.

The DHT model predicts that as expectation strengthens, more attention is given to the expected decision option, and titles consistent with this decision option are more likely to be selected. Evidence that expectation influences information selection comes from a range of empirical approaches. Firstly, research in pseudo-diagnosticity has demonstrated that participants tend to switch attention to the most likely alternative. Recall that, in PD paradigms, participants are presented with information on Decision Option A, Attribute 1, and choose to look at information on Decision Option A, Attribute 2, or Decision Option B Attribute 1 or Attribute 2. Evans et al. (2002) and Mynatt et al. (1993) found that, when the initial information provided low support for Decision Option A, participants were more likely to select information on Decision option B (Evans et al., 2002; Mynatt et al., 1993). These results suggest that attention to a decision option is retained only for as long as that option is considered plausible or probable.

Secondly, research in selective exposure has suggested that expectation can drive the selection of expectation-consistent titles. Jonas et al. (2001) propose the ‘decision focus hypothesis’. The decision focus hypothesis states that one’s prior decision is compared to each new title when assessing whether or not to select that title. The repeated recollection of one’s prior decision increases commitment to that decision and, thereby, increases the selection of information consistent with it. As defined by the DHT model, the expected decision option is the decision option that one thinks is true or expects to make. As long as commitment to a prior decision is retained or strengthened, the prior decision would also be the expected decision option. Therefore, selective exposure to information consistent with one’s prior decision can be likened to selection of expectation-consistent information.

Finally, there is evidence from research on criminal trials. For example, Rassin et al. (2010) found that, in a criminal investigation, additional information search was guided by the participants’ stated decision leaning and the strength of incriminating evidence provided, both of which would be expected to determine the expected decision option. Further, participants select more potentially incriminating investigations, and fewer neutral lines of investigation when they were led to expect that the suspect was guilty, than when led to expect that the suspect was not guilty (Kassin, Goldstein, & Savitsky, 2003). Finally, when participants were asked to name a potential suspect and list reasons for suspicion, they selected more lines of investigation focused on that suspect than participants who were not asked to name a suspect (O'Brien, 2009). Asking participants to list reasons for suspicion is likely to increase expectation that the named suspect is guilty. Accordingly, when participants were also asked to provide reasons why that suspect might not be guilty, the bias towards suspect-focused lines of investigation diminished (O'Brien, 2009).

Previous research from pseudo-diagnostic, selective exposure, and criminal cases has demonstrated expectation-based information selection, but usually in preference-neutral cases, or when preference is confounded with expectation. Experiments 3 and 4 expand on this research base by independently manipulating preference and expectation. To investigate the effect of expectation on PTS predicted by the DHT model, Experiments 3 and 4 include three information conditions. In the No-Release information condition, the content available indicates that a competitive release is unlikely. The Mixed information condition provides the same balanced information as in Experiment 2. In the Release information condition, the content available indicates that a competitive release is likely. Expectation is predicted to favour release and the selection of release-consistent titles in the Release information condition, but no release and the selection of release-inconsistent titles in the No-Release information condition.

Hypothesis 2 Expectation-based selection: *Participants will select more release-consistent than release-inconsistent titles in the Release but not in the No-Release information condition.*

Experiments 3 and 4 expand on Experiments 1 and 2 by examining decision thresholds and stopping thresholds in addition to information selection.

7.1.2. Decision Thresholds

The decision threshold refers to the level of certainty in a situation assessment at which participants switch from one action or decision to another. For a pilot, this is the certainty of a severe storm ahead sufficient to prompt a diversion. For a homebuyer, the decision threshold is the certainty that the property market will gain in value required to commit to buying a home. For the market analyst, the decision threshold is the certainty of a competitive release required to recommend speeding up release plans. In all of these cases certainty in the situation assessment informs whether action is taken or not.

The DHT model proposes that decision thresholds can be derived from the relative activation of the competing action decision options. Higher benefits and lower costs of action relative to inaction produce greater activation of the action decision option than the inaction decision option. To choose inaction despite a strong preference for action, the situation assessment would have to counteract the action preference with a strong expectation of no threat, or in this case, no competitive release. Therefore, the DHT model predicts that participants who prefer action will have lower decision thresholds, that is they will choose action over inaction at lower levels of certainty in a competitive release, than participants who prefer inaction. This is consistent with numerous theories from economic and statistical fields that attempt to predict the location of decision thresholds based on the costs, benefits, and probabilities of different outcomes as detailed in Chapter 3.1.

Hypothesis 3 Decision Threshold: *When asked what actions they would take at different levels of release probability, participants in the Prefer-Action condition will switch from maintaining release plans to speeding up release plans at lower levels of release probability than participants in the Prefer-Inaction condition.*

7.1.3. Stopping Threshold

Whereas the decision threshold determines the point at which an individual will switch from one action to another, stopping thresholds determine when an individual will choose to stop seeking further information. In many situations, there is no specific point at which one must stop seeking information. For example, there is no easily identifiable stopping point at which the pilot must decide to maintain course or divert. Homebuyers have to choose, at some point, to stop viewing houses and commit to one. Different homebuyers may view a few, tens, or even hundreds of houses before making this decision. More quantity and quality of information and more time is required to satisfy high compared to low stopping thresholds.

The DHT model proposes that decision thresholds and stopping thresholds are interdependent. Decision thresholds are based on the relative activation of opposing action decision options. For example, the market analyst might consider the costs of defensive action, speeding up release plans, to be extremely high and the relative costs and benefits of inaction much more attractive. This would create a high decision threshold. For this market analyst to choose to speed up release plans, the action-supportive situation assessment would have to be much stronger than the inaction-supportive situation assessment to counteract the strong action preference. Therefore, when action is chosen despite a high decision threshold, it implies more conflict between decision options, than when inaction is chosen with a high decision threshold. Conversely, when inaction is chosen despite a low decision threshold, it implies more conflict between decision options, than when action is chosen with a low decision threshold.

According to the DHT model, stopping thresholds require optimal differentiation between decision options within individual, situation, and informational constraints. Therefore, all other constraints being equal, participants should spend longer trying to differentiate options in high conflict situations, such as taking action with a high decision threshold or inaction with a low decision threshold, than in low conflict situations, such as choosing inaction with a high decision threshold or action with a low decision threshold.

Hypothesis 4 Stopping threshold: *The total number of titles opened and time spent on the task will be positively correlated with the decision threshold for participants choosing action, but negatively correlated with the decision threshold for participants choosing inaction.*

This is consistent with theories that combine decision and stopping thresholds (Busemeyer & Townsend, 1993; Pleskac & Busemeyer, 2010; Ratcliff & McKoon, 2007; Trope & Liberman, 1996) and the finding that participants who reach personally threatening or undesirable conclusions require more, better quality information and more decision-time than participants who reach more desirable, less threatening conclusions (Ditto & Lopez, 1992). The DHT model also extends these predictions by suggesting a weaker link between decision and stopping thresholds than theories that combine the two. The incorporation of constraints on option differentiation acknowledges that other individual, situational, and informational factors may influence the amount of information or time taken to make a decision. In addition, many of these constraints, such as fatigue, and availability of new information are likely to change throughout an investigation.

7.1.4. Final Decision

The absence of statistically significant confirmation of preference in Experiment 2 may be due to inadequate strength of preference manipulations. Confirmation of preference is therefore re-examined with stronger manipulations. If confirmation of preference is observed, participants in the Prefer-Action condition should rate the probability of release higher than participants in the Prefer-Inaction conditions because higher release probabilities support action, whereas lower release probabilities support inaction.

Hypothesis 5 Confirmation of Preference: *Participants will tend to confirm the preferred situation assessment. Participants in the Prefer-Action condition will rate the probability of release higher than participants in the Prefer-Inaction condition.*

7.2. Methods

7.2.1. Participants

A total of 120 university students from a range of disciplines participated and were paid AU$15 for one hour of their time. Of these participants, 4 cases were removed because they were suspicious of the manipulation, 3 cases were removed because they selected no titles, and 2 cases were removed because they did not complete the experiment. Of the remaining 111 participants 78% were female, 50% were in their first or second year of university, 50% were in higher undergraduate or postgraduate years, 72% participated on campus, the other 28% participated online. Participants ranged from 18 to 68 years of age with an average age of 22.06 (*SD* = 7.08). On campus and online participants were recruited in the same way, and no significant differences were found between modes of participation.

7.2.2. Design

Participants were randomly allocated to one of six conditions in a 2 preference condition (Prefer-Inaction, Prefer-Action) by 3 information condition (No-Release, Mixed, Release) design resulting in 17 to 20 participants per condition. Otherwise, the design was the same as described in Chapters 5.3.2 and 6.1.2. The three information conditions were designed to manipulate expectation via the information available as summarised in Table 12 and detailed in Table 13.

Table 12: The Conclusion Supported by the Information Available in Manipulated Information Conditions

Condition	Supported situation assessment	Expectation-Consistent Titles
No-Release	No competitive release	Release-inconsistent
Mixed	Balanced (As per Experiment 2)	Baseline
Release	Competitive release	Release-consistent

7.2.3. Apparatus and Measures

7.2.3.1. Scenario

The business scenario was identical to Experiment 2 with the following exceptions:

1. A timeframe was placed on the competitive release by adding the phrase in italics "Your company is developing real-time translation software *to be released 6 months from now*."

2. Possible actions were limited to two possibilities, rather than four: “Maintain current plans” or “Speed up development to release sooner than intended”.
3. An indication of base rate was provided as follows: “You have been asked to examine cases of potential product competition 10 times before. Of those 10 cases, 5 were preparing a competitive product release and 5 were not.”

These changes were incorporated to 1) make the scenario more specific, 2) remove the indecisive option that allowed participants to delay judgement, and 3) to standardise participants’ initial expectation of release.

Preference conditions were the same as in Experiments 1 and 2, except that the preference-inducing blurb was strengthened in the following ways:

1. The cost of the preferred action was discounted by adding the following sentence for the Prefer-Action and *Prefer-Inaction* preference conditions: “You are also aware that speeding up release plans / *maintaining current release plans* would be relatively easy, with minimal cost or risk to the product or organisation.”
2. Participants were led to believe that payment was contingent on performance by adding the following instructions for the Prefer-Action and *Prefer-Inaction* conditions: “Your pay is contingent on your performance. If you make the correct decision you receive the full $15:
    - Maintain current release plans when DCC won’t release within 6 months OR
    - Speed up release plans when DCC will release within 6 months

   If you make an incorrect decision, your pay will be docked in accordance with the consequences:

- If you incorrectly maintain current plans you will lose $<u>10</u> / *1* of your pay
- If you incorrectly speed up release plans you will lose $<u>1</u> / *10* of your pay"

3. Questions were included to check that participants understood the financial outcomes of different decisions. Misunderstandings were corrected if necessary. After the experiment, a suspicion/memory check was included to assess whether participants expected to get their pay docked. For ethical reasons, all participants were actually paid $15.

7.2.3.2. Information environment

The information environment was manipulated to create Release, No-Release and a replication of Experiment 2's Mixed information conditions. As shown in Table 13, the Release information condition had more release-consistent than release-inconsistent information items, the No-Release information condition had more release-inconsistent than release-consistent information items, and the Mixed condition had the same number of release-consistent and release-inconsistent information items.

In the Release condition, 12 release-consistent titles yielded affirmatory (release-consistent) information and 3 yielded ambiguous information, thus implying a new competitive release. Release-inconsistent titles yielded the same mixed results as in Experiment 2 (6 affirmatory, 6 contradictory, 3 ambiguous). In the No-Release condition, 12 release-inconsistent titles yielded affirmatory (release-inconsistent) results and 3 yielded ambiguous results, thus implying no new competitive release. Release-consistent titles yielded the same mixed results as in Experiment 2 (6 affirmatory, 6 contradictory, 3 ambiguous).

Table 13: Amount of each Type of Information Available in Manipulated Information Conditions

Information Condition	Number of *Information* Items Available		
	Release-Consistent	Release-Inconsistent	Ambiguous
No-Release	6	18	12
Mixed	12	12	12
Release	18	6	12

Note: Table refers to *information* type not *title* type

Reviewers commented that related titles such as “Translation expert quit” and “Translation expert hired” might be seen to contain overlapping information, thereby negating the need to open both. The content is actually designed such that each title provides independent information. For example, by opening both titles, one may find that a translation expert quit and was replaced, or that an additional translation expert was hired. Additional instructions were included to ensure that this was clear as follows: “Titles often refer to different people. For example, if one title is ‘Manager on leave’ and another is ‘Manager at work’, they probably refer to different managers to avoid overlap.” An additional true-false question checked understanding by stating, “Titles that appear to be opposite do not actually contain overlapping information”. If participants answered ‘False’ they were corrected with the following statement: “Your answer to question 4 was incorrect. Information within titles should *not* overlap even if they seem to refer to the same action or characteristic.”

7.2.3.3. Self-report measures

All measures were the same as in Experiment 2 with the following exceptions: ***Release probability*** was measured using a single prediction, instead of separate assessments of the competitor's plan and capability: "How likely is it that DCC will release a competitive new release within 6 months? Please enter a number between 0 and 100, where 0 = Impossible and 100 = Definite." *Release probability* was also measured at two time points, after reading the scenario but before the investigation (*initial release probability*), and after the investigation was complete and final action was made (*release probability* or *final release probability*).

Decision threshold was determined after the investigation had been completed by asking participants whether they would maintain or speed up release plans at various probabilities of release, in 10% increments from 0% chance (No chance that DCC will release a competitive product within 6 months) to 100%. The responses were analysed to identify the probability at which each participant switched from maintaining release plans to speeding release plans. The *decision threshold* was defined as half way between the last probability at which participants chose to maintain release plans and the first probability at which participants chose to speed up release plans. For example, a participant who chose to maintain release plans from probability 0 to 50, and chose to speed up release plans from 60 to 100, was given a *decision threshold* of 55.

Action attraction and ***inaction attraction*** were measured as in Experiments 1 and 2, with one minor difference. Experiments 1 and 2 had four possible actions whereas Experiments 3 and 4 have only two. Therefore, in Experiments 3 and 4, *action attraction* and *inaction attraction* are based on feeling and attraction towards a single option: speeding up release plans and maintain release plans respectively. Internal consistency was still high for both *action attraction* (Cronbach's alpha for Experiment 3 = .85 and Experiment 4 = .91) and *inaction attraction* (Cronbach's alpha for Experiment 3 = .91 and Experiment 4 = .90).

7.2.3.4. Behavioural measures

Total titles selected refers to the total number of titles selected including repeat selections. Therefore, whereas *selected titles* has a maximum of 36 in a 6 by 6 information grid, *total titles selected* has no theoretical upper limit. *Total titles selected* is considered a good measure of stopping thresholds because it indicates how much information, including repeat consideration, participants seek before stopping the information search and making a final decision.

Investigation time refers to the amount of time, in minutes, spent on the information grid page. This is also considered a good measure of stopping thresholds because it indicates how long participants spent seeking and considering information before making a final decision.

Action decision refers to whether participants chose to maintain (inaction) or speed up (action) release plans at the end of the investigation task.

7.2.4. Procedure

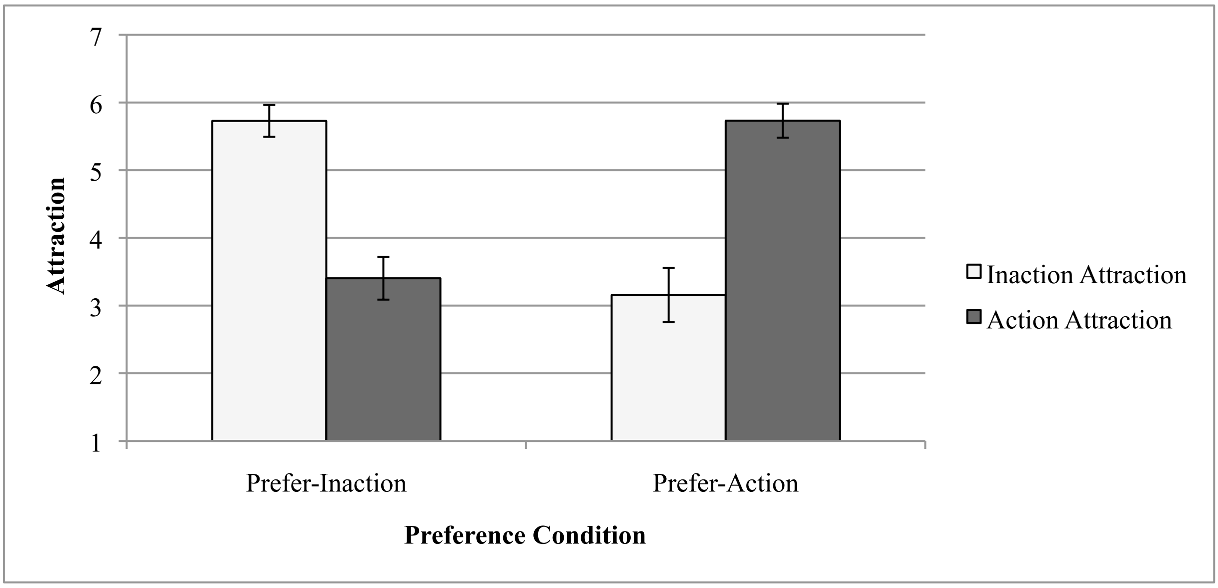
The same procedure as in Experiment 2 was used to present the scenario, manipulations, and instructions. Participants were randomly allocated to one of the six conditions.

7.3. Results

All of the dependent variables were examined for relationships with age and selected titles and for differences across gender, and information condition where applicable. When statistically significant relationships were found, those variables were controlled for in all analyses involving that dependent variable. Assumptions of normality were checked for all dependent variables used in parametric analyses. Normality assumptions were not met for investigation time. Analyses using investigation time as the dependent variable were re-run using a normal, log-transformation of the original variable. The significance and size of effects did not differ using the normal transformation. Therefore, statistics for the raw dependent variable are reported.

7.3.1. Manipulation Checks

The effect of preference condition on action and inaction attraction was large in Experiment 3, as shown in Figure 8. The effect was substantially larger in Experiment 3 compared to previous experiments. The difference between the Prefer-Action and Prefer-Inaction condition explained 54% of the variance in action attraction compared to 23% and 27% in previous experiments and 53% of the variance in inaction attraction compared to 6% and 13% in previous experiments (see Appendix D for details).

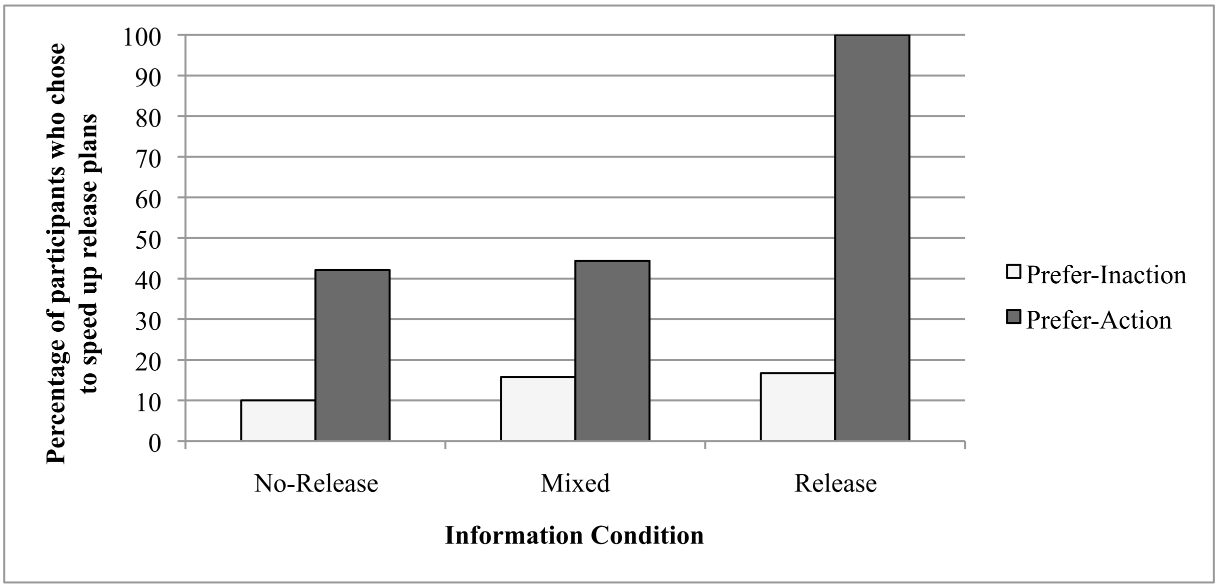


Note: A score of 4 is the midpoint of the 1 to 7 attraction scale.

Figure 8: Participants in the Prefer-Inaction (n = 57) condition reported much greater attraction to inaction than action. The reverse was true of participants in the Prefer-Action (n = 54) condition. Error bars represent 95% CI.

In addition to the observed difference in title perception detailed in Chapter 5.4.1 and Appendix D, average title perception was greater, or more consistent with release, for participants in the Release information condition, compared to the Mixed and No-Release information conditions, participants who selected fewer titles, and younger participants.

The impact of preference condition on action decision was much greater in Experiment 3 compared to Experiment 2, as shown in Appendix D. Of participants in the Prefer-Action condition, 61% chose action compared to only 14% in the Prefer-Inaction condition, as shown in Figure 9, $\chi^2(1, N = 111) = 26.38, p < .0005$. Information manipulations also impacted action decisions such that more participants in the Release condition chose action over inaction than participants in the Mixed or No-Release conditions, as shown in Figure 9 $\chi^2(2, N = 111) = 9.10, p = .006$ and detailed in Appendix D.



Note: The participants who chose inaction are not displayed. All participants chose either action or inaction.

Figure 9: The percentage of participants who chose action over inaction was greater for participants in the Release information condition compared to other information conditions, and for participants in the Prefer-Action condition compared to the Prefer-Inaction condition (n = 17-20 in each of the 6 conditions).

A fourth manipulation check was added in Experiments 3 and 4 examining whether information condition effectively manipulated the perceived probability of release. To check the effectiveness of these conditions, a univariate GLM was conducted comparing release probability across the three information conditions. Manipulations were effective. The average probability of release in the Release condition was 69.09 (SD = 15.83), in the Mixed condition was 56.08 (*SD* = 21.57), and in the No-Release information condition was 41.21 (*SD* = 21.21), F (2,108) = 18.37, $p < .0005$. Information condition explained 25% of the variance in release probability, and release probability was significantly different across all pair wise comparisons.

7.3.2. Information Selection

Hypothesis 1a Preference-based selection: *Participants will select more release-consistent than release-inconsistent titles in the Prefer-Action but not in the Prefer-Inaction condition.*

Hypothesis 2 Expectation-based selection: *Participants will select more release-consistent than release-inconsistent titles in the Release but not in the No-Release information condition.*

Hypotheses 1a and 2 were tested using a repeated measures GLM analysis with release-consistent and release-inconsistent title selection as the within participants variable, and preference and information condition as the between participants variable. Neither hypothesis was supported. Preference condition explained only 0.4% of title selection, and information condition explained only 2% of the variance. Trends were in the expected direction for information condition but not preference condition.

Hypothesis 1b. *The degree of difference between release-consistent and release-inconsistent titles selected should be positively related to the strength of the preference for action and negatively related to the strength of the preference for inaction.*

Hypothesis 1b was not supported. A repeated measures GLM analysis with release-consistent and release-inconsistent title selection as the within participants variable and action attraction and inaction attraction as covariates controlling for information condition showed no effect of action attraction or inaction attraction on title selection.

7.3.3. Decision Thresholds

Hypothesis 3 Decision Threshold: *When asked what actions they would take at different levels of release probability, participants in the Prefer-Action condition will switch from maintaining release plans to speeding up release plans at lower levels of release probability than participants in the Prefer-Inaction condition.*

A decision threshold could not be defined for 13 participants. One participant switched from maintaining to speeding up and back again across multiple consecutive probabilities, 5 participants had the actions backwards such that they recommended speeding up release plans at low probabilities of release and maintaining release plans at high probabilities of release, and 7 had too much missing data to define a decision threshold. Participants with and without decision threshold data did not differ significantly on final release probability and were fairly evenly spread across the three information and two preference conditions.

A univariate GLM was used to examine the impact of preference condition on decision threshold controlling for release probability and information condition. Hypothesis 3 was supported. On average, participants in the Prefer-Action condition said they would switch to taking action at lower probability of release ($M = 35.10$, $SD = 17.81$, $n = 49$) than participants in the Prefer-Inaction condition ($M = 77.55$, $SD = 18.63$, $n = 49$), $F(1,95) = 118.96$, $p < .0005$, explaining 56% of the variance in decision threshold. The majority (89%) of participants made an action decision consistent with their decision threshold given the final release probability they provided.

7.3.4. Stopping Threshold

Hypothesis 4 Stopping threshold: *The total number of titles opened and time spent on the task will be positively correlated with the decision threshold for participants choosing* *action, but negatively correlated with the decision threshold for participants choosing inaction.*

Hypothesis 4 was tested using two separate univariate GLM analyses regressing total titles selected and investigation time on decision threshold, action decision, and the interaction of interest, decision threshold by action decision, controlling for information condition. Hypothesis 4 was not supported, correlations were in the predicted direction, but the interaction between decision threshold and action decision was not a statistically significant predictor and explained only 0.8% and 0.4% of the variance in total titles selected and investigation time respectively.

7.3.5. Confirmation Outcomes

Hypothesis 5, Confirmation of Preference: *Participants will tend to confirm the preferred situation assessment. Participants in the Prefer-Action condition will rate the probability of release higher than participants in the Prefer-Inaction condition.*

Hypothesis 6 was confirmed. A GLM examining the effects of preference condition on final release probability controlling for information condition and initial release probability was used. On average, participants in the Prefer-Action condition gave higher final release probability predictions (M = 59.04, SD = 23.03) than participants in the Prefer-Inaction condition (M = 51.09, SD = 21.92) F (1,106) = 5.21, p = .024. Preference condition explained 5% of the variance in final release probability, information condition explained 29% of the variance, and initial release probability explained 8% of the variance.

7.4. Discussion

With stronger preference manipulations, there was some evidence of confirmation bias outcomes. Participants made situation assessments that were biased towards their preferred action. Therefore, confirmation of preference was observed in this experiment, but not in Experiment 2. Compared to Experiment 2, Experiment 3 incorporated stronger preference manipulations, but also asked participants for an initial situation assessment, prior to receiving any information. Previous research has found that just requesting a decision leaning can bias decisions towards that initial decision compared to conditions where a decision leaning is not requested (O'Brien, 2009). The initial situation assessment did explain more variance in the final situation assessment than preference condition. However, preference explained a statistically significant proportion of the variance in final situation assessment over and above the variance explained by the initial situation assessment. This expands on observations from coherence shift paradigms where one's decision leaning influences attitudes and interpretation of facts, which inform the subsequent decision leaning (e.g. Holyoak & Simon, 1999; Simon, Snow, et al., 2004). In this case, action preference manipulations, in addition to the original decision leaning, influenced the final situation assessment.

The results from Experiment 3 indicate that confirmation of preference can occur, even when the preference applies to an action that is only indirectly associated with final judgement, in this case the final situation assessment. This is important because situation assessments are often used to guide action decisions, such as when a homebuyer decides to buy based on an assessment that the housing market is trending up, or when a market analyst decides to recommend defensive action based on an assessment that competition is high. If action preferences also influence situation assessments, this could bias decisions.

The impact of action preference manipulations on final situation assessments cannot be explained by information selection, decision thresholds, or stopping thresholds. Action preference did not influence information selection. Action preference had a strong influence over decision thresholds but decision thresholds were not related to situation assessments. Therefore, there is no evidence that stopping thresholds contributed to confirmation bias outcomes. Experiment 4 tests whether this confirmation outcome can be replicated and whether it can be explained by influences of preference on information interpretation.

Action preference influenced both situation assessments and decision thresholds. Preference for action decreased decision thresholds and increased situation assessments relative to preference for inaction. Assuming that actions are chosen based on the strength of the situation assessment compared to the decision threshold, this would have biased actions towards the preferred action more than if action preference influenced only the decision threshold.

The lack of association between decision and stopping thresholds contradicts theories in which decision and stopping thresholds are combined (Busemeyer & Townsend, 1993; Pleskac & Busemeyer, 2010; Ratcliff & McKoon, 2007; Trope & Liberman, 1996). The DHT model proposes that, rather than being the same, decision and stopping thresholds are interrelated. Decision thresholds indicate which action is most strongly favoured. High thresholds favour inaction and low thresholds favour action. Stopping thresholds are based on option differentiation within situational, individual, and informational constraints. If one chooses action, the higher the decision threshold, the more conflict is implied between situation assessment and inaction preference. Conversely, if one chooses inaction, the lower the decision threshold, the more conflict is implied between situation assessment and action preference. Greater decision option conflict should drive more time and effort in information search within constraints on option differentiation, according to the DHT model. This pattern was observed but was not statistically significant. One potential option differentiation constraint is the ambiguity of information available. If individuals experience minimal or no gains in differentiation between decision options with each additional item of information, the advantages of further information search on option differentiation is constrained. Given that all conditions included conflicting information, it is possible that this ambiguity constraint reduced observable differences in information search efforts. This issue is addressed in Experiment 4.

Expectation manipulations also had strong effects on final action decision and situation assessments. This suggests that participants do base their actions and situation assessments on the information received. What cannot be determined from this experiment is whether the effect of the information condition on final situation assessments was exaggerated by the growing expectation of release in the Release condition or no release in the No-Release condition as predicted by the DHT model. This possibility is explored in Experiment 4. Experiment 4 attempts to replicate the results found here, and to provide a more comprehensive test of the DHT model.

7.5. Summary of Results from Experiment 3

Preference-based processes: Action preferences influenced decision thresholds, final situation assessments (release probability), and actions, but not information selection. Experiment 4 described in Chapter 8 examines whether the impact of preference on final situation assessments is mediated by information interpretation.

Expectation-based processes: Expectation was manipulated via the information provided in the information grids. Information condition influenced final situation assessments, and actions, but not information selection. This experiment cannot determine whether situation assessments were exaggerated by expectation or not. This possibility is explored in Chapter 8.

8. Experiment 4: Effects of Preference and Expectation on Information Selection and Interpretation, Decision and Stopping Thresholds, and Final Decisions

Experiment 4 provides an examination of the DHT model first introduced in Chapter 4. As shown in Figure 10, the original DHT Model proposes that preference, expectation, and frame influence the problem representation by activating different decision elements such as actions and situation assessments. The decision element that is most heavily activated becomes the focal decision option and influences information selection and interpretation. Information interpretation feeds back into the problem representation. When the difference between competing decision options is maximised within individual, situational, and informational constraints, information search stops and a decision is made. Experiment 4 focuses on the influence of preference and expectation on the focal decision option, the subsequent effect of the focal decision option on information selection and interpretation, and the effect of these processes on decision and stopping thresholds, and situation assessments.

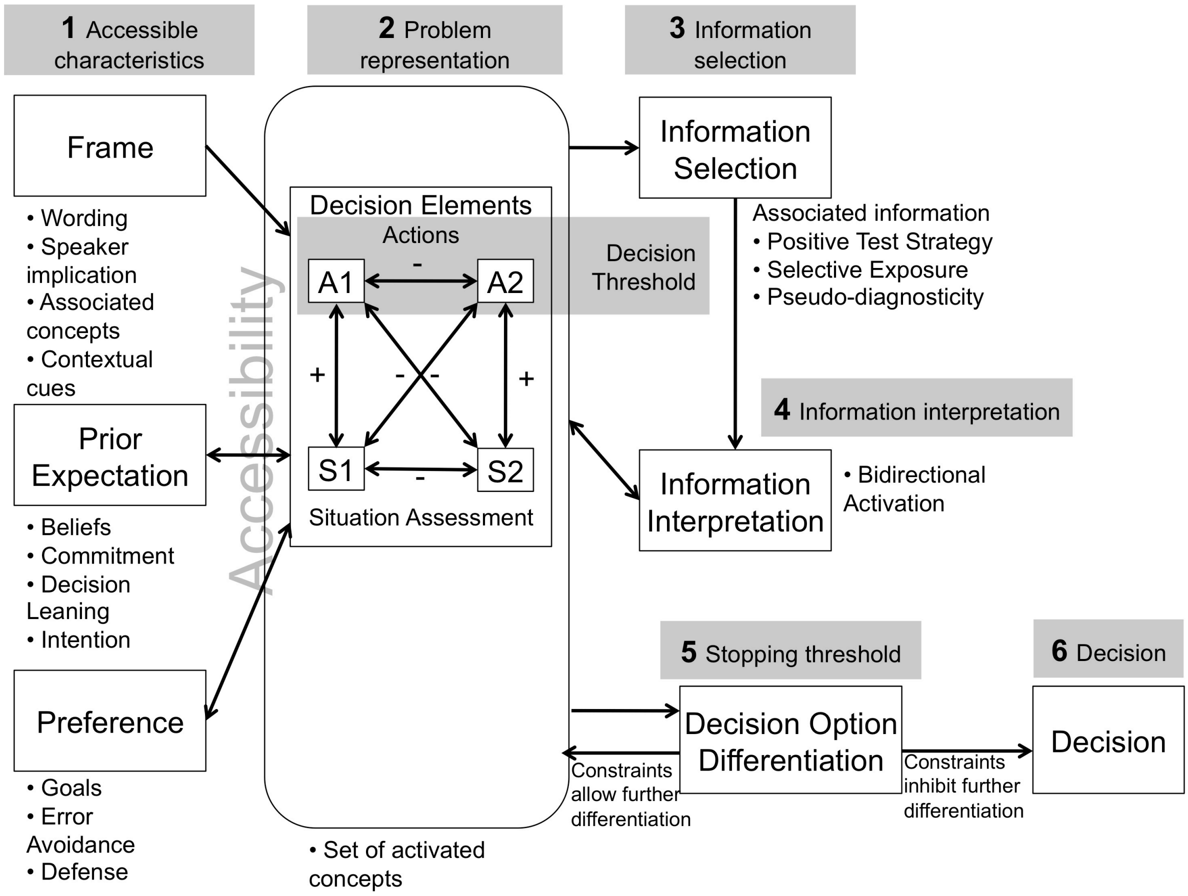


Figure 10: The original DHT model.

As shown in Figure 11, the original DHT model can be operationalised for the market analyst scenario from Experiments 1 to 3. Preference and information conditions represent the 'accessible characteristics' of preference and expectation respectively, as described in Chapter 4 and indicated by the number 1 in Figures 10 and 11. As in Experiment 3, preference is accessible immediately because it is introduced during the problem description, whereas expectation evolves over time because it is manipulated via the information received. Frame is not examined because the DHT model predicts that its effects are reduced by further information and, therefore, limited in ongoing investigations, as supported by results reported in Chapter 6.

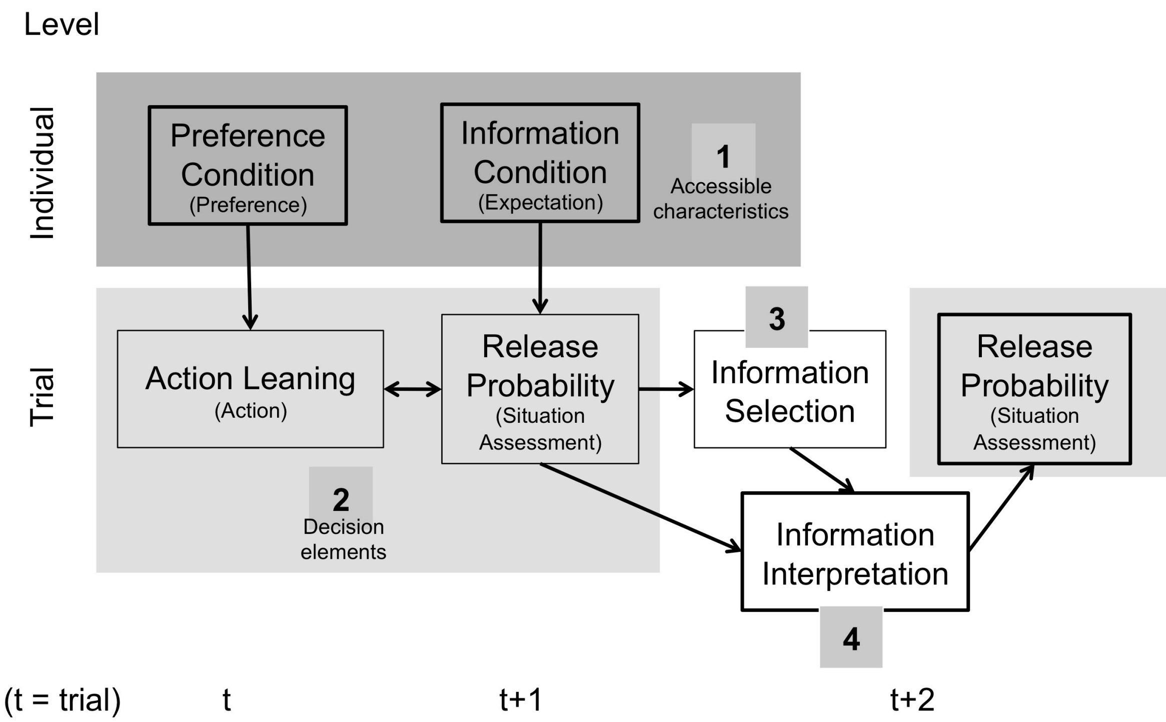


Figure 11: The original DHT model operationalised for empirical examination.

Accessible characteristics activate the corresponding decision elements indicated by the number 2 in Figures 10 and 11. The preference manipulation focuses on the costs and benefits of different actions. Therefore, it should activate the preferred action. The focal action is operationalised as the action that the individual is leaning towards at the time, and degree of certainty in that action as the best choice. The measure of certainty provides an indication of whether the currently favoured action indicates a strong focal action with little competition from the alternative action, or a weak focal decision option close in strength to the alternative action. Together, the favoured action, and confidence in this choice, is called the action leaning. The DHT model predicts that the action leaning is influenced by preference and the associated situation assessment. The expectation manipulation, information condition, alters the available information in terms of its implication for the situation assessment. Therefore, the expectation manipulation should have the most direct impact on the situation assessment operationalised as ‘release probability’, which is the perceived probability of a competitive release.

Recall that the focal situation assessment is the situational possibility that the individual is focused on, whereas the focal action is the action that is most salient to the individual at the time. In this case, the focal situation assessment is predicted to have a more direct impact on information selection and interpretation than the focal action because the available information holds direct implication for the situation assessment, specifically whether the rival organisation will release a competitive product. The number 3 indicates information selection and the number 4 indicates information interpretation in Figures 10 and 11. Information interpretation is expected to feed back into the subsequent situation assessment.

8.1.1. Model Predictions

Experiment 4 implemented the same preference and information conditions as used in Experiment 3, with one exception. The information conditions were strengthened such that the Release information condition provided only release-consistent information, the No-Release information condition provided only release-inconsistent information, and the Mixed condition provided exactly half release-consistent and release-inconsistent information. Titles in all conditions were half release-consistent and half release-inconsistent. As in Experiment 3, information implication was manipulated via whether the information content affirmed, or contradicted, the implication from the title. Experiment 4 also employed a repeated measures design, such that the same questions were asked on multiple trials to allow examination of the mediation effects predicted by the DHT model. For simplicity, only connections that would not be predicted based on the logic of the scenario were predicted and detailed, but all significant connections were tested and included in the final model displayed in Figure 15, this Chapter 8.3.2. For example, it is logical that the interpretation of information about a situation should influence one's situation assessment. Therefore, this connection is included in the final model but not extensively discussed or hypothesised.

8.1.1.1. Influence of accessible characteristics on decision elements

As shown in Figure 11, the DHT model predicts that action preference will influence situation assessments via the most activated action, operationalised as action leaning. Specifically, participants led to prefer action, should be swayed towards affirming the associated situation assessment, high release probability. Conversely, participants led to prefer inaction, should be swayed towards affirming the associated situation assessment, low release probability. These effects should be mediated by action leaning. Note that, logically, whether participants prefer action or inaction should not change the probability of a competitive release based on the scenario. The DHT model predicts this effect due to the bi-directional connection between associated actions and situation assessments in problem representation, even when the situation calls for a uni-directional connection. Based on connectionist principles, bi-directional activation operates when the directly activated element spreads some of this activation to a related element, which in turn spreads some of this activation to other associated elements, including the original source of the activation. The strength of activation decreases at each step, such that the recursive activation is weaker than the original activation. For example, if one forms, or considers a preference for action, this activates the action decision option, which activates the associated release situation assessment. Some of this activation then returns to further activate the action decision option. The formation of a situation expectation would begin the same process but activation would start at a situation assessment, rather than an action decision option.

Hypothesis 1a Effect of preference on situation assessment: *Perceived release probability will be higher in the Prefer-Action condition than in the Prefer-Inaction condition.*

Hypothesis 1b Mediation by action: *The difference in H1a will be mediated by action leaning reported on the preceding trial.*

8.1.1.2. Influence of accessible characteristics on information selection and interpretation via decision elements

The DHT model assumes that the focal decision option, in this case the focal situation assessment, drives information selection and interpretation. This coheres with research showing effects of the focal hypothesis on information selection (e.g. O'Brien, 2009; Rassin et al., 2010), and interpretation (e.g. O'Brien, 2009; Simon, Snow, et al., 2004). As per the DHT model, and as discussed in previous chapters, the focal decision option is predicted to influence information selection such that consistent titles are preferentially selected over inconsistent titles. Accordingly, higher release probability ratings should be associated with the selection of more release-consistent than release-inconsistent titles. Conditions that produce higher situation assessments should, therefore, result in selection of more release consistent and fewer release-inconsistent titles.

Hypothesis 2 Effect of the focal situation assessment on subsequent title selection: *Higher release probability on trial t will be associated with greater likelihood of selecting a release-consistent title on trial t+1 after controlling for information, preference condition, and the number of release-consistent titles already selected.*

The DHT model also predicts that the focal decision option has a bidirectional link with information interpretation. This relationship leads to the distortion of information interpretations in favour of the focal decision option, as well as potentially altering the focal decision option and its strength. These mechanisms are proposed to operate like the bidirectional activation just described. It is assumed that new information is represented cognitively, and these new cognitive representations form associations with the decision options and other associated elements. The influence of action leaning on action-related information interpretation is relatively well established. Coherence shift paradigms consistently demonstrate that attitudes, opinions, and interpretation of facts change to be more consistent with the final decision option after some time considering the decision problem (See Chapter 1.1.2.3 and Simon & Holyoak, 2002 for a review). Information distortion paradigms also demonstrate that participants asked to make a decision interpret information to be more consistent with their previous action leaning than participants who read the same information but are not asked to make a decision (e.g. Russo et al., 2008; Russo & Yong, 2011). There is also some evidence that the focal situation assessment can influence the interpretation of information related to the situation (e.g. Russo & Yong, 2011). Experiment 4 expands on previous research by examining whether preference and expectation independently impact decision leaning and subsequent information interpretation.

Hypothesis 3 Effect of the focal situation assessment on subsequent information interpretation: *Higher release probability on trial t will be associated with information interpretations that are more consistent with release (higher interpretation scores) on trial t+1 after controlling for information and preference condition.*

If Hypotheses 2 and 3 are supported, the full mediation models from preference and information conditions to release probability to information selection and interpretation will be tested.

8.1.1.3. Information distortion

Information interpretation refers to the individual's interpretation of the implication that an item of information has for the situation assessment. Information distortion refers to differences in information interpretation between participants who are, and are not, required to make a decision. In information distortion paradigms, information interpretation usually favours the decision leaning stated previously for decision-making participants compared to non-decision-making participants (e.g. DeKay et al., 2011; Russo et al., 1996). Information interpretation does not imply bias, whereas information distortion does.

Bias in information interpretation does not necessarily influence decisional outcomes. As observed by a number of theorists (e.g. Klayman, 1995; Oswald & Grosjean, 2004), if individuals are aware of these influences on their interpretation, they may account for them before making the final decision. However, it seems unlikely that individuals are aware of the degree to which their interpretation is influenced, given that a previous study of information distortion found that reported awareness of distortion had no relationship with measured distortion (Russo & Yong, 2011). It is important to assess the degree to which information distortion can influence situation assessments and actions.

Experiment 3 found that preference and information conditions influenced final release probability but was unable to determine whether final release probability was exaggerated by preference and expectation. Experiment 4 allows for an examination of the degree to which preference and expectation impact final release probability compared to Control group participants without preference or expectation, and examines what happens when preference and expectation contradict each other.

To achieve this, Experiment 4 adapts the information distortion approach, particularly the stepwise evolution of preference (SEP) method, outlined by Meloy and Russo (2004). This approach compares the implication ratings given for the same information by participants in the Treatment and Control groups. Participants in the Treatment group are given a decision task and are told that the information refers to one entity, in this case the company DCC. Participants in the Control group are not asked to make a decision and are told that the information refers to separate entities, in this case different companies. This method ensures that participants in the Control group do not form an expectation around the situation even in the absence of instructions to make a decision. This is a worthwhile precaution given that coherence shifts are observed even in groups asked to delay decision making, memorise, or comprehend information (Simon et al., 2001) and groups not required to make a choice (Russo et al., 1998).

Experiment 4 makes a number of contributions to the current body of research on information interpretation. Firstly, it examines information interpretation in a situation where the individual chose the information to examine. This is similar to a pilot choosing which indicators to examine, a potential homebuyer choosing which attributes to focus on, and a market analyst choosing what information to search for. One major way in which the choice of information might affect information interpretation is that participants might form expectations about what information they might find. Expectations might act as anchors that the information received is either assimilated towards, or contrast against (Strack & Mussweiler, 1997). Therefore, it is important to examine whether information distortion is still observed or even amplified in situations where individuals choose the information. Secondly, Experiment 4 examines the influence of preference and expectation manipulations on information interpretation, whereas the previous literature mostly focuses on the impact of the decision leaning alone. Thirdly, information distortion effects have predominantly been demonstrated in direct preference-information cases where the information is directly related to the preferred decision option. Experiment 4 expands these findings to an indirect preference-information case, where the information being interpreted is only indirectly related to the preferred decision option via the related situation assessment. Finally, the statistical methodology is refined for Experiment 4 in a number of ways. Previous studies of information distortion have often averaged information distortion (Russo & Yong, 2011), or examined distortion only on the first item of information (Russo et al., 1996), for an exception see DeKay et al. (2011). Where possible, Experiment 4 uses a multi-level modelling approach that allows for an examination of changes in information distortion over trials. Further, the original SEP method creates a distortion score by subtracting the average interpretation score for an item of information in the Control group from the individual's interpretation score for the same information in the Treatment group. This methodology fails to acknowledge and does not allow examination of individual differences between Control and Treatment group participants. To overcome this, Experiment 4 was analysed by statistically comparing scores from Control and Treatment group participants, rather than combining these scores.

Only accessible characteristics, information interpretation, and final release probability are measured in the Treatment and Control group, as indicated by the thick-bordered boxes in Figure 11. The Control group could not be asked for preliminary action leanings or release probabilities given that they were not asked to make a decision, and were ostensibly investigating numerous companies. Nor could the Control group select information, because they were yoked to Treatment group participants to keep the order and content of information identical between Treatment and Control groups.

If preference and evolving expectations influence information interpretations, which in turn influence situation assessments, as proposed by the DHT model, then final situation assessments should be biased towards expectation and preference compared to Control group participants with no preference or expectation. Operationally this means that final release probability estimates should be higher in Treatment than Control group participants in the information and preference conditions that favour release, but lower in Treatment than Control group participants in the information and preference conditions that favour no release. This logic leads to the following Hypotheses 4a, b, and c.

Hypothesis 4a. Moderated effect of preference on final situation assessments: *Treatment Prefer-Action participants will provide higher final release probability scores than the corresponding Control group participants given no preference manipulation but the same grid of information. Conversely, Treatment Prefer-Inaction participants will provide lower* *final release probability scores than the corresponding Control group participants given no preference manipulation but the same grid of information.*

Hypothesis 4b. Moderated effect of expectation on final situation assessments: *Treatment group Release condition participants will provide higher final release probability scores than the Control group participants who received the same grid of information. Conversely, Treatment group No-Release condition participants will provide lower final release probability scores than the Control group participants who received the same grid of information. No difference between Treatment and Control group participants will be observed in the Mixed information condition.*

The DHT model predicts that the effect of preference and expectation on release probability will be mediated by information interpretation. However, in the Control group, where no preference or expectation is predicted to form, there should be no influence of preference or evolving expectation on information interpretation. Therefore, the DHT model predicts that group will moderate this mediation effect such that the indirect connection between preference and information conditions and release probability via information interpretation is weaker in the Control compared to the Treatment group. Even in the Control group, some influence of information condition on information interpretation is predicted because expectation was manipulated via the information received. The difference in information content should lead to differences in interpretation and subsequent situation assessments. The DHT model predicts these differences will be exaggerated by evolving expectation in the Treatment group.

Hypothesis 4c. Moderated mediation by information interpretation: *The effects in H4a and b will be mediated by information interpretation, but the indirect effect will be weaker in the Control group compared to the Treatment group.*

There has been substantial debate over whether information distortion occurs pre-decision as well as post-decision and to what degree (see Brownstein, 2003 for a review). Although originally, theories predicted that information distortion occurred primarily after a decision (Brownstein, 2003), more recent research on information distortion has found greater distortion before a final decision than after it (Russo et al., 1996; Simon et al., 2001). To further contribute to this debate, Experiment 4 examined the degree to which assessments of release probability change pre and post decision despite no additional information.

The DHT model proposes that the choice of an action should activate that action decision option, and that this activation should spread to the associated situation assessment decision option despite no further information. Therefore, the DHT model predicts an increase in release probability after action, and a decrease after inaction. This coheres with cognitive consistency theories (Simon, Snow, et al., 2004), social justification theories (Tetlock & Mark, 1992), and argumentative theory (Mercier & Sperber, 2011) all of which suggest that individuals are motivated to justify their actions after making a choice.

Hypothesis 5 Post-decisional changes in situation assessment: *Release probability pre to post action decision will increase for participants who choose action but decrease for participants who choose inaction.*

8.1.2. Decision and Stopping Thresholds

Experiment 4 attempts to replicate the decision threshold results found in Experiment 3. Experiment 3 found that decision thresholds were strongly influenced by preference condition. The Control group in Experiment 4 effectively provide a third, no-preference condition.

Hypothesis 6a Decision Threshold: *When asked what actions they would take at different levels of release probability, participants in the Prefer-Action condition will switch from maintaining release plans to speeding up release plans at lower levels of release-*

probability than participants in the Prefer-Inaction condition. Control participants given no preference manipulation will give decision thresholds that fall between participants in the Prefer-Action and Prefer-Inaction conditions.

The DHT model proposes that decision thresholds are derived from the relative activation of opposing action decision options. Participants with stronger leanings towards the action decision option than the inaction decision option on the final trial should have lower decision thresholds, allowing action at lower levels of release probability.

Hypothesis 6b: *Final action leaning will be negatively correlated with decision threshold after controlling for preference condition.*

Experiment 3 did not find any effect of decision thresholds on stopping thresholds. Some influence was predicted based on the DHT model because exceeding a high decision threshold is only expected if opposing action decision options and situation assessment decision options are activated. Given that opposing decision options inhibit each other, and associated decision options activate each other, greater conflict between decision options is predicted for participants who exceed high decision thresholds than those who exceed low decision thresholds. The DHT model predicts that greater conflict between actions drives more information search to attempt to better differentiate opposing decision options. All of the information conditions in Experiment 3 contained some conflicting items of information. It is possible that this increased conflict among decision options in all conditions and constrained the amount of option differentiation possible. According to the DHT theory, this would increase the information and time required for all participants, and may have reduced the impact of decision thresholds. Experiment 4 removes conflicting information from Release and No Release information conditions. Stopping thresholds are only relevant to Treatment group participants because yoked Control group participants did not choose when to stop information search.

Hypothesis 7 Stopping threshold: *The total number of titles opened and the time spent on the task will be positively correlated with the decision threshold for participants choosing action, but negatively correlated with the decision threshold for participants choosing inaction.*

8.2. Methods

8.2.1. Participants

A total of 171 university students from a range of disciplines participated and were paid AU$15 for one hour of their time. Of these participants, three cases were removed: two did not complete the experiment in one sitting and one opened no cells. Of the remaining 168 participants, exactly half were in the Treatment group and half were in the Control group. As shown in Table 14, the demographics in both groups were comparable, and there were no significant differences between them. Experiment 4 was opened up to non-student populations but still predominantly advertised on campus at a large Australian university. Therefore, the sample included a minority of non-students. Of the non-student participants, four were unemployed and the rest came from a range of occupations including accounting services, communications services, education, management, and research.

Table 14: Demographics of Participants in Yoked Groups

Demographic	Group	
	Treatment (*n* = 84)	Control (*n* = 84)
Females	73%	68%
Students	89%	83%
First or second year university [a]	52%	57%
Age	*M* = 23.44, *SD* = 6.80	*M* = 24.27, *SD* = 7.33

Note: [a] Percentage of *students* in first or second year university

8.2.2. *Design*

Participants were randomly allocated to the Treatment or Control group. Participants in the Treatment group were randomly allocated to one of six conditions in a 2 preference-condition (Prefer-Inaction, Prefer-Action) by 3 information-condition (No-Release, Mixed, Release) design as in Experiment 3. There were 13 to 15 participants in each of the 6 conditions in the Treatment group, with exactly the same number in the yoked Control group.

Control participants were yoked to Treatment group participants in that they received exactly the same information, in exactly the same order as their corresponding Treatment participant. Therefore, Control group participants were effectively allocated to the same information condition as their corresponding Treatment group participant.

Participants were asked the same repeated questions at the baseline, before opening any information, after each item of information (post-information), and at a final time point. As shown in Table 15, Control group participants were not asked to form situation assessments or action leanings, and only answered information interpretation questions. After all of the information selected by the yoked Treatment participant had been viewed and interpreted, participants in the Control group were asked to “Imagine that all the information you just read was about a single company called DCC” before answering the same action leaning and release probability questions as Treatment group participants.

Table 15: Comparison of Procedure in the Treatment and Control groups

Procedural Element	Treatment Group	Yoked Control Group
Conditions		
Information condition	Release, Mixed, Release	Same [a]
Preference condition	Prefer-Inaction, Prefer-Action	No Preference
Performance-based payment	Yes ($15 with possible deductions)	No ($15)
Repeated measures		
Baseline	Action leaning (2 questions), release probability	None
Post-information (repeated after each item of information)	Information interpretation, action leaning (2 questions), release probability	Information interpretation
Final	Action decision, release probability	Same [a]

Note: [a] Same = same as yoked Treatment group participant

8.2.3. Apparatus and Measures

8.2.3.1. Scenario

The business scenario provided to Treatment group participants was identical to Experiment 3, including the financial incentives to choose the least costly action. The Control group was designed to provide an unbiased baseline for information interpretation and mimicked Russo, Meloy and Medvec's (1998) 'variable-brand' Control group. As shown in Table 15, the Control group scenario was very similar to that of the Treatment group, except that the preference manipulations were removed, as were financial incentives for correct choice. The investigation and possible actions were mentioned as in the Treatment group but

Control group participants were not required to make a decision or choose an action. Rather, they were asked to rate each item of information on the extent to which it indicated that a competitive release was likely from each company within 6 months.

8.2.3.2. Information environment

The content provided in the Control group was the same as the content available in Treatment group, except that the single competitor (DCC) was replaced with a different competitor in each information item (e.g. Company A, Company B…). This was done as per Russo et al (1998) to avoid the accumulative association with a single decision entity. For example, after selecting the title "Price reduction on current translation software" a Treatment group participant might receive the following information (Affirmatory version):

> "Historically, just prior to new software updates, DCC discounts the old version by 20 to 50 percent depending on the magnitude and popularity of the update. However, at this time of year, they would also usually run a stocktake sale reducing items by up to 20 percent. The current translation software has a 50% discount."

The yoked Control group participant would have received the following:

> "**Price reduction on current translation software**
> Historically, just prior to new software updates, Company A discounts the old version by 20 to 50 percent depending on the magnitude and popularity of the update. However, at this time of year, they would also usually run a stocktake sale reducing items by up to 20 percent. The current translation software has a 50% discount."

The information grid was reduced to a four by four, 16-cell information grid with no neutral or overlapping cells (such as "translation expert hired" and "translation expert quit") or ambiguous content. Ambiguity was removed from Release and No-Release information conditions by including only release-consistent information in the Release condition, and including only release-inconsistent information in the No-Release condition. In the Mixed information condition, four of the eight release-consistent and inconsistent titles provided affirmatory results and four yielded contradictory results resulting in an equal amount of release-consistent and inconsistent information. All three conditions had the same eight release-consistent and eight release-inconsistent titles. The display order was counterbalanced such that half the participants saw the information grid displayed in Figure 12, and half the participants saw the same information grid flipped horizontally such that "Slow release pattern" was in the top left position.

Transferred staff to research	Faults in audio production	Translation expert hired	Slow release pattern
Lost loyalty of potential consumers	Contracted software testers	Speech recognition expert quit	Scheduled press release
Branding strategy	Current language translation faults	Key software engineer hired	Barriers to development
Current speech recognition faults	Bulk production of audio headsets	Audio expert quit	Price reduction on current translation software

Release-Consistent Title	Release-Inconsistent Title

Note: Colour coding is not included in participant's display.

Figure 12: Representation of the information grid that participants selected titles from in Experiments 4 and 5 (Appendix E).

8.2.3.3. *Self-report measures*

All measures were the same as in Experiment 3 with the following exceptions:

Process-tracing questions from Meloy and Russo's (2004) SEP questions were adapted to suit the business scenario. Participants in the Treatment group were asked to answer one information interpretation, two action leaning, and one release probability question after each item of information as detailed below. As shown in Table 15 Control group participants answered only the information interpretation question until the final trial when they were asked to imagine that all information pertained to a single organisation and answered action leaning and release probability questions also.

Information interpretation was measured on a 1 to 9 scale and ascertained for each item of information for both Treatment and Control group participants. Participants were asked the following:

"Please consider ONLY the most recent item of information.

This information indicates that a competitive new product release from this organisation within 6 months is...

1(Impossible), 2(Very Unlikely), 3(Unlikely), 4(Somewhat Unlikely), 5(No indication either way), 6(Somewhat Likely), 7(Likely), 8(Very Likely), 9(Definite)"

High scores indicate that the information suggests that a competitive release is very likely. Low scores indicate that the information suggests that a competitive release is very unlikely.

Action leaning was computed by combining responses from SEP Questions 2 and 3. The questions were as follows:

"Please consider all the information so far.

Action: At this point which action seems most appropriate?

Maintain current release plans/ Speed up release plans

Confidence (50-100): How confident are you that this would be the best action to take given the situation? Please enter a number between 50 and 100, where 50 = a complete toss up and 100 = absolutely certain."

When participants chose inaction (maintaining release plans) in Question 2, their confidence for Question 3 was subtracted from 100. This resulted in a single scale where 0 = absolutely certain that inaction is best through 50 = a complete toss up between inaction and action, to 100 = absolutely certain that action is best. A similar confidence manipulation is used by Simon, Snow and Read (2004).

This scale was increasingly bipolar across trials, suggesting that participants regardless of action choice became more confident as trials progressed. All analyses that included actions leaning as a dependent variable were re-run with an n-score transformed version of action leaning. No results differed between the analyses with transformed and non-transformed dependent variables. Therefore, the results using the non-transformed action-leaning variable are reported.

Release probability was asked immediately after action leaning questions on all trials, except that it was asked on a separate page in the final trial. This allowed only the action decision to be requested at the bottom of the information grid page. This emphasised the main focus of the task, the action decision to be made. As in previous experiments, release probability was measured using the following question:

"Likelihood (0-100): How likely is it that DCC will release a competitive new product within 6 months? Please enter a number between 0 and 100, where 0 = Impossible and 100 = Definite."

8.2.3.4. Behavioural measures

The same behavioural measures were used as in Experiment 3 with one addition. *Release-consistent titles selected* was a trial-level variable indicating the number of release-consistent titles selected in all previous trials. This was controlled for in analyses of information selection because increases in the number of release-consistent titles selected indicated decreases in the number of unseen release-consistent titles available.

8.2.4. Procedure

Participants were recruited in exactly the same way as in previous experiments but were allowed to complete the experiment unsupervised online. The same procedure was used to present the scenario, manipulations, and instructions. The main difference from Experiment 3 was that process-tracing questions were introduced. Each Treatment group participant completed one baseline trial, a number of post-information trials, and one final trial. Participants followed the sequence below:

1) Answer baseline questions (Baseline trial)
2) Selected a title and read the information, close the cell (Trial 1)
3) Complete post-information questions (Trial 1)
4) Repeat 2 and 3 for the number of title selections (Trials 2…*t*)
5) Complete final questions including the final action decision (Final trial)

Differences in questions asked in each phase (Baseline, post-information, and final) between Treatment and Control group participants are detailed in Table 15.

8.3. Results

Recall that SEP questions were asked on numerous trials. The number of trials depended on the number of titles each participant selected. Trials are denoted ‘Baseline’ before any titles had been selected, ‘Trial 1’ after one title had been selected, and ‘Trial 2’ after two titles had been selected, up to ‘Final’ after the participant had made a decision. Excluding Baseline and Final Trials, the maximum number of trials was 20, and the minimum was 1 with an average of 10.39 (SD = 4.81). Assumptions of normality were checked for all dependent variables used in parametric analyses. Normality assumptions were not met for investigation time, or action leaning. Analyses using these variables as dependent variables were re-run using a normal transformation of the original variable. The significance and size of effects did not differ using the normal transformation. Therefore, statistics for the raw dependent variable are reported.

8.3.1. Manipulation Checks

A couple of qualifications were observed to the difference in title perception across release-consistent and release-inconsistent titles detailed in Chapter 5.4.1 and Appendix D. Firstly, the group by information condition interaction was statistically significant F (2, 2645) = 3.97, $p = .019$. As evident in Figure 13, participants rated release-consistent and release-inconsistent titles as providing greater indication of release in the Release content condition compared to the No-Release information condition in the Treatment group but not in the Control group. Secondly, the title type by group interaction was statistically significant F (1, 2645) = 24.85, $p < .0005$. Participants in the Treatment group perceived the implication of the two types of titles to be more similar than participants in the Control group. Further examination revealed that participants' ratings of release-consistent and release-inconsistent titles were positively correlated amongst Treatment group participants ($r = .31$, $p = .005$) but not amongst Control group participants ($r = .03$, $p = .816$). This suggests that individuals tended to rate titles consistently towards release or no release in the Treatment group, but gave relatively independent ratings of different title-types in the Control group. Together, these findings suggest that title perception was swayed towards the expectation built up through the information grid content in the Treatment group. This expectation about a single company was prevented from forming in the Control group.

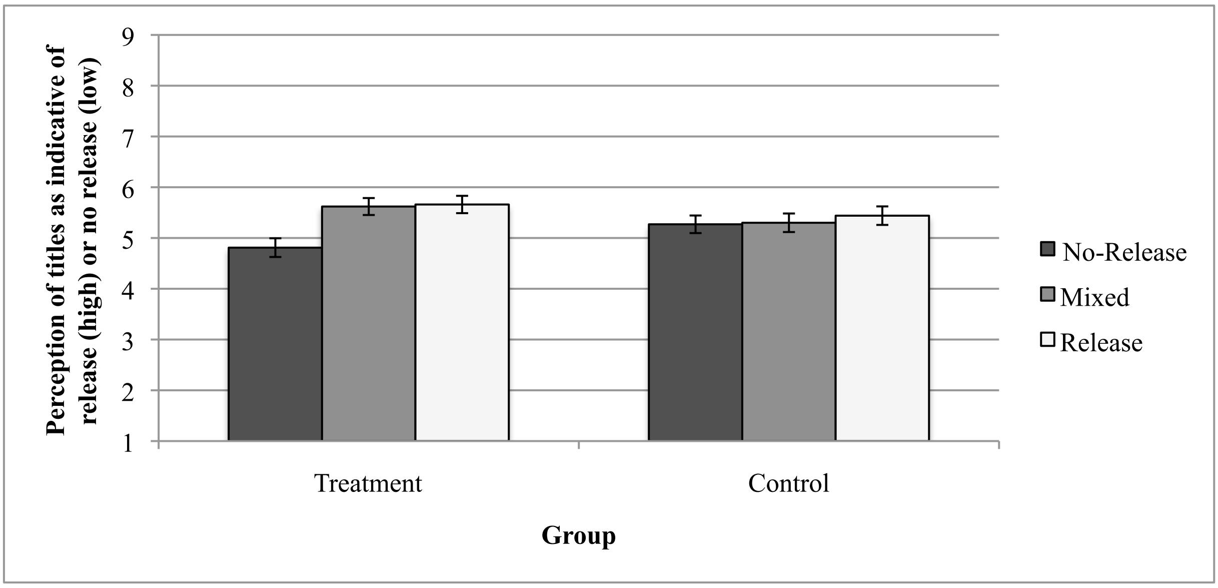
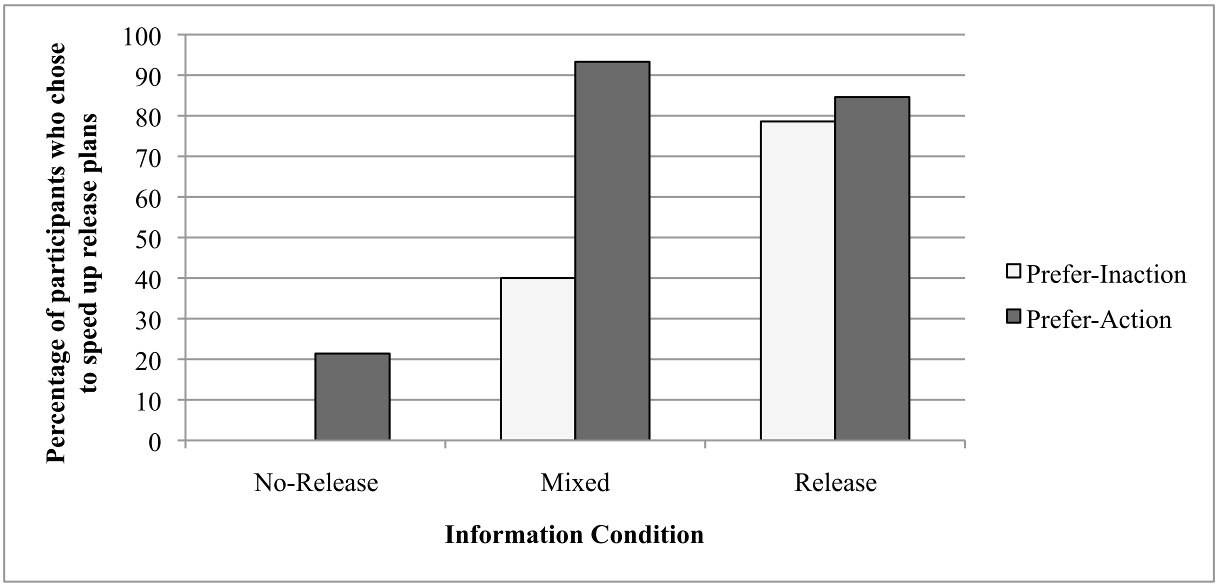


Figure 13: Titles were perceived as more indicative of release in the Release (n = 27) compared to No-Release (n = 27) condition in the Treatment group (n = 84) but not in the Control group (n = 84). Error bars represent 95% CI.

Preference condition had a similar impact on action decisions to that observed in Experiment 3, except that a greater proportion of participants in the Prefer-Inaction condition elected to speed up release plans, as shown in Appendix D. This difference was mainly driven by an increase in action selection in the Release information condition that could be attributed to the stronger information condition manipulation, relative to Experiment 3. The difference in action decision between Prefer-Action and Prefer-Inaction preference conditions, displayed in Figure 14, was statistically significant $\chi^2(1, n = 84) = 5.79, p < .0005$. Information conditions differed in Experiment 4 compared to Experiment 3 in that the No-Release condition contained only release-inconsistent information and the Release condition contained only release consistent. Accordingly, the percentage of participants who chose action over inaction was lower in the No-Release condition and higher in the Release conditions compared to Experiment 3, as detailed in Appendix D. The difference in action decision between the three information conditions, displayed in Figure 14, was statistically significant $\chi^2(2, N = 84) = 30.10, p < .0005$. Final release probability ratings were also more extreme in the Treatment group compared to Experiment 3, as shown in Appendix D. This was qualified by an interaction between information condition and group detailed in this Chapter 8.3.2.3.

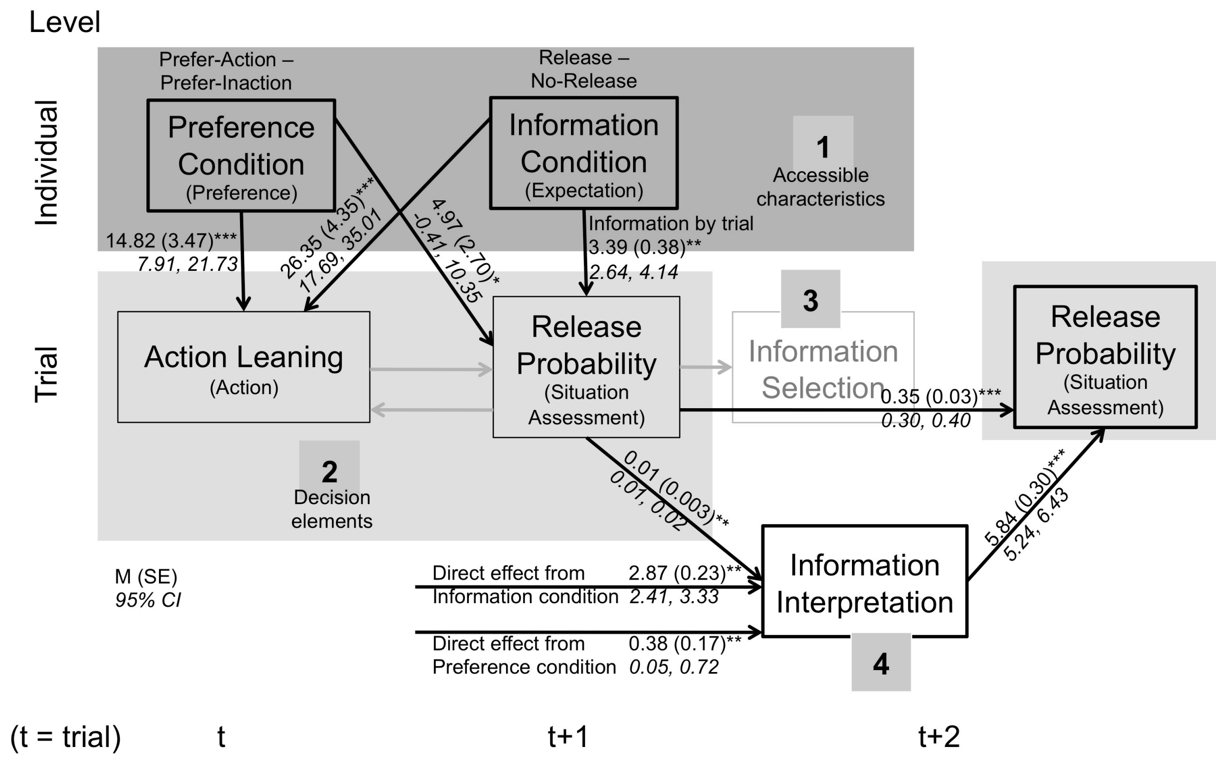


Note: The participants who chose inaction are not displayed. All participants chose either action or inaction.

Figure 14: The percentage of participants who chose action was greater for participants in the Release information condition compared to the No-Release information condition, and for participants in the Prefer-Action condition compared to the Prefer-Inaction condition (n = 13-15 in each of the 6 conditions).

8.3.2. Test of the DHT Model

The DHT model shown in Figure 15 was tested using a series of multi-level mediation analyses as per recommendations made by Hox (2010) and detailed in Appendix F. The significance of the indirect effects was examined using the Sobel test (Sobel, 1982). The Sobel test has been shown to be an appropriate test of mediation in multi-level data (Krull & Mackinnon, 1999; Tofighi & Thoemmes, 2014). Although bootstrapping methods are considered preferable for single-level data, they are not yet available for multilevel data (Tofighi & Thoemmes, 2014).



Note: * $p < .10$, ** $p < .05$, *** $p < .01$

Figure 15: The results of multilevel mediation analyses for the DHT model. Unstandardised coefficients with standard error and 95% confidence interval included.

8.3.2.1. Influence of accessible characteristics on decision elements

Hypothesis 1a. Effect of preference on situation assessment: *Release probability will be higher in the Prefer-Action condition than in the Prefer-Inaction condition.*

Hypothesis 1b. Mediation by action leaning: *The difference in H1a will be mediated by action leaning reported on the previous trial.*

Hypothesis 1a was tested using a two-level mixed model analysis that regressed release probability on trial at the trial level, preference condition controlling for information condition at the individual level, and controlling for the cross level information condition by trial interaction. As evident in Figure 15, release probability at the average trial was almost 5 percentage points higher in the Prefer-Action condition compared to the Prefer-Inaction condition after controlling for information condition and the information condition by trial interaction F (1, 79.89) = 3.38, p = .070. However, this effect did not reach significance at the .05 alpha level.

To assess mediation, the mediator, prior action leaning, was added into the model described above, and prior release probability was controlled for (Equation detailed in Appendix A.1). Prior action leaning was not a statistically significant predictor of release probability over and above the other variables in the model. Therefore, Hypothesis 1b was not supported. Excluding information condition from the model made the mediation appear significant. This suggests that the link between action leaning and release probability is actually spurious, as both variables are influenced by information condition.

Information condition and the information condition by trial interaction were also statistically significant predictors of release probability, as detailed in Figure 15. This result is expected because the information conditions are designed to manipulate the perceived probability of release and, therefore, lead to situation assessments that diverge as more information is received. This is the pattern observed. For each new item of information received, release probability in the Release condition increased by about 3 percentage points relative to release probability in the No Release condition, as shown in Figure 15.

RESULTS SUMMARY: Influence of accessible characteristics on decision elements

As depicted in the two large grey areas in Figure 15, the bidirectional link between decision elements, action leaning and release probability was not supported. Instead, preference and information conditions had direct influences on both decision elements. The results were in the predicted directions, but the impact of preference on release probability did not reach the .05 alpha level. Participants in the Release information condition and Prefer-Action preference conditions gave action leanings more supportive of action, and release probability assessments more supportive of release, than participants in the Prefer-Inaction preference condition and No-Release information conditions.

8.3.2.2. *Influence of accessible characteristics on information selection and interpretation via decision elements*

Hypothesis 2 Effect of the focal situation assessment on subsequent title selection: *Higher release probability on trial t will be associated with greater likelihood of selecting a release-consistent title on trial t+1 after controlling for information, preference condition, and the number of release-consistent titles already selected.*

A two-level, binary logistic, generalised linear mixed model analysis was used to regress title type (release-consistent or release-inconsistent title) on trial, prior release probability, and the release-consistent titles selected at the trial level, information, preference condition, and total titles selected at the individual level, and the information condition by trial cross-level interaction (Equation detailed in Appendix A.2). Hypothesis 2 was not supported, since release probability had no effect on which title type was subsequently selected. However, a couple of results that were not hypothesised did arise. Firstly, the relationship between trial and title type was statistically significant F (1, 863) = 71.39, p < .0005, ExpB = 0.64, 95% CI 0.58, 0.72. This indicates that participants tended to select more release-consistent titles in early trials and release-inconsistent titles in later trials irrespective of condition. Secondly, the relationship between the number of release-consistent titles selected and title type was statistically significant F (1, 863) = 88.25, p < .0005. This indicates that for every 1 more release-consistent title previously selected, participants were 2.61 times more likely to select another release-consistent title than a release-inconsistent title (95% CI 2.14, 3.19). This suggests that, despite the selection of release-consistent titles depleting the number of unread release-consistent titles available, the more release-consistent titles participants had already selected, the more likely they were to stick to release-consistent titles preferentially.

Hypothesis 3 Effect of the focal situation assessment on subsequent information interpretation: *Higher release probability on trial t will be associated with interpretations that are more consistent with release (higher interpretation scores) on trial t+1 after controlling for information and preference condition.*

A two-level mixed model analysis was used to regress information interpretation on trial and prior release probability at the trial level, information and preference condition at the individual level, and the information condition by trial cross-level interaction. As shown in Figure 15, Hypothesis 3 was supported. The effect of release probability on subsequent information interpretation was statistically significant F (1, 647.65) = 18.74, $p < .0005$. For every 10 percentage point increase in prior release probability there was a 0.13 (SE = 0.03, 90% CI 0.07, 0.19) increase on the 9-point information interpretation scale.

Preference condition had a direct effect on information interpretation, F (1, 61.17) = 5.19, p = .026, but the indirect effect was not statistically significant. At the average trial, participants in the Prefer-Action condition gave information interpretation scores 0.38 points higher on the 9-point scale than participants in the Prefer-Inaction condition after controlling for prior release probability. Information condition also had a direct effect on information interpretation as would be expected given that the implication of the information differed across information conditions F (2, 70.92) = 79.40, $p < .0005$. There was also a statistically significant indirect effect of the information condition by trial interaction on information interpretation via prior release probability, Sobel = 3.65, $p < .0005$. Removing the mediator from the model revealed that, for each new trial, the difference in information interpretation between participants in the Release versus the No Release information condition increased by 0.10 points (SE = 0.03, 95% CI 0.03, 0.16) on the 9-point scale. This information condition by trial interaction effect cannot be explained by differences in content, and was fully mediated by prior release probability.

RESULTS SUMMARY: Influence of accessible characteristics on information selection and interpretation

Information selection was not predicted by prior release probability, preference or information condition as indicated by the greyed out information selection box in Figure 15.

Information interpretations were influenced by prior release probability, preference and information condition. Preference condition had a direct effect on information interpretation such that information was interpreted as more supportive of release in the Prefer-Action compared to the Prefer-Inaction condition. There was no indirect effect of preference condition via release probability.

Information condition had a direct impact on information interpretation, which is not surprising given that the implication of information was manipulated. Information condition also had a statistically significant indirect impact on information interpretation. This indirect effect increased over trials and was fully mediated by release probability. This final result is supportive of an exaggeration of interpretation by evolving expectation.

8.3.2.3. Information distortion

Hypothesis 4a. Effect of preference on final situation assessments: *Treatment Prefer-Action participants will provide higher final release probability scores than the corresponding Control group participants given no preference manipulation but the same grid of information. Conversely, Treatment Prefer-Inaction participants will provide lower final release probability scores than the corresponding Control group participants given no preference manipulation but the same grid of information.*

Hypothesis 4b. Effect of expectation on final situation assessments: *Treatment group Release condition participants will provide higher final release probability scores than the Control group participants who received the same grid of information. Conversely, Treatment group No-Release condition participants will provide lower final release probability scores* *than the Control group participants who received the same grid of information. No difference between Treatment and Control group participants will be observed in the Mixed information condition.*

Hypothesis 4a and b were tested using a three-level nested generalised linear mixed model analysis with individuals nested within groups, nested within the order of title selection shared by yoked control-treatment pairs (Equations provided in Appendix F). This model was used to regress final release probability on information and preference condition at the individual level, and group at the group level. The cross-level interactions preference condition by group, and information condition by group provided tests of Hypothesis 4a and 4b respectively. The three-way interaction preference condition by information condition by group was included to examine whether the differences between groups were smaller when preference and expectation conflicted compared to when they did not.

The three-way interaction between preference condition, information condition and group was statistically significant F (2,156) = 3.58, p = .030. The difference in final release probability between Treatment and Control groups was greater when both preference and expectation favoured no release (Figure 16 left) than when expectation favoured no release but preference did not (Figure 16 right). The difference between Treatment and Control groups was almost equal when both preference and expectation favoured release (Figure 17 right) and when expectation favoured release but preference did not (Figure 17 left). Therefore, the evidence for an additive effect of expectation and preference on final release probability is mixed. Final release probability fell on either side of the Control group in the Prefer-Inaction and Prefer-Action preference conditions only in the Mixed information condition, as shown in Figure 18. This suggests that when information condition produced a strong expectation in either direction, preference condition had relatively less influence than expectation over final situation assessments.

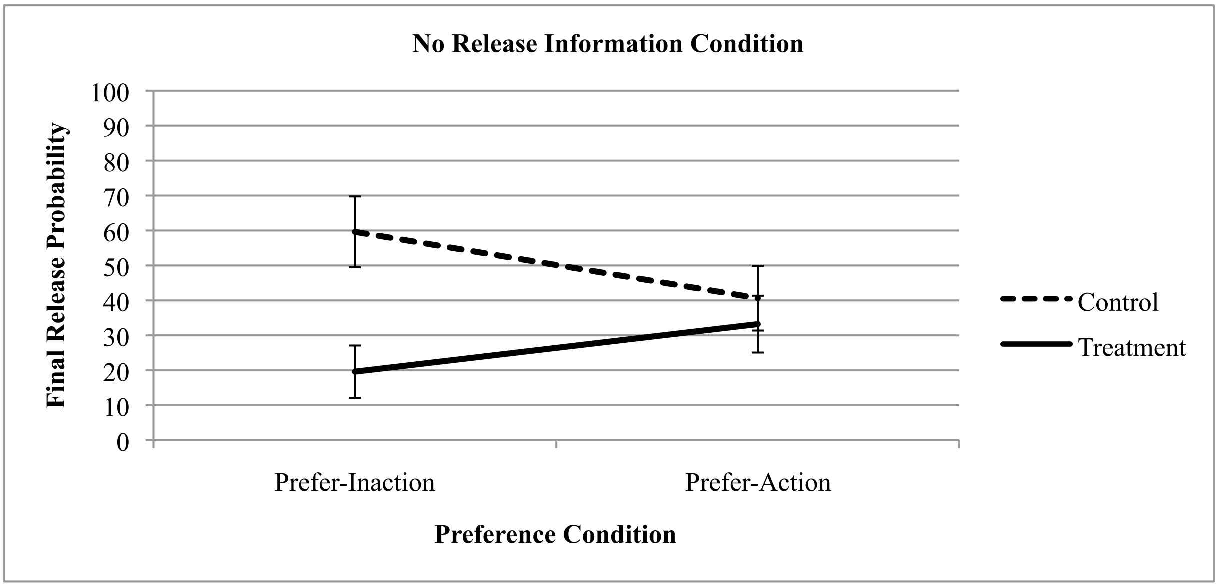


Figure 16: There was a greater difference between Treatment and Control groups when both information and preference condition favoured no release and inaction (left; n = 13) than when only the information condition favoured no release (right; n = 14). Error bars represent 95% CI.

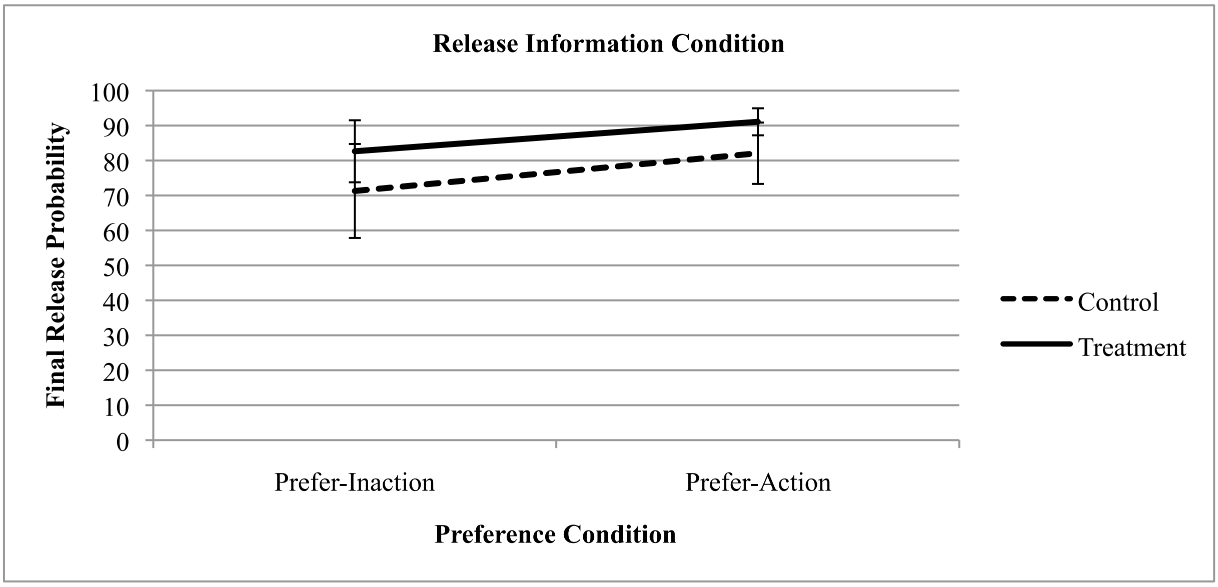


Figure 17: The difference between Treatment and Control groups was constant when information condition favoured release and action whether preference favoured release (right; n = 13) or no release (left; n = 14). Error bars represent 95% CI.

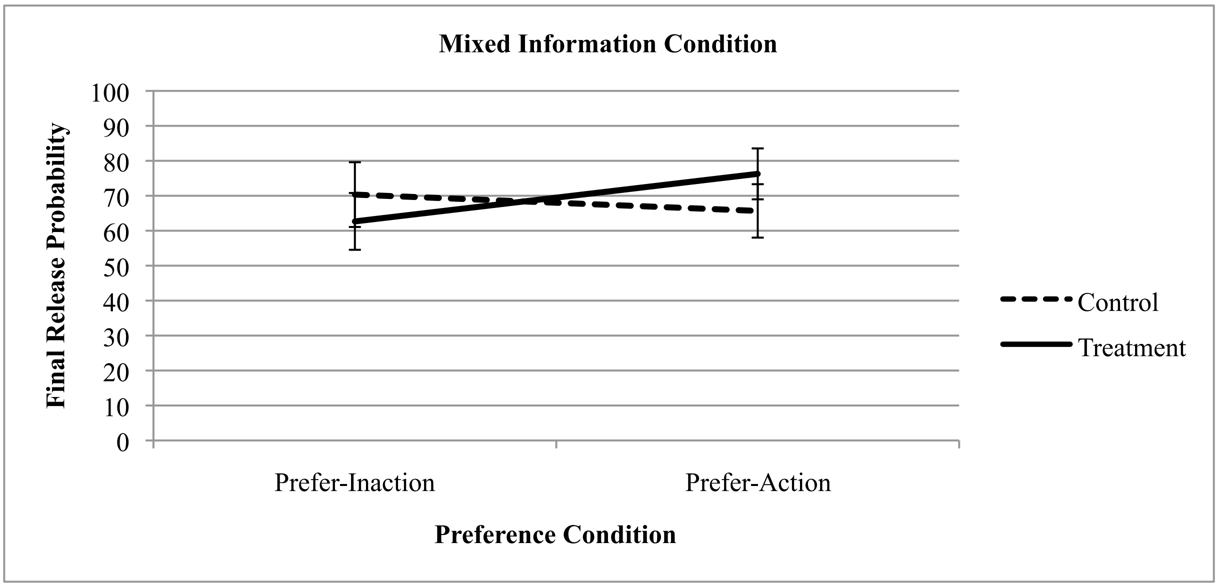


Figure 18: Treatment participants with opposing preferences (n = 15 per condition) fell either side of their yoked control group with no preference when in the Mixed information condition. Error bars represent 95% CI.

Hypothesis 4a was partially supported. The preference condition by group interaction was statistically significant F (1, 156) = 9.42, p = .003. As evident in Figure 19, participants in the Prefer-Inaction condition provided final release probability estimates 12.10 percentage points lower than the yoked Control group participants who saw exactly the same information without the preference manipulation, SE = 3.72, t (156) = 3.25, p = .001. Participants in the Prefer-Action condition showed no statistically significant difference in final release probability compared to the yoked Control group although trends were in the expected direction.

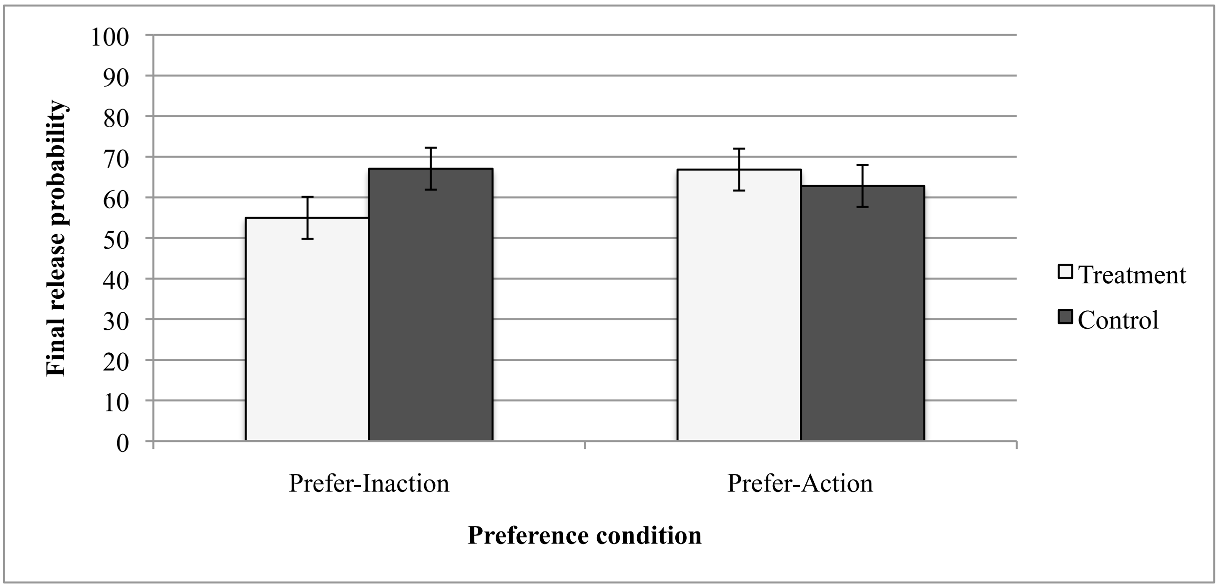


Figure 19: Participants in the Prefer-Inaction (n = 42) condition gave lower estimates of final release probability than their yoked Control group (n = 42). The difference was not statistically significant for participants in the Prefer-Action (n = 42) condition and their yoked Control group. Error bars represent 95% CI.

Hypothesis 4b was supported. The information condition by group interaction was statistically significant F (2, 156) = 14.47, $p < .0005$. As evident in Figure 20, participants in the No Release information condition provided final release probability estimates 23.71 percentage points lower than the yoked Control group participants who saw exactly the same information, SE = 4.64, t (156) = 5.11, $p < .0005$. Participants in the Release information condition provided final release probability estimates 10.18 percentage points higher than the yoked Control group participants who saw exactly the same information, SE = 4.64, t (156) = 2.19, p = .030. There was no statistically significant difference in final release probability estimates given by Treatment and Control group participants in the Mixed information condition. This is consistent with the exaggeration of final release probabilities towards the expectation built up by the available information for Treatment participants, who were asked to make a decision, compared to Control participants, who were not required to make a decision.

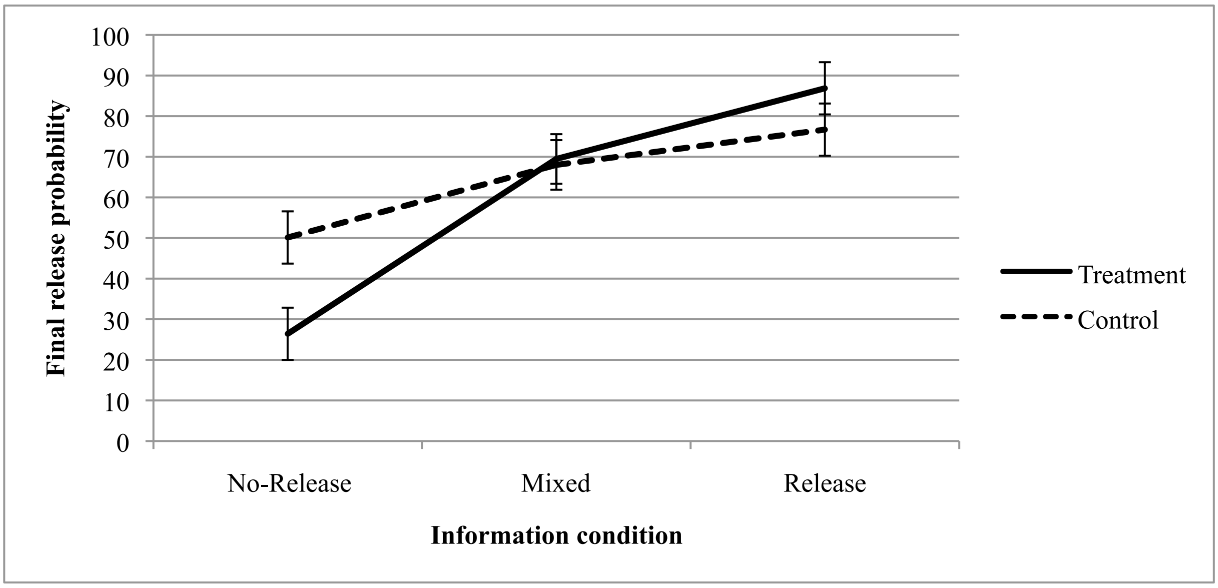


Figure 20: The difference in final release probability between No-Release (n = 27) and Release (n = 27) information conditions was exaggerated in the Treatment group (n = 84) compared to the Control group (n = 84). Error bars represent 95% CI.

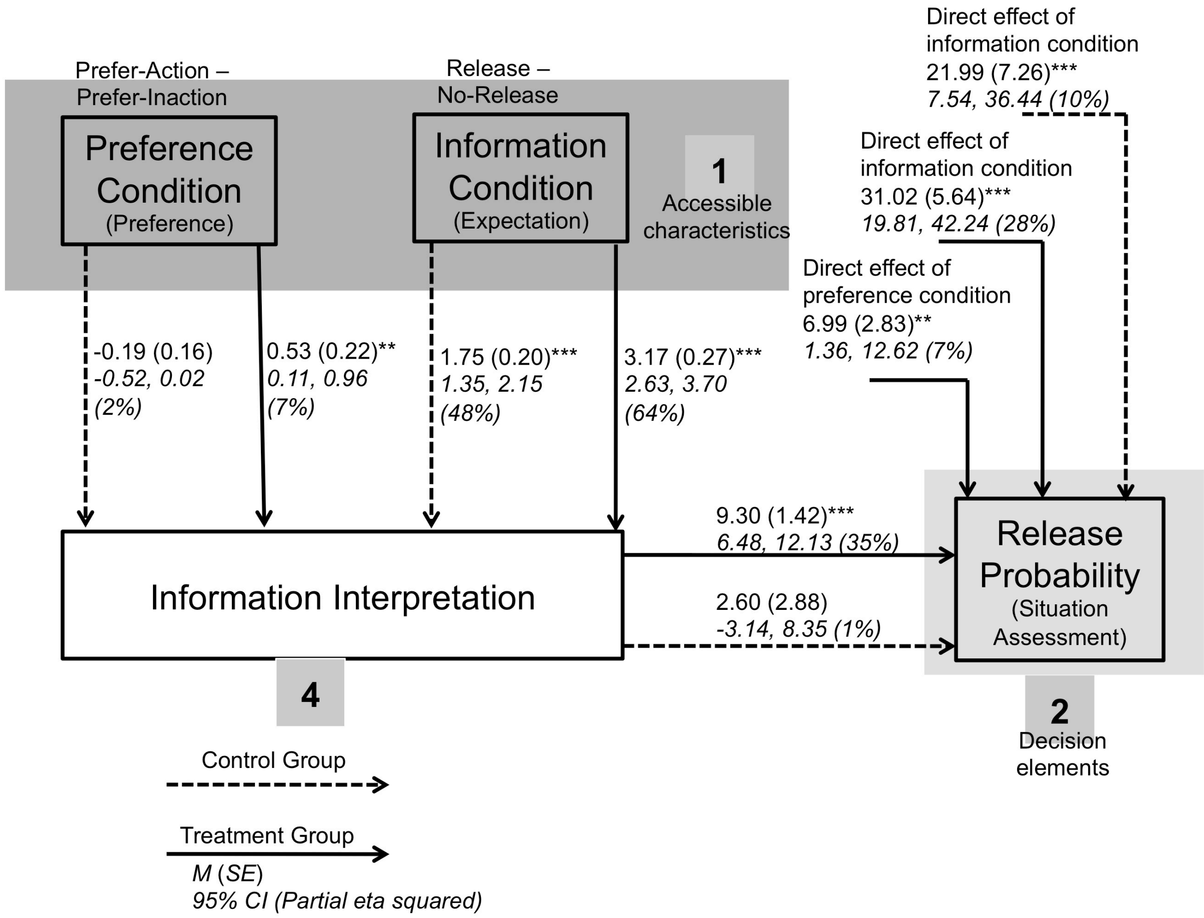
Hypothesis 4c. Moderated mediation by information interpretation: *The effects in H4a and b will be mediated by information interpretation, but the indirect effect will be weaker in the Control group compared to the Treatment group.*

Moderated mediation was examined based on recommendations made by Muller, Judd, and Yzerbyt (2005). Given that group moderated the overall effect of preference and information conditions on final release probability as discussed above, the first condition for mediated moderation is met. Other conditions are identical for both moderated mediation and mediated moderation. The moderated mediation conceptualisation will be retained for ease of interpretation as recommended by Hayes (2008). Mediation analyses within each group are used to demonstrate the difference between mediation in the Control and Treatment groups, as shown in Figure 21.

There are two subsequent steps to examining moderated mediation. Firstly, an examination of whether group moderates the influence of the independent variables, preference and information condition on the mediator, average information interpretation.

This was examined using a three-level nested generalised linear mixed model analysis with individuals nested within groups, nested within the order of title selection shared by yoked control-treatment pairs (Equations in Appendix D). The mediator variable, information interpretation was regressed on information and preference condition at the individual level, and group at the group level. The cross-level interactions preference condition by group, and information condition by group provided tests of moderation by group. The three-way interaction preference condition by information condition by group was again included to examine whether the differences between groups in information interpretation were smaller when preference and expectation conflicted compared to when they did not.

The three-way interaction was not statistically significant but both two-way interactions of interest did show statistically significant effects. Group significantly moderated the influence of preference condition on information interpretation $F(1,156) = 8.78$, $p = .004$, and the influence of information condition on information interpretation $F(2,156) = 14.25$, $p < .0005$. This is supportive of moderated mediation. Consistent with Hypothesis 4c the difference between Prefer-Action and Prefer-Inaction conditions in information interpretation was smaller in the Control compared to the Treatment groups, explaining 2% and 7% of the variance respectively, as shown in Figure 21. The difference between Release and No-Release information conditions in information interpretation was also smaller in the Control compared to the Treatment groups, explaining 48% and 64% of the variance in information interpretation respectively, as shown in Figure 21.



Note: Information interpretation is measured on a 9 point scale. Final release probability is a percentage figure.

* p <.10, ** *p* < .05, *** *p* < .01

Figure 21: Effects of preference and information condition on information interpretation and final release probability were stronger in the Treatment (n = 84) than in the Control (n = 84) group. Partial mediation was statistically significant only in the Treatment group.

Conditions for moderated mediation are met if the mediator, average information interpretation, influenced final release probability after controlling for the independent variables and their interactions with group. This was tested by adding information interpretation and information interpretation by group interaction term into the analysis used to test Hypotheses 4a and b.

Group moderated the effect of the mediator, information interpretation on the outcome variable, final release probability $F(1,154) = 7.23$, $p = .008$. As shown in Figure 21, information interpretation explained 35% of the variance in final release probability in the Treatment group, but only 1% in the Control group.

Final release probability was significantly influenced by average information interpretation after controlling for the interaction with group F (1,154) = 12.52, p = .001. Therefore, the conditions for moderated mediation are met and Hypothesis 4c is supported. The indirect effect of preference condition on final release probability via average information interpretation was statistically significant in the Treatment group, Sobel = 2.26, p = .024, but not in the Control group. The indirect effect of information condition on final release probability via average information interpretation was statistically significant in the Treatment group, Sobel = 5.72, p < .0005, but not in the Control group.

In addition to indirect effects, there were direct effects of preference and information conditions on final release probability in the Treatment group, and of information condition in the Control group, as shown in Figure 21. The direct effect of information condition was also smaller in the Control group compared to the Treatment group, explaining 10% and 28% of the variance in final release probability respectively.

Hypothesis 5 Post-decisional changes in situation assessment: *Release probability pre to post action choice will increase in participants who choose action, but decrease in participants who choose inaction.*

Hypothesis 5 was partially supported in the Treatment group by a repeated measures GLM model, with the release probability given on the second last and final trials as the within participants variables and final action decision as the between participants variable. As shown in Figure 22, release probability increased pre to post action decision among participants who chose action (speeding up release plans), and this increase was significantly steeper compared to participants who chose inaction (maintaining release plans) Wilks' Lambda = 0.90, F (1,82) = 8.74, p = .004 explaining 10% of the variance. The hypothesis was only partially supported because participants who chose inaction also showed a statistically significant increase in release probability pre to post decision, although not to the same degree as participants who chose action. This effect remained after controlling for preference and information conditions.

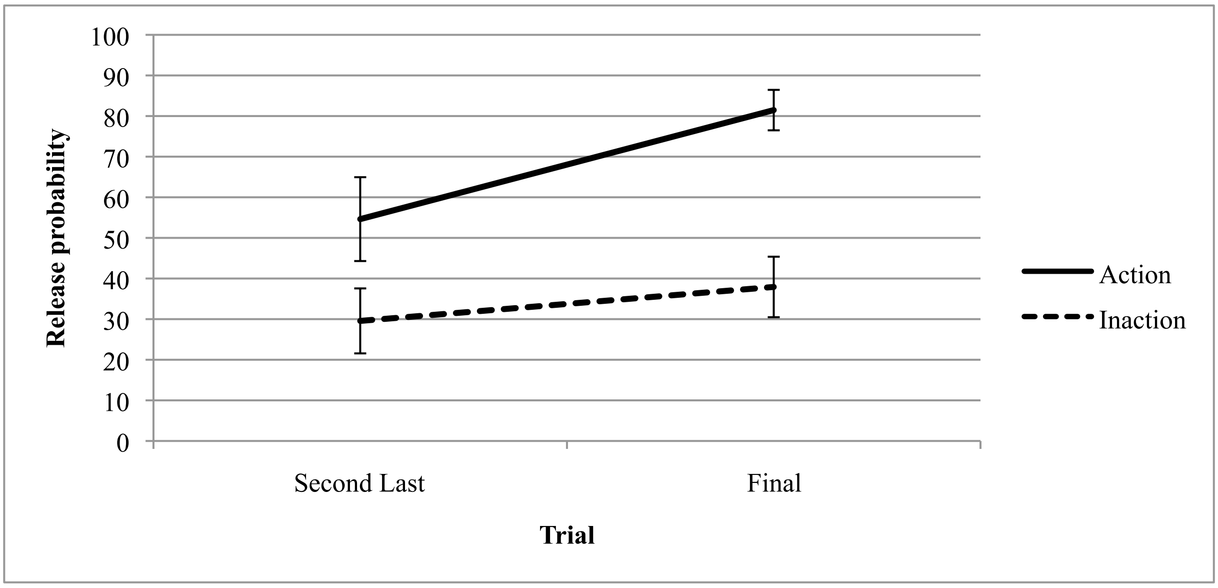


Figure 22: The increase in release probability between second last and final trials was greater for participants who chose action (n = 45) than those who chose inaction (n = 39). Error bars represent 95% CI.

RESULTS SUMMARY: Information distortion

As evident in Figure 21, preference and information conditions distorted final release probability both directly and via information interpretation, compared to yoked Control group participants who saw the same information but were not given preference manipulations or allowed to develop expectations about the situation. The differences in information interpretations and final release probability between preference conditions, and Release and No Release information conditions, were greater in the Treatment group compared to yoked Control groups. This is consistent with preference and evolving expectation both influencing judgements beyond the influence of the information alone.

Release probability also tended to increase after a decision had been made, especially for participants who chose action, despite no new information being received. This is partially supportive of a bidirectional relationship between action decisions and situation assessments.

8.3.3. Decision and Stopping Thresholds

Hypothesis 6a Decision Threshold: *When asked what actions they would take at different levels of release probability, participants in the Prefer-Action condition will switch from maintaining release plans to speeding up release plans at lower levels of release-probability than participants in the Prefer-Inaction condition. Control participants given no preference manipulation will give decision thresholds that fall between participants in the Prefer-Action and Prefer-Inaction conditions.*

A decision threshold could not be defined for 13 participants in the Treatment group and 17 participants in the Control group. Three participants in the Treatment group and five in the Control group switched from maintaining to speeding up and back again across multiple consecutive probabilities, ten participants in the Treatment group and five in the Control group had too much missing data to define a decision threshold, and seven participants in the Control group had the actions the wrong way around such that they were speeding up release plans at low probabilities of release and maintaining release plans at higher probabilities. Participants with and without decision threshold data did not differ significantly on final release probability, and were fairly evenly spread across the three information condition and two preference conditions.

A univariate GLM was used to examine the impact of preference condition on decision threshold controlling for final release probability and information condition. Hypothesis 6a was supported. On average, participants in the Prefer-Action condition said they would switch to taking action at lower probability of release (M = 37.00, SD = 19.82, n = 35) than participants in the Control group (M = 48.51, SD = 16.17, n = 67), t (132) = 3.00, *p* = .003, explaining 6% of the variance. Participants in the Control group also gave lower decision thresholds than participants in the Prefer-Inaction condition (*M* = 69.44, *SD* = 20.94, *n* = 36), *t* (132) = 5.23, $p < .0005$, explaining 17% of the variance. Overall, the impact of preference condition, including the no-preference Control group was statistically significant, *F* (2,134) = 26.51, $p < .0005$, and explained 28% of the variance in decision threshold.

The majority of participants in the Treatment (90%) and Control groups (76%) made an action decision consistent with their decision threshold given the final release probability they provided. The difference in proportions between Treatment and Control groups was statistically significant χ^2 (*N* = 136, *df* = 1) = 4.90, *p* = .027.

Hypothesis 6b: *Action leaning will be negatively correlated with decision thresholds after controlling for preference condition.*

A univariate GLM was used to examine the impact of the final action leaning on decision threshold controlling for preference and information condition, group, and the preference by group interaction. Hypothesis 6b was supported. After controlling for other factors, for every 10 percentage point increase in final action leaning, there was a 2.34 percentage point (*SE* = .60, 95% CI -1.16, -3.54) decrease in the decision threshold *F* (1, 131) = 15.32, $p < .0005$.

Hypothesis 7 Stopping threshold: *The total number of titles opened and the time spent on the task will be positively correlated with the decision threshold for participants choosing action, but negatively correlated with the decision threshold for participants choosing inaction.*

Hypothesis 7 was tested using two separate univariate GLM analyses regressing total titles selected and investigation time on decision threshold, action decision, and the interaction of interest decision threshold by action decision controlling for information condition. The decision threshold by action decision interaction was not a statistically significant predictor of investigation time F (1,65) = 3.02, p = .087 after controlling for information condition and explained 4% of the variance. Participants who chose action showed a small positive correlation (r = 0.20) between investigation time and decision threshold, whereas participants who chose inaction showed a small negative correlation (r = -0.22). The results were in the same direction for total titles selected. The interaction between decision threshold and action decision was not statistically significant and explained only 2% of the variance.

RESULTS SUMMARY: Decision and stopping thresholds

Preference condition had a strong effect on stated decision thresholds. Participants in the Prefer-Action condition said they would switch from inaction to action at lower levels of release probability than participants from Control and Prefer-Inaction conditions. Participants in the Prefer-Inaction said they would switch from inaction to action at higher levels of release probability than participants from Control and Prefer-Action conditions.

Action leaning and stated decision thresholds were negatively correlated. This lends support to the DHT assertion that decision thresholds are based on the relative activation of competing action decision options.

The relationship between decision and stopping thresholds was in the predicted direction but effects were small and not statistically significant.

8.4. Discussion

Experiment 4 provided support for the impact of preference and expectation on information interpretation and situation assessments. The DHT model was supported with a few minor adjustments, as shown in Figure 15. The nature and implications of these results will be explored in this Chapter 8.4. The results from all experiments, and implications for the final DHT model, will be considered in Chapter 9.

Preference manipulations influenced judgements directly. Both information interpretations and final situation assessments were more supportive of a competitive release in the Prefer-Action condition compared to the Prefer-Inaction condition. The DHT model predicted this outcome. However, the influence of preference on information interpretation was predicted to be indirect, via action leaning and release probability. The results suggest that, at least in this case where the action decision was clearly dependent on the situation assessment, preference applied directly to the action leaning, final situation assessment, and information interpretations relevant to the situation assessment.

The impact of preference manipulations on the final situation assessment was qualified by an interaction with information condition. A possible interpretation for this is that the amount of influence that preference could exert over final situation assessments was dependent on the strength of the information available. This is consistent with the review by Kassin et al. (2013), which suggested that greater confirmation bias was possible in more ambiguous contexts. The Mixed information condition provided a balance of release-consistent and release-inconsistent information. This was the only information condition in which the Prefer-Action and Prefer-Inaction condition participants gave situation assessments that fell either side of their yoked No-Preference Control group. Preference condition had very little impact on final situation assessments in the Release information condition where all information favoured a competitive release, but greater impact in the Mixed condition and much greater impact in the No-Release information condition. Note that both preference conditions fell below the No-Preference Control groups in the No-Release condition. This suggests that the No-Release information built an expectation of no release, but the perceived strength of the evidence differed between Prefer-Action and Prefer-Inaction participants. If greater ambiguity in the information environment allows for greater impact of preference on situation assessments, this would imply that the No-Release information condition was more ambiguous than the Release information condition. These findings are consistent with Bayesian rationality theory. Bayesian rationality theory would predict that the competitive product release within 6 months would be perceived as a rare event given both the specificity of the detail and wording of the scenario. Therefore, the Release condition provides evidence for a rare event, which is stronger than the evidence against a rare event provided in the No Release condition. Strong evidence is likely to allow for less ambiguity than weaker evidence. Further, the influence of preference condition on situation assessments was not significant until the final situation assessment. This may reflect the greater scope for interpretation involved in judging the final situation assessment, which involved the recollection and integration of all information within cognitive limits, compared to incremental judgements, which require an adjustment of interpretation based on only a single item of information.

The final situation assessment given by participants in the Prefer-Inaction group was significantly different from the yoked No-Preference Control group, but the final situation assessment given by participants in the Prefer-Action group was not. The DHT model suggests that action preferences can influence situation assessments and Experiment 4 supported that assertion for final situation assessments. Therefore, one possible explanation is that the scenario alone, without the preference manipulation, drove a propensity towards action that was more similar to that produced in the Prefer-Action, than in the Prefer-Inaction, condition. Manipulation checks were not conducted in the Control group to avoid highlighting the need for action. Therefore, this suggestion cannot be directly tested. However, it is plausible given that the scenario regarded a threat, and DeKay, Patiño-Echeverri, et al. (2009) found that, in threatening scenarios, participants favour incorrect defensive action over correct inaction. Further, overall more participants chose action in Experiment 4 than inaction. Finally, the difference in decision thresholds was greater between the Control and Prefer-Inaction conditions compared to the difference between the Control and Prefer-Action conditions, as detailed in Chapter 8.3.3. This supports the assertion that participants in the Control group had a propensity towards action that was more similar to that of Prefer-Action participants than Prefer-Inaction participants. This could explain observed differences in final situation assessments between Control and Prefer-Inaction, but not between Control and Prefer-Action, conditions.

Expectation also distorted information interpretation and exaggerated situation assessments. Given that expectation was manipulated via the information provided, large effects of information condition on both information interpretation and situation assessments were expected and not necessarily non-normative. Evidence for distortion was found in three main areas. Firstly, the difference in information interpretation between Release and No-Release information conditions increased across trials. Information interpretation was a rating of each individual item of information. Although items of information may have varied in implication, most participants selected information in a different order, information titles did not reveal the implication of content, and expectation did not influence information selection. Therefore, there is no reason why later information should be any more or less indicative of release. The interaction between information condition and trial in the Treatment group, therefore, suggests that as expectation evolved, it influenced information interpretation. The impact of the information condition by trial interaction on information interpretation was fully mediated by release probability in the Treatment group. This suggests that the information received impacted the expectation, measured by perceived release probability, which impacted the information interpretation as predicted by the DHT model.

Secondly, there were significant differences in the judgements made by Treatment and Control participants. The difference in average information interpretation between the Release and No-Release conditions was almost double in the Treatment compared to the Control group. The difference in final situation assessments between the Release and No-Release conditions was 34 percentage points larger in the Treatment group compared to the Control group who received the same information in the same order as the participant they were yoked to. The DHT model predicted these effects due to evolving expectation exaggerating judgements in the Treatment group compared to the Control group who were not allowed to form an expectation.

An alternative explanation is that the ratings given by the Control group were less reliable than those provided in the Treatment group due to differences in how they were asked to process the information. The Control group participants read information about ostensibly separate organisations and were then asked to imagine they all related to a single organisation to form a final situation assessment. The situation assessment in the Control group was, therefore, dependent on memory, and the participants' ability to reinterpret and integrate all information received to form an assessment. This may have been a less reliable and a more error-prone process than Treatment participants who were asked to revise their assessment after each item of information. Accordingly, effects from information interpretation, and direct effects from information condition on final situation assessment had somewhat higher standard deviations in the Control compared to the Treatment group despite exactly the same sample size in each group, as shown in Figure 21. The influence of information interpretations on final situation assessments was also weaker in the Control compared to the Treatment group (Figure 21). However, this increased variability and smaller effect of average information interpretation is unlikely to account for such a large shift towards more moderate situation assessments in the Control group compared to the Treatment group. This explanation can also not account for the difference between groups in information interpretation, which was conducted after each item of information for all participants and differed only in the name of the company referred to.

Finally, the effect of expectation on information interpretation appeared somewhere unexpected, in the interpretation of titles. Release-inconsistent titles were rated as more indicative of release in the Release information condition than in the No-Release condition only among Treatment group participants, not among Control group participants. Further, there was a positive correlation between the interpretations of release-consistent and release-inconsistent titles among Treatment group participants but not among Control group participants. The fact that these results held for Treatment but not Control group participants suggests that this was not a change in title interpretation based on the information found under those titles, but rather the influence of expectation built up through the Treatment information conditions.

These interpretations assume that participants developed a situational expectation in the Treatment, but not in the Control group. There is some evidence that this is assumption is warranted given that Treatment participants stated more extreme final situation assessments than Control participants, implying that they had more certainty in a competitive release occurring or not occurring. Precautions were also taken by referring to different companies in the Control condition, as opposed to a single company in the Treatment group, and ostensibly not requiring Control participants to make a decision or assessment.

Experiment 4 provided evidence that expectation and preference influenced information interpretation and situation assessments. This is consistent with previous findings from information distortion (e.g. Russo & Yong, 2011) and coherence shift paradigms (e.g. Holyoak & Simon, 1999; Simon, Snow, et al., 2004), which noted information interpretation shifts in support of the leading choice. The present study expands on previous findings in a number of ways. Firstly, it demonstrates that expectation influenced the leading action and situation assessment. The leading situation assessment in turn influenced information interpretation. Secondly, preference had a direct impact on information interpretation and final situation assessments. This effect was found even though the preference related to the action and not to the situation assessment directly. Thirdly, the use of a multi-level modelling approach allowed a demonstration that information distortion increased over trials as the strength of expectation changed, and that this change over trials was fully mediated by the measure of expectation, release-probability, on the previous trial. This supports the assertion that expectation influences the focal decision option, which in turn influences information interpretation. It is also consistent with the correlation between certainty in one's action leaning and information distortion found by Meloy and Russo (2004). Fourthly, the influence of expectation on information interpretation translated to corresponding changes in final situation assessments. Therefore, it appears that participants do not adequately adjust for information distortion. This is consistent with Russo and Yong's (2011) finding that information distortion was not associated with reported awareness of distortion. Finally, these results were found where Treatment participants were allowed to select information themselves. This is a step closer to database searches in personal and business life where the individual chooses which information to view, and in what order, from the search results. Choice of information could increase or decrease information distortion effects. Assuming that individuals form some expectation about the information available when selecting a title, interpretations could be either assimilated with, or contrasted against, this expectation (Strack & Mussweiler, 1997). Future research could explore differences in information distortion with and without choice of titles by including a second treatment group yoked to the information selection of the first.

The mechanism for information distortion given by parallel constraint satisfaction (PCS) models, and the new DHT model, is that there is bidirectional activation between information interpretation and related elements including, in this case, the current situation assessment. Accordingly, Experiment 4 found that situation assessment influenced subsequent information interpretation. Information interpretation also influenced the subsequent situation assessment over and above the influence of the previous situation assessment.

Further evidence of bi-directional activation was evident in that final situation assessments increased more after choosing action than inaction compared to the pre-decision situation assessment, even though no additional information was received between the two ratings. This suggests that the action decision, which should be an outcome of the situation assessment, influenced the final situation assessment.

The change in pre-decision to post-decision assessments raises a couple of contradictory results that are worth exploring, both of which may be explained by a difference between step-by-step and end-of-sequence processing (Hogarth & Einhorn, 1992). Treatment participants were asked to process information in a step-by-step manner. After each new item of information, they were asked for updated action leaning and situation assessments. Hogarth and Einhorn (1992) asserted that this effectively forces participants to use an anchoring and adjustment approach whereby each new item of information is incorporated into the most recent judgement. The judgement requested after opening the last title and making their decision may elicit a different processing style because no new information had been presented for incorporation. This may be more similar to an end-of-sequence judgement where a number of items of information are recalled and integrated at once (Hogarth & Einhorn, 1992). The results from Experiment 4 support this interpretation. Information condition had a direct effect on the final situation assessment, which was not accounted for by the interpretation of individual items of information. This suggests that, at some point, the information was integrated such that the whole was different from the sum of individual information interpretations. This direct effect of information condition was also present in the Control group and, in fact, was the only significant effect of information condition on final situation assessments in the Control group. This is consistent with an end-of-sequence judgement for the final situation assessment made in the Treatment group, in addition to the step-by-step judgements made throughout the investigation, and only an end-of-sequence judgement made in the Control group.

The first conflict to explain is that there was evidence that action *decision* influenced the final situation assessment but action *leaning* did not influence situation assessments throughout the investigation. Post-hoc analyses revealed that the relationship between action leaning and situation assessment did not increase over trials. Therefore, this was not an influence that evolved over time and trials. Participants appear to have updated action leaning and situation assessments relatively independently based on the information during the step-by-step processing. Only after the decision had been made, when participants engaged in an end-of-sequence integration of the information did action decision feed into the final situation assessment.

These results appear to fit with early cognitive consistency theories, such as cognitive dissonance theory, which proposed that decision elements did not get integrated into the cognitive representation until a decision had been made leading only to post-decisional distortion not pre-decisional distortion (see Brownstein, 2003 for a review). However, more recent approaches have favoured incorporation of decision leanings into cognitive representations before a decision is made leading to pre- and post- decisional distortion (Brownstein, 2003; Simon, Snow, et al., 2004). Experiment 4 also found that preliminary situation assessments impacted the interpretation of information regarding the situation. This coheres with findings that evolving situation preferences influence risk assessments (Russo & Yong, 2011). Previous research has also found that preliminary action leanings impacted the interpretation of information regarding favourability of action decision options such as a choice of gambles or choice of product brands (DeKay et al., 2011; Russo et al., 1998). Therefore, there is evidence that pre-decisional distortion does occur, and did occur in

Experiment 4. Another explanation is that the requirement of step-by-step processing prevented the integration of action leaning and situation assessments during the investigation. Consistent with this view, Simon et al. (2001) found that action leanings towards choosing one job or another influenced attribute ratings after considering information on numerous aspects of the job without step-by-step questioning, but prior to committing to a choice. It is possible that the action and situation assessment decision elements were incorporated into the cognitive representation of the problem during the information search, as proposed by the DHT model and recent cognitive consistency models, but bi-directional activation between the decision elements was not detected in this case due to the step-by-step questioning.

There was a difference between the step-to-step and final questions about action leaning and situation assessment. In all trials action leaning questions were asked prior to the situation assessment (release probability) question. However, step-to-step questions presented all questions in the one pop up window, whereas in the final trial the situation assessment question was asked on a separate page, after the action decision had been made. There is evidence that when questions are asked together, participants assume that the second question precludes information already provided in the first, resulting in lower correlations between questions presented together compared to questions asked in the same sequence but on different pages (for a review see Hilton, 1995). This could explain the lack of association between action leaning and situation assessments in the step-to-step questioning mode compared to the final trial.

An explanation for post-decisional shifts in situation assessment that complements bi-directional activation mechanisms is that situation assessments are changed after a decision to justify that decision. This explanation is supported by Tetlock and Mark's (1992) social contingency model and Mercier and Sperber's (2011) argumentative theory. These explanations are complementary because the DHT and PCS models largely present an argument for how pre- and post-decisional shifts occur. Whereas Tetlock and Mark (1992) and Mercier and Sperber (2011) focus more on why pre- and post-decisional shifts occur. The major conflict might appear to be whether individuals intentionally alter their assessments for the goal of justification but this is not actually a necessary part of these theories. Argumentation theory suggests that humans have evolved to be good at justifying their decisions to gain the support of others. This does not imply that the justification is intentional, only that it is now part of human nature. Tetlock and Mark (1992, p. 345) suggest more intentionality and state that post-decisional bolstering is activated to satisfy the "desire for approval and respect". However, they also acknowledge that the accountability of conduct is a "universal feature of the natural decision environment" (Tetlock & Mark, 1992, p. 337) and that individuals are expected provide acceptable reasons for their actions. The inclusion of bidirectional activation of information interpretation and related situation assessment or decision leanings in PCS processes could satisfy these goals.

The second apparent conflict is that situation assessments increased pre to post decision for participants who chose inaction, only more so for those who chose action. It is possible that, since the question was worded in terms of the likelihood of release, it produced an anchor at the release end of the scale and elicited recollection of predominantly release-consistent information. This is consistent with motivated reasoning theories (Kunda, 1990; Pyszczynski & Greenberg, 1987) as well as more recent explanations of the anchoring effect (Kahneman, 2011; Strack & Mussweiler, 1997). This anchoring effect would only be expected to occur when participants are required to recall a range of information as in end-of-sequence processing, but not when they reflect on a single item of information as in step-by-step processing, thus explaining the difference between pre-decisional and post-decisional assessments.

These results raise a number of important points for future research. Firstly, the nuanced difference between the influence of action leaning on situation assessments and action decision on final situation assessment could easily have been missed if preference and expectation were not controlled. Both action leaning and situation assessments were influenced directly in the same direction by preference and information conditions throughout the investigation. When these conditions were not controlled, it did appear that there was a bi-directional link between action leaning and situation assessment. This could be relevant for future research using information distortion paradigms that base information distortion on the decision leaning alone without controlling for individuals' expectation and preference.

Secondly, the suggestion that step-by-step processing may have prevented an association between action leaning and situation assessment, which may otherwise have formed, has important implications for research. Process-tracing techniques, such as asking for judgements after each item of information, provide data that can be otherwise difficult to access. In this case, it is suspected that the difference may be due to the presentation of questions together throughout the investigation, but separately after the investigation. This is an important consideration for future research. When the correlation between two process-tracing questions is of interest, it may be advisable to either ask questions separately during the step-to-step as well as final questioning, or ask questions alternately on different trials. There are a number of other reasons why process-tracing techniques may alter decision processes (see Kuhberger et al., 2010 for a review). Process-tracing techniques can alter the information processing mode as discussed, increase the cognitive load on participants, and require participants to provide a decision leaning before they may naturally have formed one. For example, O'Brien (2007) found more evidence of confirmation processes for participants who had stated a prime suspect in a murder trial compared to participants who had not. Future uses of process-tracing techniques should include a Control group that does not receive the questions after each item of information so that important outcome variables, such as final situation assessment, or final decision, can be compared. The results from Experiment 4 mostly mirror those from Experiment 3 where participants were exposed to the same scenario and conditions without process tracing measures. In both experiments, information and preference condition influenced final release-probability, and information selection was not influenced by treatment manipulations. However, due to the different size and content of the information grids in Experiments 3 and 4, it is not meaningful to compare effect sizes.

Consistent with previous experiments, neither expectation nor preference manipulations impacted information selection. However, the use of multi-level modelling techniques revealed some unexpected results. Firstly, selection favoured release-consistent titles initially, and release-inconsistent titles after more information had been examined. Secondly, as the number of release-consistent titles already selected out of a finite pool of eight increased, the likelihood of selecting another release-consistent title also *increased.* Further examination of data from previous experiments revealed that neither of these results was replicated in previous experiments. Therefore, care needs to be taken in interpretation. However, these results do have potential for further research and may have important implications for confirmation bias if replicated. The first observation may be indicative of a perception that release-consistent titles are of greater quality and therefore selected first, or the influence of frame over early information selection. The second observation, that the more release-consistent titles participants had selected, the more they were likely to select, could reflect individual differences. Consistent with this possibility, an exploratory analysis revealed that participants with high need for predictability were more likely to display this pattern than participants with low need for predictability. However, this interaction was not replicated in previous experiments either. An examination of individual differences was beyond the scope of this thesis but may be an important aspect of confirmation bias. Future research is needed into the characteristics and decision-making behaviour of individuals who display, and do not display, tendencies towards confirmation bias.

As in Experiment 3, preference condition had a strong influence on decision thresholds as predicted by the DHT model. Participants who preferred action would choose action at lower levels of release probability than participants who preferred inaction. These findings are also consistent with prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992), signal detection theory and variants (Green & Swets, 1966; Pleskac & Busemeyer, 2010), and expected utility theory (Mongin, 1997) all of which directly, or indirectly, predict decision thresholds based on the possible costs and benefits of actions or prospects. The DHT model provides a potential mechanism for these effects by suggesting that decision thresholds are based on the relative activation of opposing decision options, which are influenced by possible costs and benefits associated with each. In support of this action leanings were negatively associated with stated decision thresholds over and above preference condition. Implications of this finding are discussed in Chapter 9.1.4.

Decision thresholds were only self reported but were consistent with the action taken considering the final release probability for the vast majority of participants. However, this consistency was significantly higher for participants in the Treatment compared to the Control group. Only 10% of participants in the Treatment group gave decision thresholds that did not fit, very similar to the 11% figure in Experiment 3, whereas 24% of participants in the Control group gave decision thresholds that did not fit their situation assessments and chosen actions. The similarity in proportion between the Experiment 4 Treatment group, and Experiment 3, suggests that this cannot be attributed to process tracing measures. This indicates greater internal consistency in the action, situation assessment, and decision threshold judgements in the Treatment compared to the Control group. The DHT model and PCS processes can explain this outcome. Both theories suggest that participants who are asked to make a decision and given information pertaining to a single entity strive to maximise consistency among associated cognitive elements within constraints. The DHT model proposes that decision thresholds are based on the relative activation between action decision options. These action decision options are strongly influenced by preference, but can be counteracted by the activation of situation assessment options. The Treatment group would be expected to consider both action decision options and situation assessment decision options throughout the investigation, leading to greater coherence between the chosen action, the stated situation assessment, and the decision threshold devised from activation of action decision options. The Control group was not compelled to make a situation assessment or action decision and, therefore, had to form impressions of these elements when asked the questions. The shorter time frame may have constrained ability to form a consistent representation of the elements in a greater portion of the Control group participants. This highlights an advantage of PCS and bi-direction activation processes. Although they can exaggerate coherence, they can also lead to greater internal consistency among decisions made by the same individual (see Monroe & Read, 2008 for a PCS model of attitude structure and change). There was no statistically significant association between decision and stopping thresholds observed. Discussion of this null finding is delayed to Chapter 9.1.4.

Experiment 4 provided an important step towards understanding and unifying confirmation of preference and expectation and refining the DHT model. Chapter 9 will bring findings together from all Experiments to detail implications for the final DHT model, and practical applications.

8.5. Summary of Results from Experiment 4

Preference-based processes: Action preferences directly influenced decision thresholds, information interpretation, final situation assessments (release probability), and actions, but not information selection.

Expectation-based processes: Expectation was manipulated via the information provided in the information grids. Information condition influenced information interpretation, final situation assessments, and actions, but not information selection. Information interpretation and final situation assessments were compared for Treatment participants and Control group participants who received exactly the same information but were not asked to make a decision. Expectations exaggerated final situation assessments compared to the no-decision Control group. This effect was partially mediated by exaggerations in information interpretation compared to the no-decision Control group.

Preference and Expectation: There was some indication that, when preference and expectation support opposing decision options, expectation had a greater influence on information interpretation and subsequent situation assessments than action preference.

9. General Discussion: The DHT Model, Implications for Theories of Confirmation Bias and Practical Applications

This thesis has made a number of important contributions to understanding confirmation bias by proposing a single model to account for confirmation of preference, expectation, and frame outcomes, as well as the constituent confirmation processes. This chapter is intended to integrate the results from all of the experiments and consider the implications for the DHT model. The series of experiments detailed in Chapters 5 to 8 tested a number of assertions from the DHT model, as summarised in Table 16. Empirical results for each of these assertions will be integrated with a discussion of implications for the final DHT model. An expansion of the DHT model from how to why confirmation bias occurs will then be proposed. Strengths and limitations of the DHT model and empirical studies will then be discussed, with a focus on future research directions. Finally, practical applications will be suggested before concluding with the contributions of this research to an understanding of the many forms of confirmation bias.

Table 16: Summary of DHT Model Assertions Empirically Tested through Experiments 1 to 5

Process	DHT model assertion
Problem Representation	
✖	1. Associated situation assessments and action decision options will exert bi-directional influence over each other.
Information Selection	
✔	2. PTS behaviour can be observed in complex, ambiguous, cue-based environments.
✔	3. Frame-based PTS is observed only in the absence of new information that provides additional context.

✖	4.	Participants select information associated with the preferred and expected decision options.
✖	5.	Participants select information consistent with, rather than inconsistent with, the previous focal situation assessment.
Information Interpretation		
✔	6.	Information interpretation is biased towards the previous focal situation assessment.
Decision and stopping thresholds		
✔	7.	Decision thresholds for action increase as costs of action increase, and decrease as costs of inaction increase.
✔	8.	Decision thresholds are based on the relative activation of opposing action decision options.
?	9.	Less differentiation between options leads to more information seeking behaviour, assuming constraints are equal.
Final situation assessment		
✔	10.	Preference for an action can exaggerate final situation assessments such that they favour the preferred action.
✔	11.	Final situation assessments are biased towards the expectation built up through the information available in the treatment, compared to the control group.

Note: ✔ = Assertion empirically supported, ✖ = Assertion not empirically supported, **?** = Assertion partially supported.

9.1. The Final DHT Model

As shown in Figure 23, the final DHT model is very similar to the original DHT model. Chapter 4 provided a detailed introduction to the DHT model. Refinements, extensions, and implications for future research are detailed here. The discussion starts with behavioural components of the model including information selection, interpretation, decision and stopping thresholds and the decision outcome, before returning to the mechanisms of the theory, specifically, accessible characteristics, and problem representation.

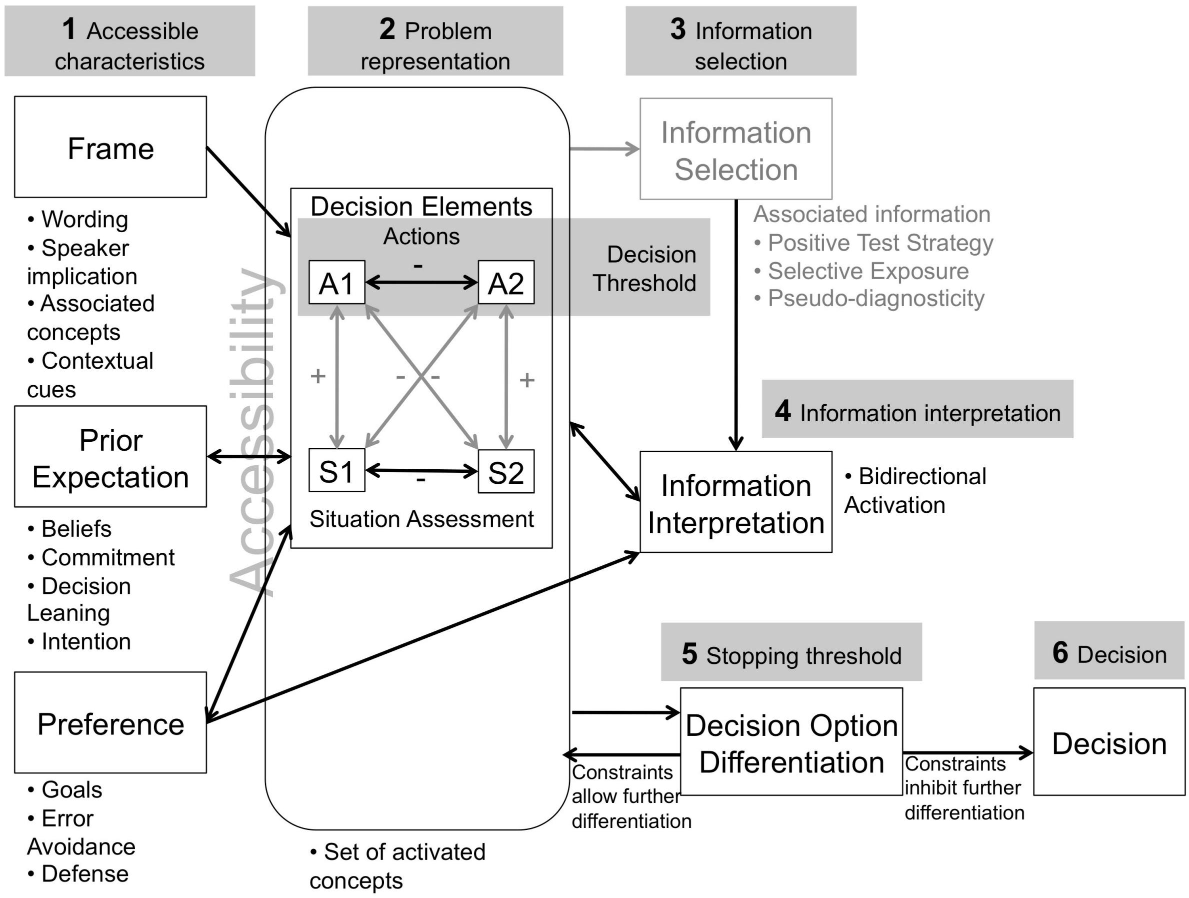


Figure 23: The final Dynamic Hypothesis Testing (DHT) model.

9.1.1. *Problem Representation*

The bidirectional activation between associated decision options was not observed during the investigation in Experiment 4 as represented by the grey arrows in the final DHT model (Figure 23), therefore Assertion 1 (Table 16) was not supported. The DHT model does require this bidirectional activation to be somewhat limited due to decision threshold predictions. The DHT model proposes that the relative activation of action decision options determines the decision threshold. A high decision threshold is created by a strong preference for inaction over action. High decision thresholds can be surpassed if the activation of the situation assessment decision option associated with action is strong enough. If bidirectional activation between associated decision options were too strong, the situation assessment decision option associated with action would activate the action decision option, thus forcing a more moderate decision threshold. Therefore, if bidirectional activation were too high, the distinction between the action and the situation assessment decisions would be meaningless.

One possibility is that these bidirectional links are absent, or too weak to be detected. Alternatively, there is a possibility that the simultaneous presentation of questions throughout the investigation limited bidirectional activation that would otherwise have occurred as discussed in Chapter 8.4. Further research is required to determine the degree to which associated decision options, such as related situation assessments and actions, are connected in mental representation, and whether connections are bidirectional even when the situation calls for a unidirectional connection. It is also important to control for expectation and preference, as these conditions were found to create a spurious connection between action and situation assessment decision leanings. Further research into the degree of bi-directional association between representations of related actions and situation assessments could help to refine the DHT model in terms of the conditions under which bi-directional association is observed, and the strength of this association.

9.1.2. Information Selection

Recall that frame-based Postive Test Strategy (PTS) is the selection of titles containing concepts that are mentioned in or implied by the question wording (frame-consistent titles), rather than the inverse of those concepts (frame-inconsistent titles). There was evidence of frame-based PTS in the first experiment, which was replicated using the same information grid as in Experiment 4 (see Appendix E for details). Participants selected more titles consistent with a competitive release possibility, mentioned in the scenario, than titles inconsistent with this possibility. Therefore, there is some support for Assertion 2 (Table 16), that PTS behaviour can be observed in complex, ambiguous, cue-based environments.

This suggests that the titles used were identifiable as release-consistent or release-inconsistent and that the tendency for PTS can be demonstrated in this information space.

In support of Assertion 3 (Table 16), Experiments 1 and 2 (Chapter 6.2.2) demonstrated that frame-based PTS was evident in a simultaneous information search task, where participants selected titles prior to ostensibly receiving the information contained, but not in a sequential information search task, where the information was available upon selecting a title. This difference occurred despite participants seeing exactly the same information space. This suggests that PTS might be a more common strategy in simultaneous information search tasks, like many of those traditionally used to study PTS (e.g. Snyder & Swann, 1978; Wason, 1968), than in sequential information search tasks, like common database searches.

The DHT model predicted that expectation would become more influential on information selection throughout the investigation (Assertion 4 in Table 16), thereby reducing the impact of frame, but expectation was not found to have any effect on information selection in Experiments 3 or 4. There was speculation that the time limit and reduced number of titles selected in the sequential information search condition may have altered selection strategy. However, a comparison of title selection using the 4 by 4 information grid in Experiment 4 and 5 (Appendix E), neither of which had a time limit, found that participants selected more titles in the sequential information search scenario, but frame based PTS was still only evident in the simultaneous information search experiments.

There are at least three possible explanations for the observation of frame-based PTS in simultaneous but not sequential information search experiments.

1. Temporary frame: The effect of frame was temporary. Information selection was influenced by other factors once more context was received from the information selected or as time passed.

2. Expectation: Expectations influenced the interpretation of titles such that the perceived difference between the title types diminished as expectation for a particular situation increased.
3. Selective exposure: Participants expected titles to contain affirmative information. That is release-consistent titles would hold release-consistent information and release-inconsistent titles would hold release-inconsistent information. Therefore, behaviour in the simultaneous information search condition was an attempt at Selective Exposure (SE), which was no longer supported in the sequential information search condition.

Based on the DHT model, the influence of frame was predicted to be temporary. As the investigation progressed, new context provided by further information, the persistence of preference, and evolving expectation were predicted to become more influential on the focal decision option than the original frame. Experiment 4 found that the selection of release-consistent titles was more likely earlier in the investigation than later, which is supportive of a temporary influence of frame, but this finding was not replicated in other experiments. An investigation of attribute framing also found that the impact of attribute framing on judgements was significantly reduced by subsequent information (Weeks & Wastell, Under review).

The expectation explanation fits with the findings from Experiments 3 and 4 that release-consistent and release-inconsistent titles were considered more supportive of release in the Release condition compared to the No-Release information condition. Experiment 4 demonstrated that this applied to the Treatment condition only, not to the Control group where an overall situation expectation was prevented. Further support for the expectation explanation is found in the examination of the title-perception manipulation checks across Experiments 1 to 5. As detailed in Appendix D, on average, release-consistent titles were considered more indicative of release than release-inconsistent titles across all 5 experiments. In simultaneous information search Experiments 1 and 5, this difference remained constant, regardless of the number of titles the participant selected. In sequential information search with expectation manipulations, Experiments 3 and 4, the perceived difference between release-consistent and release-inconsistent titles was smaller for participants who selected more titles compared to those who selected fewer titles. This suggests that the information received when selecting titles reduced the perceived difference in implication between the title types. This convergence of the perception of release-consistent and release-inconsistent titles was observed in the Treatment, but not Control group of Experiment 4, even though both Treatment and Control participants used sequential information search. It was also observed in Experiments with expectation manipulations, but not the sequential information search experiment without expectation manipulations, Experiment 2. This supports the suggestion that expectation sways title perception such that the perceived difference between title-types diminishes, and that expectation was built during sequential but not simultaneous information search, and the Treatment but not the Control group.

The SE account can explain both the absence of frame-based PTS, and the convergence of title perception as more titles were selected in the sequential information search experiments. However, if the finding that titles did not contain affirmative information swayed title interpretation, the SE account cannot explain why this did not apply in the Control, as well as the Treatment groups given that both received information that contradicted the title. Further, participants in the simultaneous information search conditions were told that the title type did not predict the information type and the vast majority answered correctly when asked about the type of information they could expect, as detailed in Chapter 6.3.

Explanation 1 and 2 are not mutually exclusive. Recall that the frame was applied via a scenario that focused on the possibility of release, whereas expectation was built up via the implication of the information available for examination. It is possible that frame held a temporary effect over information selection that was reduced by the receipt of further information. In addition, evolving expectation swayed title interpretation such that the perceived difference between release-consistent and release-inconsistent titles reduced, which resulted in participants relying on factors other than release-implication to select information.

The results from these series of experiments are consistent with a diminishing impact of frame that can be observed in complex information environments as per the DHT model assertions. However, frame was not manipulated in any of the five experiments. Therefore, whether frame-based PTS was observed in Experiments 1 and 5 due to the impact of frame, or due to another factor confounded with frame, cannot be determined. Further research is needed to manipulate frame in simultaneous and sequential information search conditions to examine whether the results from these Experiments can be replicated and whether the temporary influence of frame, and expectation explanations hold. The DHT model predicts frame to have a temporary influence relative to other accessible characteristics because it is not constantly reactivated by consideration of goals or new information. Research is needed into whether framing effects decrease predominantly due to new information and thought on the topic, or due to the passing of time and decays in memory, or both.

Contrary to Assertion 4 (Table 16), preference condition did not influence information selection in any of the four experiments. This contrasts with previous findings using variants of the Wason selection task (Dawson et al., 2002; Smeets et al., 2000), and theories that suggest that preference (Kunda, 1990; Pyszczynski & Greenberg, 1987; Trope & Liberman, 1996), or error avoidance (Friedrich, 1993; Klayman & Ha, 1987; Lewicka, 1998) motivate different title selections. There are a number of possible explanations for this null finding.

Firstly, participants may alter information selection based on danger versus safety cues as found by Smeets et al. (2000), but not based on more subtle differences in error costs. The scenario used throughout this thesis is predominantly a danger scenario regarding the threat of a competitive release. The manipulation of costs associated with maintaining or speeding up plans may be too subtle to influence information selection. This could be indicative of inadequate manipulations, given that preference was manipulated via the emphasis of action costs, strengthened with only a small financial consequence for participants in Experiments 3 and 4. Alternatively, it may suggest that individuals are insensitive to subtle shifts in error costs and thus rarely alter their strategy. This is inconsistent with some error-avoidant theories (Friedrich, 1993; Lewicka, 1998), but consistent with Klayman and Ha's (1989) depiction of PTS as being advantageous in many naturally occurring situations but only altered in response to each situation under optimal conditions. Klayman and Ha (1989) asserted that individuals might be better able to adjust their strategy under favourable conditions including light memory load, adequate time, and extensive experience. The PTS results reported throughout this thesis, with novices probably experiencing high memory load, may not generalise to more experienced populations or familiar tasks. Further research is required to extend these results to expert information selection.

Secondly, the efficacy of different actions in different situations may have been questioned. If poisonous mushrooms can be identified, there is no doubt that not eating them will avoid the dangerous outcome. It is not so clear that speeding up release plans would effectively mitigate the costs of a competitive release. It is possible that actions were not considered efficacious enough at avoiding costs to warrant altering information selection in this case.

None of the accessible characteristics, frame, preference, or expectation, predicted information selection in the sequential information search experiments. These experiments were limited to the examination of PTS selection behaviour. Investigations of information selection in complex sequential information search situations may need to look beyond PTS, to other predictors of information selection such as diagnosticity (e.g. Rusconi, Sacchi, Toscano, & Cherubini, 2012).

There was no evidence that the previous situation assessment influenced subsequent PTS behaviour, which is inconsistent with Assertion 5 (Table 16). Accordingly, the link between decision elements and information selection is greyed out in the final DHT model (Figure 23). The information available had a strong influence over information interpretation as demonstrated by differences in interpretations between Release and No-Release information conditions. It follows that, in cases where information selection results in a non-representative sample of information, that this would still impact information interpretation. Therefore, the connection between information selection and information interpretation remains. Further research is required into how particular selection strategies may alter the quality and implication of information received.

9.1.3. Information Interpretation

The role of information interpretation in the DHT model was supported. Information interpretations were positively associated with the situation assessment stated on the previous trial. This suggests that the situation expectation influenced subsequent interpretation of new information, as per Assertion 6 (Table 16). A direct influence of preference on information interpretation was also added to the model. The impact of preference and expectation on information interpretation appears to be an important driver of confirmation bias outcomes. Experiments 3 and 4 found evidence of confirmation of preference despite no impact of preference on information selection or stopping thresholds, and Experiment 4 found that information interpretation was a significant mediator of confirmation of expectation and preference outcomes.

The bidirectional link between information interpretations and decision leaning was supported in Experiment 4. Specifically, situation assessment influenced subsequent information interpretation, which in turn influenced the subsequent situation assessment, after controlling for information and preference conditions. The DHT model, consistent with PCS models (Simon, Snow, et al., 2004), suggests that new information is represented cognitively and that bidirectional connections form between this new cognitive representation and associated elements. An interesting direction for future research might be how the initial connections formed impact later recall and incorporation of that information into judgements. According to the DHT model, if new information conflicts with the focal decision option at the time, it is inhibited by the focal decision option, thus reducing its impact on the focal decision option. If the focal decision option was to change by the end of the investigation, and the participant was asked to consider all information received to form a judgement, there are a number of possible outcomes for the previously inhibited information. It may be activated by the new focal decision option thus gaining in strength relative to before. Alternatively, the initial inhibition of that information could hinder later recall, or create an impression of low quality or strength of information that is retained in future recall. Developing an understanding of these processes could have implications for the impact of discredited evidence (see Lagnado & Harvey, 2008 for a discussion), as well as effective study and investigation techniques where expectations form, but all information needs to be recalled or integrated to form a judgement.

9.1.4. Decision and Stopping Thresholds

Experiments 3 and 4 confirmed a strong influence of preference condition on self-reported decision thresholds consistent with the DHT model Assertion 7 (Table 16), and both normative (Green & Swets, 1966; Mongin, 1997) and descriptive (Kahneman & Tversky, 1979, 1990; Tversky & Kahneman, 1992) models of decision making. Further, the DHT model asserted that the relative activation of competing action decision options is used to determine when to switch from inaction to action. Consistent with this assertion (Assertion 8, Table 16), participants who were more strongly inclined towards action at the end of the investigation reported that they would choose action when the threat of release was lower, compared to participants more strongly inclined towards inaction at the end. This effect held after controlling for preference condition. This raises an interesting possibility. Given that the direction and strength of inclination towards action or inaction would be expected to change throughout an investigation, and was observed to change over trials in Experiment 4, this would imply that the decision threshold would also shift throughout an investigation. According to the DHT model, decision thresholds are not stopping thresholds. Therefore, the point at which an individual chooses, or is required, to stop the information search may impact the decision made, due to the shifting nature of the decision threshold.

The DHT model predicted that choosing action despite a high action decision threshold, or choosing inaction despite a low action decision threshold implies conflict between competing action decision options and situation assessment decision options. This was predicted to be associated with more information search as measured by the amount of information sought and the time spent searching for and considering information (Assertion 9, Table 16). The relationship between stopping and decision thresholds was in the predicted direction but consistently weak and not statistically significant across the two measures of information search behaviour in both Experiments 3 and 4. Therefore, there was no evidence that participants required more information or time to accept undesirable as opposed to desirable conclusions. The DHT model predicts that higher action decision thresholds should be associated with more information search when three conditions are met. 1) When action, rather than inaction, is chosen, implying low option differentiation 2) When there is minimal bidirectional association between associated decision elements, as observed in Experiment 4, because high bidirectional association would decrease conflict between action and situation assessment decision options. 3) When other constraints on decision option differentiation are minimal. Other constraints on option differentiation such as cognitive load, ambiguous and conflicting information, and fatigue were probably fairly high in these experiments compared to other laboratory experiments, but may be similar to the option differentiation constraints experienced in many professional and personal decision making contexts, especially when the task or information environment is novel as detailed in this Chapter 9.3. In contradiction with theories that combine decision and stopping thresholds (Busemeyer & Townsend, 1993; Pleskac & Busemeyer, 2010; Ratcliff & McKoon, 2007; Trope & Liberman, 1996), the DHT model predicts the relationship between decision and stopping thresholds, and resultant impact on confirmation bias outcomes, to be small in most decisions, as observed in Experiments 3 and 4. An exception could occur for affect-laden preferences as noted in Chapter 3.1. Affect-laden preferences are presumably stronger than affect-neutral preferences (see Rottenstreich & Hsee, 2001; Rottenstreich & Shu, 2004). According to the DHT model a strong preference for one option, should decrease the decision threshold for choosing that action decision option more than a weak preference. Compared to a weak preference, a strong preference would also be predicted to have a stronger influence over the situation assessment such that it supports the preferred action. This would artificially increase option differentiation leading to more limited information search behaviour for strong than weak preferences. This is consistent with evidence that the relationship between decision and stopping thresholds is stronger for affect-laden preferences, as detailed in Chapter 3.1.

The DHT model makes important theoretical advancements in the area of decision and stopping thresholds. Firstly, it separates decision and stopping thresholds, which are often theoretically and conceptually combined (Busemeyer & Townsend, 1993; Pleskac & Busemeyer, 2010; Ratcliff & McKoon, 2007; Trope & Liberman, 1996), for an exception see

(Gigerenzer & Gaissmaier, 2011). Secondly, it incorporates decision and stopping thresholds into an associative network model using PCS mechanisms. Decision thresholds are represented by relative activation of competing action decision options. Information search stops when an optimal level of differentiation between decision options is achieved. Greater differentiation is achieved as the difference between action decision options increases and the difference between situation assessment decision options increases in the same direction. For example, option differentiation increases as an individual who originally had no decision leaning becomes more supportive of defensive action and more certain of a threatening situation. ‘Optimal’ differentiation is maximal differentiation within constraints. The level of differentiation possible could be limited by factors that produce conflict between decision options, such as preference and expectation conflicts and evidence conflicts, or factors that limit the energy and time available for further differentiation, such as restrictions on time, motivation, or cognitive resources.

The term threshold is used to maintain consistency with the literature but the DHT model does not assume that individuals compare their judgements to a threshold. Rather, thresholds can be drawn from relative activation of decision options and are fluid and expected to change with the individual’s problem representation and differentiation constraints. This fits with observations that decision thresholds lack consistency within individuals across trials (Mueller & Weidemann, 2008).

Finally, the DHT model predicts that decision thresholds and the situation assessment that feeds into them are not necessarily independent. Consistent with this view, Experiments 3 and 4 found that preference for action decreased decision thresholds and increased final situation assessments compared to preference for inaction. This combination increases the likelihood of choosing the preferred action.

9.1.5. Decision Outcome

Confirmation of preference was found in Experiments 3 and 4, but not in Experiment 2. Specifically, participants predicted that a competitive release was more likely when the preference manipulation favoured defensive action than when the manipulation favoured inaction, which supports Assertion 10 (Table 16). The main difference in the preference conditions between Experiment 2 and Experiments 3 and 4 was that participants expected financial costs for incorrect decisions in Experiments 3 and 4, but not in Experiment 2. It is possible that the financial costs made preferences manipulations stronger, and more personally relevant, thus producing a noticeable bias. Additionally, Meloy, Russo, and Miller (2006) found that information distortion was greater amongst student participants when there were financial incentives for accuracy. Therefore, it is also possible that the differences between Experiment 2 and subsequent experiments could be attributed to differences in information distortion. The effect of preference on final situation assessments cannot be fully attributed to changes in information distortion, because a direct effect of preference condition on final situation assessments after controlling for the indirect effect via information interpretation was also observed in Experiment 4. Therefore, it seems likely that the addition of financial incentives strengthened the preference manipulation, thereby producing effects of preference on judgements. It is possible that this may have been further exaggerated by a more direct influence of financial incentives on information distortion.

Experiments 3 and 4 also demonstrated that final situation assessments were strongly influenced by the implication of information available throughout the investigation. Experiment 4 demonstrated that final situation assessments were exaggerated towards the situation implied by the available information for participants asked to make a decision compared to participants not expecting to make a decision. This suggests that final situation assessments were biased towards the developing expectation for participants asked to make a decision, as per Assertion 11 (Table 16) and as discussed in Chapter 8.4.

The DHT model outlines how decisions can be swayed by the accessible characteristics: frame, expectation, and preference. The DHT model does not preclude choosing a less preferred option or switching to an initially unexpected conclusion. This is consistent with attitude polarisation studies, where participants with opposing views diverge but are still swayed somewhat by information counter to their position (e.g. Feldman, 2011; Lord et al., 1979).

9.1.6. Accessible Characteristics

Experiments 3 and 4 highlighted the importance of considering preference independently from expectation. Previous research has focused largely on decision leaning as a predictor of information selection (e.g. Klayman & Ha, 1989), interpretation (e.g. DeKay et al., 2011; Russo & Yong, 2011), and decision outcomes (e.g. Lord et al., 1979). Experiment 4 found that decision leanings towards actions and situation assessments were influenced independently by preference and expectation.

Preference and expectation differed in the degree and nature of their influence over decision processes. In this case, preference generally had a lesser impact on final situation assessments than expectation as detailed in Chapter 8.3.2.3. This result could be peculiar to this research for a couple of reasons. Firstly, preference manipulations targeted the action decision, whereas the expectation manipulation targeted a related situation assessment, and the main outcome of interest was the situation assessment. Therefore, expectation manipulations were more directly related to the outcome variables than preference manipulations. Secondly, preference was manipulated in a scenario that was novel to participants and the only personal impact was a small financial penalty for incorrect decisions that was larger for one incorrect decision than the other. The scenario was intentionally novel, to explore the impact of preference in a relatively affect-neutral situation. The impact of preference is likely to be greater with more affect-laden outcomes (Rottenstreich & Hsee, 2001). The nature of the impact of expectation and preference also differed. As shown in the final DHT model (Figure 23), preference had direct effects on most judgements, including information interpretation, and final situation assessments. In contrast, expectation impacted information interpretation only indirectly via the previous situation assessment or decision leaning.

The DHT model as outlined in Chapter 4 and refined here provides mechanisms for how confirmation bias outcomes might occur, but not why. The next section expands the DHT model to include an explanation of why confirmation bias occurs.

9.2. DHT Model: Why Does Confirmation Bias Occur?

The DHT model asserts that confirmation bias is a natural side effect of striving for certainty and consistency and that mechanisms that produce confirmation bias also allow people to make sense of the world around them and take definitive action in uncertain, ambiguous environments. Striving for certainty is defined here as attempting to feel like one understands the problem in focus. The DHT model asserts that individuals strive for certainty more in some contexts than in others. Certainty becomes more important as the situation increases in personal relevance, importance, and interest, and as perceived control over outcomes increases. For example, individuals required to make a decision or choice and experience the outcomes, are expected to strive for certainty more than individuals not required or able to make a decision or choice.

Gaining a *sense* of understanding does not necessarily correspond with seeking the truth. In many cases the situation cannot be observed directly. For example, in most cases, the market analyst cannot directly observe the intentions of competitors, homebuyers cannot directly observe the market trend, and pilots cannot directly observe a storm. This is especially true when attempting to predict future situations. Therefore, decision makers have to rely on numerous cues that have imperfect correspondence with reality and may be perceived imperfectly. One source of a sense of understanding is consistency and redundancy among those cues, such that information fits together and overlaps. Consistent cues, even with a degree of redundancy, have been found to increase confidence (Karelaia, 2006; Tsai et al., 2008; Yaniv, Choshen-Hillel, & Milyavsky, 2009). Consistency is the degree to which information fits together such that it converges on a single, coherent situation or decision option. The DHT model argues that mechanisms that increase consistency among items of information are favoured because they increase certainty. Consistent with this view, Experiment 4 found that participants tasked with making a decision that required an understanding of the situation gave more extreme situation assessments, indicating greater perceived probability of the anticipated situation occurring, and showed greater consistency among their situation assessment, action and decision threshold than participants not required to make a decision.

The assertion that people strive for a sense of understanding, derived from consistent and coherent information, is not uncommon. The story model (Pennington & Hastie, 1992) asserts that jurors attempt to gain a sense of understanding in court cases by constructing a coherent story of the events. Need for closure theory (Kruglanski, 2004) asserts that many individuals strive for a sense of closure whereby they try to reduce ambiguity and increase predictability. Coherence-based models (Simon, Snow, et al., 2004) assert that people attempt to get different elements of cognition to fit together.

There is also empirical support that striving for consistency contributes to many confirmation processes. For example, Jonas et al. (2001) found that SE (selective exposure) was greatest when participants compared new information to their focal decision option, thus making the consistency or inconsistency of the information salient. SE was lower when participants were encouraged to focus on the quality of the new information, independent of their focal decision option. Russo et al. (2008) found that the degree to which information interpretation was distorted towards the focal decision option was 119 percent greater for participants primed with consistency goals compared to an un-primed control group. Information distortion was also related to participants' reported levels of consistency goal activation.

There are also many advantages to striving for certainty and consistency that have been proposed as independent motives. Firstly, certainty and consistency-seeking can contribute to differentiating competing options, a central motive in the differentiation and consolidation theory (Svenson, 1992), and important component of the stopping threshold in the DHT model. Russo et al. (2008) demonstrated that information distortion favoured the focal decision over alternatives, and in effect, exaggerated the perceived difference between decision options. Similar findings are demonstrated in the PCS literature (e.g. Simon & Holyoak, 2002; Simon, Krawczyk, et al., 2004). Experiment 4 also found that information distortion increased certainty that the expected or preferred situation would occur.

Secondly, certainty supports confident action by providing a sense of understanding and, therefore, control over ones environment. Confident action can be socially advantageous, even in cases where the action is suboptimal. For example, Tetlock (2005) found that confident experts, even if less accurate than their more cautious peers, were more commonly cited in the media. In the case of argumentative theory (Mercier & Sperber, 2011), confidence in and arguments for, a certain action are asserted to be beneficial for winning the support of others. Further analysis of Experiment 4 revealed that, on average, Treatment participants tasked with making a decision were significantly more confident in the action they chose than their yoked Control participants, despite having a greater potential loss for incorrect action. This effect was robust and remained whether controlling for preference, information condition, action taken and potentially influential interactions or not. This is supportive of the assertions that greater information distortion is associated with greater gains in certainty, and that more information distortion occurs when there is greater personal relevance.

Thirdly, given that cues available are imperfect representations of reality, striving for consistency helps to contain the noise produced by imperfect cues and perception. Karelaia (2006) demonstrated that consistency as a heuristic strategy performed well in guiding multi-attribute binary choice. The strategy sought at least two consistent items of information supporting the same binary decision option before choosing that option. The quality of decisions was comparable to other heuristic strategies in the probability of selecting the optimal choice, and decision quality was relatively insensitive to presentation order.

Although a sense of certainty may not perfectly correspond with knowing the truth, for most people, one’s understanding needs to fit within the bounds of reality. To borrow story model terminology, it is difficult to weave a coherent story when most of the known facts and information support a different set of events. Kunda (1990) and Pyszczynski and Greenberg (1987) also assert that individuals are bound by reality but they assert that people strive for a particular outcome and try to make it justifiable within the bounds of reality. In contrast, the DHT model asserts that individuals genuinely try to gain a sense of understanding. The speculative conclusion is that confirmation bias occurs because the mechanisms used to maximise consistency and, therefore, a sense of certainty, sway decisions towards confirmation of, and consistency with, previously held expectations, preferences, and framed concepts.

If this is the case, confirmation bias should be greatest for individuals who value a sense of certainty compared to individuals who are comfortable with uncertainty. Confirmation bias should also be higher in situations that call for a high degree of certainty than in situations in which there is little incentive to understand the situation. This fits with the observation in Experiment 4 that expectation exaggerated certainty in the competitive release situation in the Treatment group assigned with investigating the situation to make a decision but not in the Control group assigned the task of assessing the information without the decision requirement. Confirmation bias should also be greater when the individual perceives some control over the outcomes, than when the individual perceives outcomes as beyond their control. Further research is required to test these assertions.

9.3. Strengths and Limitations

All experiments in this thesis examined behaviour in a very complex information environment. This has advantages and disadvantages. It is important to examine behaviour in complex information environments (Chapter 5.1 and Weeks et al., 2012). However, complex information environments also introduce potential confounds.

A number of confounds arose from the scenario chosen. A single scenario was used with a variety of manipulations. The scenario presented the possibility of a competitive release. It is more natural to think about the presence of something, such as a competitive release, rather than the absence of something, such as no competitive release (Evans, 1989; Gale & Ball, 2002; Klayman, 1995). Therefore, a number of the results that were attributed to frame may actually be common in scenarios where one is to investigate the presence or absence of something regardless of the information frame. Further research manipulating the frame is required to explore this possibility.

Another potential confound, again due to the presence versus absence nature of the scenario, was that many release-inconsistent titles indicated no release on the whole but contained elements that could be associated with release. For example, “Barriers to product development” contains the element “product development” that could be associated with release even though on the whole the title seems indicative of no release assuming that the barriers are found to be affirmed. This could be problematic if, as suggested by numerous theories (e.g. Evans, 2006; Pyszczynski & Greenberg, 1987; Sperber & Wilson, 2004) including the DHT model, associative processes drive PTS.

Finally, participants rated release-consistent titles as more diagnostic of release, than release-inconsistent titles were of no release. It is impossible to tell whether this was specific to the titles chosen for this scenario, or a general tendency to consider positive titles to be more diagnostic than negative titles. Attempts were made to minimise this confound in the original selection of 36 titles, but it could not be eliminated because within the original set of 44 titles there was a strong tendency to rate release-consistent titles as more diagnostic than release-inconsistent titles. Differences in diagnosticity could account for the apparent framing effects found in simultaneous information search conditions. However, none of the scenario- and title-based confounds can explain why frame-based PTS disappeared in sequential compared to simultaneous information search because the scenario and titles were held constant.

Many of these confounds may have arisen because they are common across many information environments or they could have been created or exacerbated by the construction of information. The construction of information can be problematic if it deviates from common experience. This has been the criticism levelled at many heuristics and biases findings (e.g. Gigerenzer, 1996; McKenzie, 2003). These criticisms apply just as readily to constructed complex information environments. For example, the titles used were a perfectly balanced number of release-consistent and release-inconsistent titles. This balance of titles is unlikely to be representative of many information sources, especially given the trend towards personalisation of Internet search results (Jeh & Widom, 2003; Radlinski & Dumais, 2006).

Research into decision-making behaviour in complex decision environments is important because artificial or overly simplistic environments may exaggerate or underplay biases in decision making (see Chapter 5.1 and Weeks et al., 2012). Information distortion research particularly lends itself to the examination of true sources of information, such as the information selected from the first page of a Google or another database search. This is a promising area for future applied decision-making research. Research using true sources of information cannot avoid confounds but can make sure that those confounds are present in the information environment under examination. This could yield important insight into the magnitude of information distortion in certain information environments, but not necessarily the reasons behind that information distortion.

Another strength and limitation of the empirical studies reported is the manipulation of preference. Manipulating preference allowed a relatively controlled comparison of participants who favoured action or inaction. The efficacy of these manipulations was confirmed with strong impact on attraction and feeling towards the preferred action, especially in Experiments 3 and 4 where preference was found to influence judgements. However, preference was manipulated by altering how the potential costs and benefits of different actions were framed. Therefore, it is possible that not all effects attributed to preference actually reflected a genuine preference, they may have reflected unintended emphasis or information provided through the frame. There is mixed support for this possibility. Further examination of the data revealed that the effects of preference on information interpretation and final situation assessment judgements found in Experiments 3 and 4 were not mediated by attraction towards action or inaction. Therefore, the measure of preference used could not fully explain the impact of preference conditions on interpretations. However, if framing primarily drove the effect of preference manipulations on interpretations and judgements, a similar effect of preference manipulations on final situation assessments would be expected across all experiments. The majority of the preference manipulation text was identical between Experiments 2, 3, and 4, but preference only impacted final situation assessments when financial incentives were included, in Experiments 3 and 4. Together these results suggest neither preference nor the frame, can account fully for the observed results. As noted in Chapter 9.1.5, financial incentives have been observed to increase distortion (Meloy et al., 2006), so this may account for a portion of the effects. The DHT model suggests that circumstances, such as financial incentives, that increase the personal relevance or importance of decisions can increase need for certainty. The DHT model would predict that greater need for certainty is reflected in more efforts to increase option differentiation, which should drive stopping thresholds up. This should increase certainty by the end of the decision making process. Greater option differentiation would be reflected in a stronger focal decision option, and, therefore, greater information distortion. Therefore, the impact of preference manipulations on judgements may be attributable to a combination of preference, frame, and financial manipulations, which increased the personal relevance of the decision. Unfortunately these assertions cannot be tested in this dataset due to differences between measures used in Experiments 2 and 3. The manipulation of preference was an important method for separating the effects of preference and expectation, and examining the impact of preference in a relatively affect-neutral environment. Future research should consider methods for manipulating preference that do not rely heavily on the framing of information, or attempt to minimise confounds between groups with naturally occurring preferences, while manipulating expectation.

A number of factors limit the ability to generalise the empirical findings of this thesis. Firstly, the scenario used a slow-paced information-gathering task with the hypothetical timeframe of 6 months. Processes used to analyse information about events with a 6-month timeframe may deviate substantially from fast-paced decisions made within minutes such as those made by pilots, fire fighters, and police.

Secondly, a student population was drawn from and the task was not familiar to them. This allowed for an examination of confirmation processes and outcomes in the absence of strong prior convictions, preferences, or expectations. However, findings may not extend to a professional population in a work-related domain. There are a number of observed differences between novice and expert information processing, including techniques available to experts such as chunking related information together (Gobet et al., 2001), attending to only essential cues (Shanteau, 1992), and recognising situations from past experience (Klein, 1993, 1997), that allow experts to complete the same task with less load on working memory than novices. This could have a number of implications for the results reported here. Firstly, as outlined earlier in this Chapter 9.1.2, experts may be more likely to adapt PTS selection behaviour in response to cues in the environment, such as costly errors. Secondly, the lack of additional context available to novices, compared to experts, can increase reliance on information frame (e.g. Lehman et al., 1992). Therefore, given that some of the impact of preference manipulations may be attributable to the frame of the manipulations, the impact of preference on judgements may be exaggerated.

Despite these potential differences between novices and experts, many of the processes predicted by the DHT model would be expected to extend to expert decision making. For example, experts may rely less on frame, but also hold stronger preferences and expectations based on experience. Regardless of these differences, bi-directional connection between focal decision options and information interpretation would still be predicted. Consistent with this suggestion, previous research suggests that information distortion still occurs for auditors and salespeople with only small reductions for job-relevant decisions (Russo, Meloy, & Wilks, 2000), is greater for prospective jurors than students on a mock trial (Carlson & Russo, 2001), and actually increases with expertise in horse-race betting (Brownstein, Read, & Simon, 2004). Therefore, findings around information distortion, might apply to at least some professional populations also.

Despite limitations, the experimental work presented throughout this thesis, has taken an important step towards examining and explaining confirmation of preference, expectation, and frame in a complex information environment. Confirmation of preference and expectation were demonstrated in a complex information space. This is likely to be closer to those observed in many personal and organisational settings in terms of cognitive load, amount of information available, and personal control over information selection, than many laboratory examinations. For example, information distortion paradigms do not allow choice of information (for an exception see DeKay, Patino-Echeverri, et al., 2009), whereas most database searches do, and Wason selection tasks and variants usually provide four items of information to choose from (e.g. Dawson et al., 2002; Smeets et al., 2000; Wason, 1968), which is less than most database searches would yield. This thesis also expanded on the theoretical and empirical literature by examining a situation in which preference did not directly apply to the situation under investigation but to a related action.

9.4. Practical Implications

Before identifying ways to decrease confirmation bias and information distortion, it is important to distinguish the situations in which biases could be beneficial from those where they could be detrimental. That way, intervention can target situations where confirmation bias outcomes are detrimental. Therefore, this section focuses first on the situations where bias can be beneficial and detrimental before focusing on when and how to intervene. Biases resulting from expectation and preference will be addressed separately.

The DHT model and findings from Experiments 3 and 4 suggest that information interpretation and situation assessments can become exaggerated by developing expectations. The DHT model suggests that this process helps in supporting a sense of understanding, and confident action. Other theorists have also suggested that this process helps to support confident action and avoid decision paralysis. For example, the differentiation and consolidation theory argues that information distortion helps to provide sufficient confidence in one option over others to avoid post-decisional regret or decision reversal (Svenson, 1992). Kahneman (2011) suggests that some individuals "need the security of distorted estimates to avoid paralysis" (Kahneman, 2011, p. 193). Indeed, Experiment 2 (Chapter 6) found that when given an option to delay the decision, 60% of participants took this option, suggesting that reluctance to commit to a decision is common, at least in novel situations. Therefore, although not perfectly accurate, exaggerated situation assessments may be adaptive in some if not many circumstances for supporting confident action and avoiding decision paralysis.

Exaggerated situation assessments could be problematic if they lead to overly extreme actions or reduce the motivation for contingency planning. Overconfidence has been cited in a number of cases as an explanation for inappropriate actions. Overconfidence is where confidence in a judgment exceeds accuracy (Tsai et al., 2008). Overconfidence was implicated in the Yom Kippur surprise attack of Egyptian and Syrian forces on Israeli positions. Key intelligence officers withheld new intelligence that, if disseminated, may have prompted the mobilisation of the Israeli reserve army. The reasons for withholding this information are partially attributed to key intelligence officers' overconfidence that the Egyptians would not stage an attack (Bar-Joseph & Kruglanski, 2003).

An organisational application might be to consider whether decision paralysis, or overconfidence poses a greater danger. If overconfidence is of concern, incorporating processes that require individuals to consider why the leading decision option could be wrong or suboptimal may help to reduce confirmation of expectation effects. For example, O'Brien (2009) asked a group of participants to consider why their prime suspect in a criminal investigation may be innocent. Compared to participants asked to consider evidence for and against three suspects, or asked only for their current prime suspect, these participants showed less coherence shift towards the guilt of the prime suspect, and chose fewer lines of investigation targeting the prime suspect (O'Brien, 2009). Another technique that may allow for the benefits of exaggerated situation assessments in the action planning phase, while helping to mitigate overconfidence and the resultant lack of contingency planning, is Klein's (2008) premortem technique. The premortem technique is generally instigated after an action plan has been formed. At this stage, according to the DHT model, situation assessments are likely to be exaggerated, providing the confidence required to plan for action. The premortem is conducted in an organisational setting and asks the team to explain why the planned action went terribly wrong. This could help to moderate the overconfident situation assessment by eliciting images of contrary situations and improve contingency planning by imagining and preparing for ways in which the plan could fail. Accordingly, the premortem technique has been shown to decrease confidence in a plan more than a baseline and other commonly used techniques such as critiquing or generating weaknesses of a plan (Veinott, Klein, & Wiggins, 2010).

The DHT model and findings from Experiments 3 and 4 suggest that information interpretation and situation assessments are directly and indirectly influenced by action preferences. Normative models such as Bayesian inference (Fischhoff & Beyth-Marom, 1983) and expected utility theory (Mongin, 1997) suggest that preference derived from differential costs and benefits of different actions should influence action decisions. For example, consider the pilot deciding whether to take defensive action by deviating or inaction by maintaining course. Bayesian inference identifies a critical ratio akin to the decision thresholds found in Experiments 3 and 4 (Fischhoff & Beyth-Marom, 1983). The costs associated with erroneous action (deviation) and costs associated with erroneous inaction (maintaining course) form the critical ratio. If, after all practicably possible information is received, the odds that there is a storm severe enough to warrant deviation exceed the critical ratio, then action should be taken. Given that the potential costs of failure to deviate are likely to outweigh costs of deviating un-necessarily, the critical ratio is likely to favour deviation. Normatively, the cost and benefit based preference, and the situation assessment should contribute independently to an action decision (Fischhoff & Beyth-Marom, 1983). However, Experiments 3 and 4 suggest that action preference can influence situation assessments as well as decision thresholds, thus lending excess weight to preference in the decision-making process.

Having action preferences influence situation assessments may not be problematic in some cases. For example, when one action is clearly dominant, and it is better to be safe than sorry, biased assessments may encourage the safer action with greater urgency and confidence. Participants have been found to place greater value on evacuating an area needlessly, than not evacuating even when the threat does not eventuate (DeKay, Patiño-Echeverri, et al., 2009). Therefore, processes that exaggerate the need for evacuation may lead to action that is applauded regardless of the outcome.

The influence of action preference on situation assessment would be problematic when an individual's preference deviates from the best interest of the clients or organisation. For example, DeKay and Asch (1998) and DeKay (2009) detail how doctors' preferences to minimise personal liability can lead to diagnostic tests and treatments that are not in the best interest of their clients. DeKay (2009) argues that this occurs because physicians' decision thresholds for diagnostic testing are lowered by concerns about liability. The effect of concern about costly actions on decision thresholds is supported by the DHT model, and findings in Experiments 3 and 4. In addition, Experiments 3 and 4 suggest that these preferences may also influence situation assessments and information interpretation such that perceived risk is artificially inflated and more likely to surpass the lowered thresholds for diagnostic testing. The impact of preference on situation assessments needs to be replicated in a professional population to confirm this implied generalisation to experienced doctors.

A number of approaches could be taken to address the effect of preference on situation assessments. Firstly, given the evidence that preference is constructed and not recalled (Lichtenstein & Slovic, 2006; Simon, Krawczyk, et al., 2004), different individuals could be tasked with assessing the costs and benefits of actions, and assessing the relevant situation. Theoretically, this would only work in cases where the individual assessing the situation has not yet formed a preference. Therefore, this is unlikely to work in cases such as personal liability concerns where media and professional experience are likely to have prompted individual thought on the costs and benefits of certain actions. Secondly, organisations need to be alert to, and minimise incentive schemes or other factors that may create individual preferences that conflict with organisational or client preferences, such as litigation concerns for doctors (DeKay, 2009; DeKay & Asch, 1998), and individual incentives in team situations (Condly, Clark, & Stolovitch, 2003). Finally, there is some evidence from this series of experiments that preference distorts judgement more when there is ambiguity in the information environment or greater room for interpretation in the process by which the judgement is made. Therefore, the influence of preference is likely to be greatest in ambiguous information environments and may be reduced by narrowing the scope of the interpretation. For example, marking criteria that call for ratings on individual sections of performance are likely to be swayed less by preference than ratings on performance as a whole. This is consistent with the efficacy of algorithms that combine a small number of relatively unambiguous judgements over expert judgements that incorporate a much wider variety of predictors but are processed holistically (Kahneman, 2011). These suggestions are made on predominantly theoretical grounds. Further research is required to determine their efficacy.

9.5. Thesis Contributions and Conclusion

This thesis has presented and tested the DHT model, which is an important contribution to the confirmation bias literature in a number of ways. Firstly, the DHT model distinguishes three potential sources of confirmation bias that are often confounded in the literature: preference, expectation, and frame. Preference and expectation are frequently confounded due to a focus on the decision leaning. Decision leaning was influenced by both preference and expectation. The separation of expectation and preference proved important because they influenced decision-making processes in different ways as detailed in Chapter 8. By allowing expectation and preference independent influence on the decision elements and subsequent processes, the DHT model also allows for confirmation of expectation even with conflicting preference. Confirmation of expectation in the presence of a conflicting preference was observed in this thesis (Chapter 8.3.2.3), but runs contrary to predictions made by a number of motivated reasoning theories (e.g. Kunda, 1990; Pyszczynski & Greenberg, 1987).

Secondly, the DHT model incorporates the numerous confirmation processes, and distinguishes these from confirmation outcomes. Confirmation bias reviews took an important step towards clarifying the difference between confirmation processes and outcomes. The DHT model details the possible connections between these processes. Empirically, this thesis found that information interpretation had greater influence on confirmation outcomes than information selection and stopping rules in this complex environment.

Thirdly, the DHT model acknowledges and incorporates the dynamic nature of investigative decision making. The decision making process is predicted to change over time as expectations, contextual frame, problem representation, and the focal decision option strengthen or change, and as constraints on decision making such as fatigue and information availability change. New information is predicted to bring about the most impactful changes, but thought and time are also predicted to impact the activation of elements central to the mechanics of the DHT model and, therefore, alter problem representations and resultant processes and judgements. The DHT model challenges the concept of confirmation bias as a relatively static outcome of an original focal decision option. Rather, confirmation bias is conceptualised as a bias of degrees that results from a dynamic process of integration between original and evolving preferences, expectations, and context, and new information.

Finally, the DHT model expands PCS mechanisms to explain information selection processes, decision, and stopping thresholds as well as information interpretation to which PCS models usually apply (e.g. Monroe & Read, 2008; Simon, Snow, et al., 2004). The DHT model provides a foundation for further research and theoretical discussions around the drivers, mechanisms, and reasons behind confirmation bias and decision-making generally.

10. Appendices

10.1. Appendix A: Glossary

Type refers to whether the term refers to a *research paradigm*, a generally applicable *theoretical* concept, including confirmation processes and confirmation bias, or an element specific to this thesis such as a variable *measure*, *scenario element, or research manipulation*.

Table A1: Glossary of terms

Term	**Type**	**Associated concepts**	**Definition**
Accessibility	Theoretical	Also called cognitive accessibility	The ease with which examples or concepts can be retrieved, constructed, or associated (Tversky & Kahneman, 1973).
Action	Theoretical	Situation assessment	The behavioural choices one makes often in response to a situation assessment.
Action attraction	Measure	Inaction attraction	Attraction and positive feelings towards action (speeding up release plans).

Term	**Type**	**Associated concepts**	**Definition**
Action leaning	Measure	Focal decision option	The action that the individual is leaning towards at the time. 0-100 scale where 0 = absolutely certain that inaction is best and 100 = absolutely certain that action is best.
Activation	Theoretical	Accessibility	The amount of energy, salience, and cognitive accessibility associated with a cognitive concept, which is the product of the number, strength, and valence of connections that are also receiving activation.
Assimilation	Theoretical	Information interpretation	When the implication of new information is interpreted in such a way that it is consistent with the focal decision option.

Term	**Type**	**Associated concepts**	**Definition**
Attitude polarisation	Theoretical, confirmation bias	Decision outcome	Where participants who start with different focal decision options end up polarising, such that their final decisions are even further apart in extremity and certainty, despite access to the same information.
Attribute framing	Theoretical	Frame	Where the description of an object or event characteristic affects the evaluation of that object or event (Levin et al., 1998).
Bi-directional reasoning	Theoretical	Information interpretation	Where “evidence influences the conclusions and, at the same time, the emerging conclusion affects the evaluation of the evidence” (Simon, Snow, et al., 2004, p. 814).
Cognitive effect	Theoretical	Relevance theory	The degree to which new information meaningfully alters one’s problem representation given the original context.

Term	**Type**	**Associated concepts**	**Definition**
Cognitive effort	Theoretical	Relevance theory	The intellectual energy required to process the information.
Coherence Shift	Confirmation process	Information interpretation, information distortion	Where assessments of attitudes, opinions, or facts tend to shift from pre-decision to post-decision such that they are more supportive of the final decision option.
Coherence Shift Paradigms	Research Paradigm	Information interpretation, information distortion paradigm	Where participants are asked to make assessments on a variety of apparently unrelated items before and after, and sometimes during, an investigative or decision task.
Confirmation bias	Theoretical, Confirmation bias	Confirmation of expectation, preference, or frame	The outcome where the final decision is pulled towards the original focal decision option.
Confirmation of expectation	Theoretical, Confirmation bias	Expected decision option	A bias towards confirming what one thinks is true or the decision one expects to make.

Term	Type	Associated concepts	Definition
Confirmation of frame	Theoretical, Confirmation bias	Framed decision option	The tendency to affirm whatever decision option is implied by the information or question originally provided about the problem.
Confirmation of preference	Theoretical, Confirmation bias	Preferred decision option	The tendency to accept desirable or rewarding decision options and reject undesirable or costly decision options.
Confirmation process	Theoretical, Confirmation process	Confirmation bias	Any human process or behaviour that can, in isolation or in combination with other processes, produce a tendency towards accepting, rather than rejecting, the focal decision option.
Consistent information	Theoretical	Release-consistent, inconsistent information	Information that supports the focal decision option.

Term	Type	Associated concepts	Definition
Consistent title	Theoretical	Consistent information	Titles with concepts that would be expected if the focal decision option were true.
Decision elements	Theoretical	Decision option	The range of related decision options. For example, situation assessment options and related action options.
Decision leaning	Theoretical	Expected decision option, action leaning. Also called a preliminary decision.	The decision option that a participant considers to be leading at any point in time such as a favoured product for purchase or a favoured business action.
DHT	Theoretical	Confirmation bias	Dynamic hypothesis testing model. The model constructed and refined throughout this thesis to explain confirmation bias.

Term	**Type**	**Associated concepts**	**Definition**
Diagnostic information	Theoretical	Pseudo-diagnosticity	Information that distinguishes between decision options. Often calculated using the Bayesian likelihood ratio.
Diagnosticity	Theoretical	Information selection	The ability of questions, or information, to distinguish between two or more decision options.
Direct preference-information case	Theoretical	Indirect preference-information case	Where preference or decision leaning is directed towards the same action (or situation assessment) that the available information pertains to.
End-of-sequence processing mode	Theoretical	Belief-adjustment model, step-by-step processing mode	Where a single adjustment is made based on an aggregate assessment of all information received.
Expectation-consistent information	Theoretical	Consistent information	Information that supports the expected decision option.

Term	Type	Associated concepts	Definition
Expectation-inconsistent information	Theoretical	Inconsistent information	Information that opposes the expected decision option.
Expected decision option	Theoretical		The situation one thinks is true or the decision one expects to make.
Focal action	Theoretical, focal decision option	Focal decision option, Focal situation assessment	The action that is most salient to the individual at the time.
Focal decision option	Theoretical	Also called hypothesis or focal hypothesis. Preferred, expected, or framed decision option	A single possible situation or action, that an individual dedicates attention to testing or evaluating. The focal decision option refers to whichever possibility is most salient to the decision maker at the time, and could correspond with the preferred or expected decision option, or the decision option implied by the presentation of the problem.

Term	Type	Associated concepts	Definition
Focal situation assessment	Theoretical, Focal decision option	Focal decision option, Focal action	The situational possibility that the individual is focused on.
Focus of judgement effect	Theoretical	Frame, Attribute framing, Framed decision option	Where interpretations "are biased towards supporting any implicit assertion or hypothesis *or decision option* that is the focus of a question stem" (Lehman et al., 1992, p. 691).
Frame	Theoretical	Attribute framing, Focus of judgment effect	The way in which the problem, question, or instructions are phrased to imply a particular context.
Frame-based PTS	Theoretical, Confirmation process	Positive test strategy	Where participants preferentially seek information under concepts that are mentioned in or implied by the question wording (frame-consistent titles), rather than the inverse of those concepts (frame-inconsistent titles).

Term	Type	Associated concepts	Definition
Frame-consistent information	Theoretical	Consistent information	Information that supports the framed decision option.
Frame-consistent titles	Theoretical	Release-consistent titles	Cell labels with concepts that are mentioned in or implied by the question wording.
Frame-inconsistent information	Theoretical	Inconsistent information	Information that opposes the framed decision option.
Frame-inconsistent titles	Theoretical	Release-inconsistent titles	Cell labels with concepts that are opposite to those mentioned in or implied by the question wording.
Framed decision option	Theoretical	Confirmation of frame	The decision option implied by the information or question originally provided about the problem.
Framing effects	Theoretical	Attribute framing, Valence-consistent shift	Where different linguistic descriptions of the same message produce different problem representations (Keren, 2011).

Term	Type	Associated concepts	Definition
Inaction attraction	Measure	Action attraction	Attraction and positive feelings towards inaction (maintaining release plans).
Inconsistent information	Theoretical	Release-inconsistent, consistent information	Information that opposes the focal decision option.
Inconsistent title	Theoretical	Inconsistent information	Titles with concepts that would not be expected if the focal decision option were true, or would be expected if the focal decision option were false.
Indirect preference-information case	Theoretical	Direct preference-information case	Where preference or decision leaning is directed towards an action (or situation assessment) that is separate from the situation (or action) that information pertains to.
Inference rules	Theoretical	Positive test strategy	If-then statements.

Term	Type	Associated concepts	Definition
Information distortion	Confirmation process, information interpretation	Information selection, coherence shift	Where information interpretation favours the previously stated decision leaning for participants who are required to make a decision, compared to participants who are not required to make a decision.
Information distortion paradigms	Research paradigm	Information selection, coherence shift	Where participants rate the implication of information during or after an investigation and their ratings are compared to the ratings of a comparison group.
Information interpretation	Theoretical, Confirmation process	Information distortion	The process of interpreting the implication of information for the focal decision.
Information selection	Theoretical, Confirmation process	Positive test strategy (PTS), pseudo-diagnostic (PD) selection, selective exposure (SE)	The strategies one uses to gather information or evidence.

Term	Type	Associated concepts	Definition
Information weighting paradigms	Research paradigm	Information distortion, coherence shift	Where participants are asked to assess the quality of information received.
Matching bias	Theoretical	Positive test strategy	The tendency to focus on the values explicitly named in the rule, hypothesis, or framed decision option.
Mental simulation	Theoretical	Heuristic-analytic theory	Representing an imaginary or hypothetical situation without confusing it with reality.
Mistaken acceptance	Theoretical	Mistaken rejection	When a situation assessment is accepted, when it is actually false.
Mistaken rejection	Theoretical	Mistaken acceptance	When a situation assessment is rejected, when it is actually true.
Mixed condition	Research condition	Release condition, No-Release condition	The information condition in which an equal amount of the information available indicated that a competitive release was unlikely and likely.

Term	Type	Associated concepts	Definition
Negative questions	Theoretical	Release-inconsistent titles	Questions that seek information on elements that would not be expected if the focal decision option were true or correct, or would be expected if the focal decision option were false or incorrect.
No-Release condition	Research condition	Release condition, Mixed condition	The information condition in which the information available indicated that a competitive release was unlikely.
Opposing views	Research paradigm	Confirmation of expectation	Where experimenters observe participants with opposing preferences, attitudes, or beliefs.
Overconfidence	Theoretical		Where confidence in a judgment exceeds accuracy (Tsai et al., 2008).
PD		See Pseudo-Diagnostic selection	

Term	Type	Associated concepts	Definition
Positive questions	Theoretical	Release-consistent titles	Questions that seek information on elements that would be expected if the focal decision option were true or correct.
Positive test strategy (PTS)	Theoretical, Confirmation process	Positive Questions, Negative Questions	Where participants investigate a focal decision option by preferentially asking positive questions as opposed to negative questions.
Positive test strategy paradigm	Research paradigm	Pseudo-diagnostic paradigm, selective exposure paradigm	Where participants are asked to selection from positive and negative questions that do not reveal the implication of the information for the decision.
Prefer-Action	Research condition	Prefer-Inaction	The preference condition in which costs of inaction and benefits of action were highlighted.
Prefer-Inaction	Research condition	Prefer-Action	The preference condition in which costs of action and benefits of inaction were highlighted.

Term	Type	Associated concepts	Definition
Preference-based PTS	Theoretical, confirmation process	Positive test strategy	Where participants select more preference-consistent titles than preference-inconsistent titles.
Preference-consistent information	Theoretical	Consistent information	Information that supports the preferred decision option.
Preference-inconsistent information	Theoretical	Inconsistent information	Information that opposes the preferred decision option.
Preferred decision option	Theoretical	Confirmation of preference	The most desirable or rewarding or least undesirable or costly decision option.
Primacy effects	Theoretical	Recency effects	Where final decisions or beliefs are more heavily influenced by information seen early in the decision making process than information seen later.
Probabilistic mindset	Theoretical	Bayesian rationality	The consideration of data and outcomes as probabilistic, rather than absolute.

Term	Type	Associated concepts	Definition
Problem representation	Theoretical	Focal decision option	One's mental depiction of the problem, decision, proposition, assessment, rule, or question under investigation.
Pseudo-diagnostic paradigm	Research paradigm	Positive test strategy paradigm, Selective exposure paradigm	Where participants are told the frequency of an attribute within a decision option and asked to select other attribute-decision option pairs to find corresponding frequencies.
Pseudo-diagnostic selection	Theoretical, Confirmation process	Information selection	When presented with information on the frequency of an attribute within a decision option, selecting information on the same decision option but a different attribute and neglecting information on an alternative decision option and the same attribute.
PTS		See Positive Test Strategy	

Term	Type	Associated concepts	Definition
Recency effects		Primacy effects	Where final decisions or beliefs are more heavily influenced by information seen late in the decision making process than information seen earlier.
Release condition	Research condition	No-Release condition, Mixed condition	The information condition in which the information available indicated that a competitive release was likely.
Release probability	Measure	Situation assessment	The perceived likelihood of a competitive release from 0 (impossible) to 100 (definite).
Release-consistent titles	Scenario element	Release-consistent information	Titles with concepts expected if a product release was immanent such as “DCC schedules a media release”.
Release-inconsistent titles	Scenario element	Release-inconsistent information	Titles with concepts not expected if a product release was immanent such as “DCC encounters barriers to product development”.

Term	Type	Associated concepts	Definition
SE		See Selective Exposure	
Selected titles	Measure	Release-consistent title selection	The number of titles that each participant selected for investigation at least once.
Selective exposure (SE)	Confirmation process	Information selection, positive test strategy, pseudo-diagnostic selection	Where participants preferentially attend to and recall the information that is consistent, rather than inconsistent, with their focal decision option in a SE paradigm.
Selective exposure (SE) paradigms	Research paradigm		Where participants are asked to choose articles from an array of titles where the argument or outcome is evident from the title or description.
Sequential information search	Theoretical	Simultaneous information search	Where individuals conduct a database search, select a title of interest, read the content, and then return to the search to select another title.

Term	Type	Associated concepts	Definition
Simultaneous information search	Theoretical	Sequential information search	Where individuals conduct a database search and select all the titles of interest before reading any of the content.
Situation assessment	Theoretical	Release-probability (Measure)	Where an individual is required to acquire and interpret information to form an understanding of the current state of a system (Wiggins, 2014).
Situation assessment level	Theoretical	Decision thresholds	The perceived probability of the situation, such as the perceived probability of a threatening event occurring.
Step-by-step processing mode	Theoretical	The belief-adjustment model, end-of-sequence processing mode	Where adjustments are made to the situation assessment after each new item of information.

Term	Type	Associated concepts	Definition
Stopping threshold	Theoretical, confirmation process	Decision Threshold	The point at which an individual stops seeking further information and makes a decision. This point could be conceptualised as the point at which certainty or confidence in the decision leaning is adequate to commit to it.
Title perception	Measure		The degree to which each title is perceived as release-inconsistent at the low end of the scale to release-consistent at the high end of the scale.
Transient motives	Theoretical	Confirmation bias	Goals that are present to varying degrees across individuals or situations.
Type 1 processing	Theoretical	Type 2 processing	A cognitive processing mode that is autonomous in that it does not require controlled attention and, therefore, does not require working memory.

Term	Type	Associated concepts	Definition
Type 2 processing	Theoretical	Type 1 processing	A cognitive processing mode that requires working memory, and allows for mental simulation.
Valence-consistent shift	Empirical observation	Framing effects	Where assessments tend to shift towards the valence of the attributes mentioned.

10.2. Appendix B: Business Scenario

10.2.1. Experiments 1 and 2

PLEASE read the scenario, questions and instructions carefully and ask the experimenter if you don't understand.

Your company, Transmate, is developing real-time translation software. A rival organisation, DCC, is suspected of planning a new product release in direct competition that may beat your product to the market. As a market analyst for Transmate you have been asked to head up an investigative team to examine this potential competition and recommend a course of action.

There are 4 possible responses:

New competitive product release is not expected – Maintain current plans

New competitive product release could occur – Monitor DCC's research and development activity

New competitive product release is likely – Speed up development and release sooner than intended

New competitive product release is imminent – Speed up development and release as soon as possible

(Prefer-Inaction preference condition only)

As an experienced market analyst you are aware that higher levels of response can cause premature product release. Some features may have to be withheld and testing may be rushed. This could result in loss of product credibility, customer dissatisfaction and negative branding. Rushing release plans unnecessarily could also result in unforeseen product flaws and inferior features and quality. This could potentially allow DCC to outstrip our product on quality and gain greater market share, potentially threatening our organisation's profitability.

(Prefer-Action preference condition only)

As an experienced market analyst you are aware that lower levels of response can allow DCC first release. This could result in loss of early adopter loyalty and missing the promotional hype that surrounds new technology. Maintaining release plans unnecessarily could also result in a perception of our product as a copy with inferior features and quality. This could potentially allow DCC to outstrip our product on consumer sentiment and gain greater market share, potentially threatening our organisation's profitability.

10.2.2. Experiments 3 and 4

10.2.2.1. Treatment group

This information is important. Please read carefully.

Your Task

Imagine...

Your company is developing real-time translation software to be released 6 months from now. A rival organisation, DCC, is suspected of planning a new product release in direct competition that may beat your product to the market. As a Market Analyst, you have been asked to head up an investigative team to examine this potential competition and recommend a course of action.

There are 2 possible responses:

Reject this possibility and maintain current plans

Accept this possibility and speed up development to release sooner than intended

You have been asked to examine cases of potential product competition 10 times before. Of those 10 cases, 5 were preparing a competitive product release and 5 were not.

(Prefer-Inaction preference condition only)

Your Knowledge

As an experienced market analyst you are aware that if you accept the possibility of competition, it could result in premature product release. Some features may have to be withheld and testing may be rushed. This could result in loss of product credibility, customer dissatisfaction, and negative branding. Rushing release plans unnecessarily could also result in unforeseen product flaws and inferior features and quality. This could potentially allow DCC to outstrip our product on quality, and gain greater market share, potentially threatening our organisation's profitability.

You are also aware that maintaining current release plans would be relatively easy, with minimal cost or risk to the product or organisation.

Your Pay

Your pay is contingent on your performance.

If you make the **correct decision** you receive the **full $15**:

If you maintain current release plans when DCC won't release within 6 months OR

If you speed up release plans when DCC will release within 6 months

If you make an incorrect decision your pay will be docked in accordance with the consequences:

If you incorrectly **maintain current plans** you will **lose $1** of your pay

If you incorrectly **speed up release plans** you will **lose $10** of your pay

(Prefer-Action preference condition only)

Your Knowledge

As an experienced market analyst you are aware that if you reject the possibility of competition, you may allow DCC first release. This could result in loss of early adopter loyalty and missing the promotional hype that surrounds new technology. Taking no action could also result in a perception of our product as a copy with inferior features and quality. This could potentially allow DCC to outstrip our product on consumer sentiment, and gain greater market share, potentially threatening our organisation's profitability.

You are also aware that speeding up release plans would be relatively easily, with minimal cost or risk to the product or organisation.

Your Pay

Your pay is contingent on your performance.

If you make the correct decision you receive the full $15:

If you maintain current release plans when DCC won't release within 6 months OR

If you speed up release plans when DCC will release within 6 months

If you make an incorrect decision your pay will be docked in accordance with the consequences:

If you incorrectly maintain current plans you will lose $10 of your pay

If you incorrectly speed up release plans you will lose $1 of your pay

10.2.2.2. Control group (Experiment 4)

Your Task

Imagine...

Your company is developing real-time translation software to be released 6 months from now. Rival organisations are suspected of planning new product releases in direct competition that may beat your product to the market. As a Market Analyst, you have been asked to head up an investigative team to examine your potential competition.

In response your organisation might:

- Maintain current plans or
- Speed up development to release sooner than intended

You have been asked to examine cases of potential product competition 10 times before. Of those 10 cases, 5 were preparing a competitive product release and 5 were not.

You will now be presented with separate information on a number of rival organisations. Your task is to determine what implication each piece of information has for whether or not that company will release a competitive product within 6 months. After each item of information, you will be asked the following:

Please consider ONLY the most recent item of information.

This information indicates that a competitive new product release from this organisation within 6 months is...

1) Impossible

2) Very Unlikely

3) Unlikely

4) Somewhat Unlikely

5) No indication either way

6) Somewhat Likely

7) Likely

8) Very Likely

9) Definite

Note: Some information may be repeated. This is intentional. Please be patient and provide considered answers each time.

Please click next to continue.

10.3. Appendix C: Complete set of Questions and Instructions

10.3.1. Experiment 1

On the following pages you will be presented with a scenario and related questions, followed by a series of questionnaires.

PLEASE read the scenario, questions and instructions carefully and ask the experimenter if you don't understand.

Thank you for your help. Please click next to begin.

---Page Break 1---

Please select the best definition for this term: Real-time translation software

- Software that converts the meaning of spoken language into a different language with minimal delay.
- Software that converts the meaning of spoken language into a different language after each statement is complete.
- Software that converts the meaning of written language into a different language with the click of a button.

---Page Break 2---

(If 1.) Correct. For the purposes of this scenario we are defining "Real-time translation software" as software that converts the meaning of spoken language into a different language with minimal delay.

(If 2 or 3.) Incorrect. For the purposes of this scenario we are defining “Real-time translation software” as software that converts the meaning of spoken language into a different language with minimal delay.

---Page Break 3---

SCENARIO as per Appendix B.1.

On the next page you will be asked to answer some true/false questions on the above scenario. Please click "Next" to continue.

---Page Break 4---

Based on the scenario you just read, are the following statements true or false?

(Prefer Inaction)

Speeding up development could cause premature product release, resulting in customer dissatisfaction (True/False)

Speeding up development could result in loss of product credibility and negative branding (True/False)

Speeding up development could result in product flaws and *superior* features and quality (True/False)

Speeding up development would be an opportunity for the DCC to beat our product on quality (True/False)

(Prefer Action)

Failing to take prompt developmental action could allow DCC first release, meaning Transmate would miss the promotional hype surrounding new technology (True/False)

Failing to take prompt developmental action could result in loss of early adopter loyalty and negative product perceptions (True/False)

Failing to take prompt developmental action could result in a perception of our product as a *superior* copy (True/False)

Failing to take prompt developmental action would be an opportunity for the DCC to beat our product on consumer sentiment (True/False)

(No Preference)

If a new competitive product release is not expected, current plans would be maintained (True/False)

If a new competitive product release could occur, DCC's research and development activity would be monitored (True/False)

If a new competitive product release is *unlikely,* the product would be released sooner than planned (True/False)

If a new competitive product release is imminent, the product would be released as soon as possible (True/False)

---Page Break 5---

Please mark your answers based on the scenario below (The scenario has not changed). *(Scenario repeated, Questions repeated with previous answers indicated, and an opportunity to mark own answers as correct or incorrect)*[3]

---Page Break 6---

(Prefer Inaction)

Please list the potential risks involved in speeding up release plans. (You don't have to fill the space, just list the risks that come to mind).

[3] This activity was included to encourage participants to think about and engage with the scenario

(Prefer Action)

Please list the potential risks involved in maintaining current release plans. (You don't have to fill the space, just list the risks that come to mind).

(No Preference)

Please list the main points made in the scenario. (You don't have to fill the space, just list the elements that come to mind).

---Page Break 7---

Preference manipulation check detailed in Chapter 5.4.1.

---Page Break 8---

The information on the next page refers to the DCC's recent characteristics and actions. Each heading contains information received on this behaviour or characteristic. Information may reveal that the behaviour or characteristic was present or absent.

For example, selecting the heading "Manager on leave" you may find the following information "Examination of DCC's HR records provide no indication that the Manager is, or is intending to take leave." Alternatively, you may find that the manager is currently on leave.

Time is limited so please select information for review carefully. Information about DCC was randomly selected for display, so some information may not be relevant to your task.

Please answer the following questions to check that you understand the task. You can refer to the instructions above if you need to.

- The heading "manager on leave" contains information about the manager of DCC (True/False)
- The heading "manager on leave" could contain information that the manager is working, not on leave (True/False)
- All the information is relevant to the investigation (True/False)

---Page Break 9---

(If 1. Answered False) Your answer to question 1 was incorrect. All headings refer to the DCC's characteristics and actions. Therefore, the heading "manager on leave" would be about the manager of DCC.

(If 2. Answered False) Your answer to question 2 was incorrect. Information may reveal that the behaviour or characteristic was present or absent. Therefore, the heading "manager on leave" could actually show that the manager is not on leave.

(If 3. Answered True) Your answer to question 3 was incorrect. Information about DCC was randomly selected for display, so some information may not be relevant to your task.

---Page Break 10---

Please read all the information that is available, then carefully select only the information that you would need to make an informed decision.

Summary of instructions: A rival organisation, DCC, is suspected of planning a new product release. This product may be in direct competition with your new real-time translation software and may beat your product to the market. As a market analyst for Transmate you have been asked to head up an investigative team to examine this threat and recommend a course of action. The information below refers to the recent characteristics and actions of your rival organisation DCC.

Please select only the information that you would need to make an informed decision. *(Titles could be selected from the information grid shown in Chapter 5.3.3.2)*

---Page Break 11---

Imagine that you could examine 100 different software development organisations. How many of these 100 organisations would you expect to have the following characteristics or to have recently taken the following actions?

Titles from the information grid were displayed vertically, with space to enter a number. The column read: "Number of organisations (out of 100) who have…" e.g. scheduled press release.[4]

---Page Break 12---

Title perception question detailed in Chapter 5.3.3.3.

---Page Break 13---

Please provide a brief explanation of how you selected the information.[5]

---Page Break 14---

[4] This question was asked to measure the individual's perception of extremity for each title. The results were not used.

[5] This question was included to add qualitative depth but was not used.

Please be honest - the data will be anonymous. For the following two questions, please think about your experience searching and selecting the information for investigation.

How much effort did you put in?

How difficult was it?[6]

---Page Break 15---

FEEDBACK: Do you have any comments, questions or concerns about the previous section? Were there any instructions that you didn't understand? [7]

---Page Break 16---

Demographic questions

---Page Break 17---

Relevant individual difference questions were included in all experiments. The results were examined briefly, but no relationships were found that held across experiments. Each scale was presented on a separate page.

Experience with software development products and companies was measured using questions based on Lehman et al. (1992) that measured both amount of knowledge gathered on the topic, and consideration and discussion of the topic. This is in line with Koehler's (1991) suggestion that the amount of knowledge and novelty of the topic can differentially influence confirmation bias.

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[6] This question was included to identify participants who put in very little effort. No scores were low enough to raise concerns.
[7] Responses to this question were scanned and used to improve the clarity of future experiments and identify problematic data.

Error responsiveness was measured using the Behavioural Inhibition System (BIS) scale (Carver & White, 1994). The BIS scale measures sensitivity to negative outcomes on a four point scale from strongly disagree to strongly agree and includes questions such as “If I think something unpleasant is going to happen I usually get pretty ‘worked up’”. It has been found to have a reasonable reliability (Cronbach’s = .74, test-retest = .66) as well as good convergent and discriminant validity and predicts the experience of anxiety prior to anticipated negative outcomes (Carver & White, 1994).

Confirmation proneness was measured using the 10 item confirmatory inventory developed by Rassin (2008). Responses were given on a five point scale from strongly disagree to strongly agree to questions such as “I only need a little information to reach a good decision”. Reliability was reasonable (Cronbach’s = .65 - .70, test-retest = .73). Scores were also found to correspond to behaviour on 3 of 5 behavioural measures of confirmatory behaviour.

The **Causality Uncertainty Scale (CUS)** measures people’s beliefs about their ability to understand or detect causal relations in the social world. High scores indicate greater causal uncertainty and have been associated with the tendency to seek to reduce uncertainty via more extensive information search (Weary et al 1993). Responses were given on a six point scale from strongly disagree to strongly agree to questions such as “I do not know what it takes to get along well with others”. Reliability was good (Cronbach’s = .83) and convergent and discriminant validity have been demonstrated (Weary & Edwards, 1994).

Need for Closure subscales for Closed mindedness, Decisiveness, and Predictability were included. Responses were given on a six point scale from strongly disagree to strongly agree.

Closed mindedness and Predictability were measured using two 8 item scales developed by Webster and Kruglanski (1994). Both were found to have reasonable reliability

(Cronbach's = .62 and .78 respectively). Closed mindedness measures an unwillingness to have ones ideas confronted by alternative views or conflicting evidence, and is measured with items such as "I do not usually consult many different opinions before forming my own view". Predictability measures a desire to be able to predict how situations will play out and includes items such as "I don't like to go into a situation without knowing what I can expect from it".

Decisiveness was measured using the 6 item scale developed by Roets and Van Hiel (2007) to tap the need for quick and unambiguous answers and included questions such as "When I have made a decision, I feel relieved". Reliability was good (Cronbach's = .73) and convergent and discriminant validity have been demonstrated. Scores were also found to correspond to tendencies to come to decisions early (Roets & Van Hiel, 2007).

Need for cognition was measured using the short, 18 item version of the scale (Cacioppo, Petty, Feinstein, & Jarvis, 1996). Responses were given on a five point scale from extremely uncharacteristic to extremely characteristic of me, to questions such as "I would prefer complex to simple problems". Reliability tends to be good (Cronbach's = .90) and convergent and discriminant validity have been demonstrated. High scores indicate a preference for deep thinking and have been found to correspond to tendencies to engage in greater information processing (Cacioppo et al., 1996).

Bias against disconfirmatory evidence was measured using five written scenarios from the BADE task (Woodward, Buchy, Moritz, & Liotti, 2007). Participants were presented with a 'hint' such as "Tiffany watches her diet" and asked to rate the plausibility of four sentences individually on a scale from 0 to 10 with nominal labels "Poor", "Possible", "Good", and "Excellent". Sentences consisted of one true (e.g. "Tiffany is diabetic"), two plausible lures (e.g. "Tiffany is a fitness instructor", "Tiffany has an eating disorder") and one absurd (e.g. "Tiffany does not know how to cook eggs"). Participants rated the same four sentences after receiving two subsequent hints (e.g. “Tiffany must be careful to avoid sugar” “Tiffany uses needles every day”) designed to reduce the likelihood of the plausible sentences and increase the likelihood of the true sentence. Average change scores in the plausible lure sentences from hint 1 to hint 3 are used as a measure of bias against disconfirmatory evidence. The scale has been associated with delusional ideation sections of schizophrenic spectrum in both normal (Woodward et al., 2007) and clinical populations (Woodward, Moritz, Cuttler, & Whitman, 2006).

10.3.2. Experiment 2

Instructions, scenario, and questions were identical to Experiment 1 up to Page Break 10.

---Page Break 10---

DATABASE OPERATION INSTRUCTIONS

Soon you will be presented with a database (like the one below) that provides information on the DCC's characteristics and actions. To understand how to use the database, please read the instructions below, the letters refer to different sections of the database as marked in the picture.

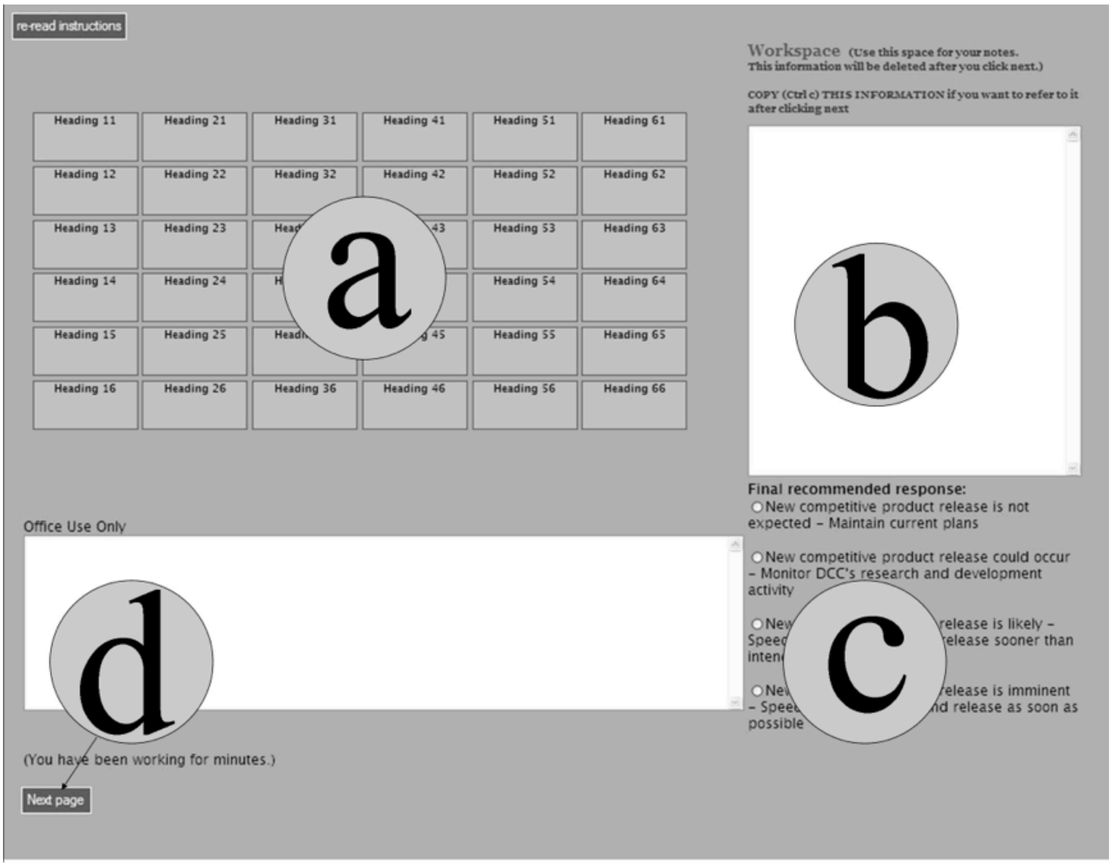
a) Clicking on a heading shows information on that topic. Clicking the red ‘x’ (top left of the box) closes the box.

Note: You need only select those headings that you think will contain information relevant to the task.

b) You can type notes and thoughts and collect information to help with your investigation here. You may want to refer to your notes later in the experiment, so just before you click next, select the information and copy it (ctrl c).

c) You will be asked to use the information to make a decision.

d) Once you have made your decision, please click 'next' but first, please copy any information you typed in the workspace.



---Page Break 11---

You will be able to click next to go to the database in a minute. You'll only have 5 minutes for your investigation, so you probably won't have time to read the information under every heading. Please use this time to plan what information you will examine. The timer won't start until you have read the instructions pages.

(Screen shot of the relevant information grid given the display order condition – example below. Participants were allowed to click next after 40 seconds.)

Target market	Translation expert quit	Contracted software testers	Audio headset source bankrupt	Increased development activity	Annual Report
Slow release pattern	Translation expert hired	Product List	Bulk production of audio headsets	Barriers to development	Key software engineer hired
Scheduled press release	Speech recognition expert quit	Recent advances on speech recognition	Current speech recognition faults	Transferred staff to research	Key software engineer quit
Cancelled Press Release	Speech recognition expert hired	Recent problems in speech recognition	Share price	Audio headsets poor language translation	Audio expert hired
Price reduction on current translation software	Current language translation faults	Recent advances on language translation	Faults in audio production	Increased alliance with potential consumers	Audio expert quit
Price reduction on all products	Branding strategy	Recent problems in language translation	Improvements in audio production	Lost loyalty of potential consumers	Social events

---Page Break 12---

Instructions

- Once you click next you will have 5 minutes to examine the information and come to a decision.
- You may click next to move on whenever you have made your decision.
- Information about DCC was randomly selected for display, so some information may not be relevant to your task.
- The scenario and database instructions are repeated below for your information and can be returned to at any time by clicking on the synopsis button on the top left hand side of the next page.
- Once you click "Next Page" the timer will start and you will be taken to the database of information on the DCC's characteristics and actions.

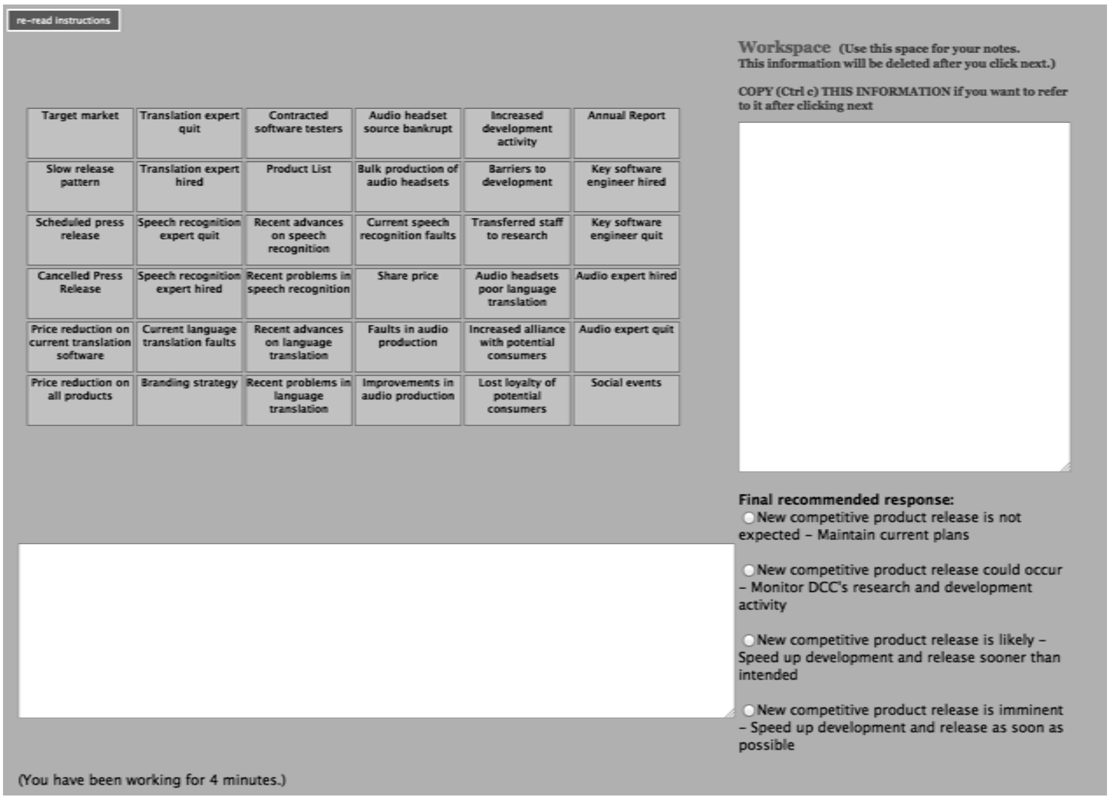
SCENARIO (Reminder)

Scenario stated as before.

DATABASE INSTRUCTIONS (Reminder)

Database operation instructions stated as before.

---Page Break 13---



---Page Break 14---

Questions

Given the information you just read...

How likely is it that the DCC is planning a competitive product release?

Please enter a number between 0 and 100, where 0 = Impossible and 100 = Definite.

How likely is it that the DCC is capable of a competitive product release?

Please enter a number between 0 and 100, where 0 = Impossible and 100 = Definite.

Instructions

The next page will look very similar to the last, except the headings now have numbers before them. In the box labelled "justification" Please list the numbers of the cells that most influenced your decision. You can check the content of cells again but you don't have to.

Your answer may look something like this:

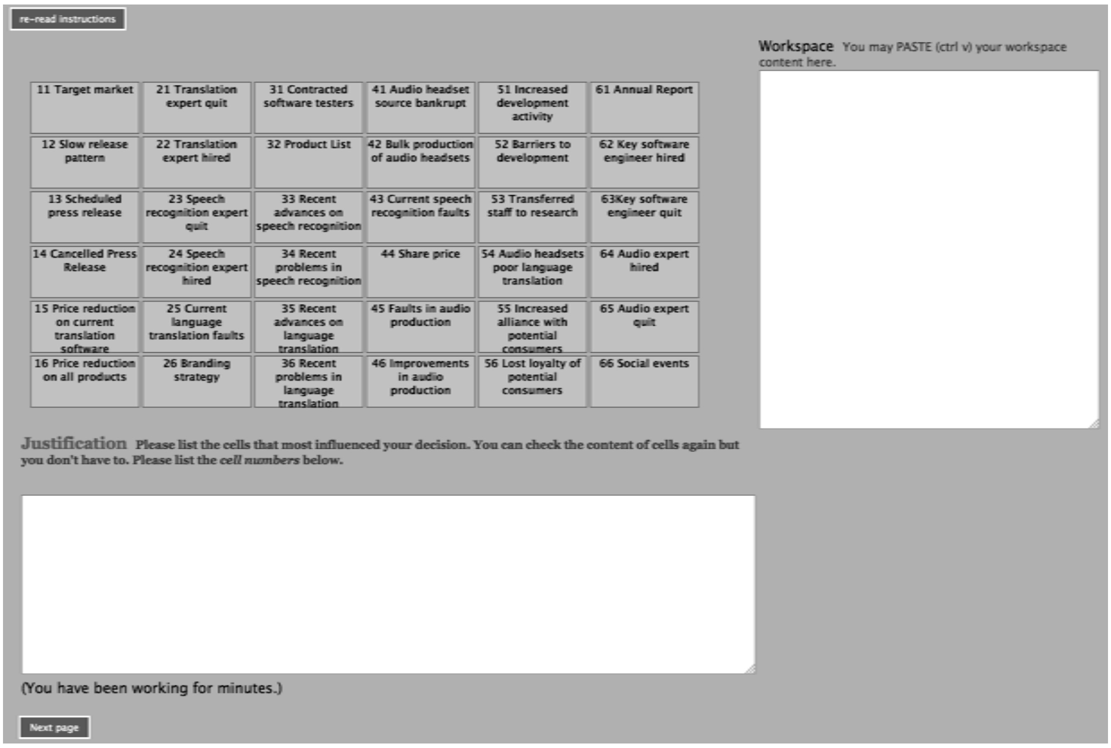
67

72

58

etc.

---Page Break 15---



---Page Break 16---

Title perception question detailed in Chapter 5.3.3.3.

---Page Break 17---

Demographic and individual difference questionnaires from Experiment 1 Page Break 16, except for the exclusion of the causality uncertainty scale – omitted due to time constraints.

10.3.3. Experiment 3

Experiment 3 was conducted online for a number of participants. Therefore, the information and consent form, and the following instructions were added at the start of the experiment:

What to Expect:

You will be presented with a specific work scenario, given the opportunity to gather information on this scenario, and asked to use this information to make a decision. You will proceed through a number of stages as follows:

1. Read Scenario
2. Answer questions to check that you understand the scenario
3. Read information database instructions
4. Revise all Instructions
5. Gather information and decide
6. Answer scenario-related questions
7. Answer questions about you

First I'd like to check that we share an important definition. Please click 'next'.

---Page Break 1---

Please select the best definition for this term: Real-time translation software

- Software that converts the meaning of spoken language into a different language with minimal delay.
- Software that converts the meaning of spoken language into a different language after each statement is complete.
- Software that converts the meaning of written language into a different language with the click of a button.

---Page Break 2---

(If 1.) Correct. For the purposes of this scenario we are defining "Real-time translation software" as software that converts the meaning of spoken language into a different language with minimal delay.

(If 2 or 3.) Incorrect. For the purposes of this scenario we are defining “Real-time translation software” as software that converts the meaning of spoken language into a different language with minimal delay.

---Page Break 3---

SCENARIO as per Appendix B.2.

On the next page you will be asked to answer some questions on the information above. Please click "Next" to continue.

---Page Break 4---

Based on the scenario you just read, are the following statements true or false?

If a new competitive product release is not expected, current plans would be maintained

If a new competitive product release is expected, the product would be released sooner than planned

---Page Break 5---

Please mark your answers based on the scenario below (The scenario has not changed).

Scenario

Please mark your answers based on the scenario above (The scenario has not changed).

Question 1 repeated.

You answered: *Answer* (Correct/Incorrect)

---Page Break 6---

Correct.

If a new competitive product release is not expected, current plans would be maintained.

OR

Incorrect.

If a new competitive product release is not expected, current plans would be maintained.

AND

Correct.

If a new competitive product release is expected, the product would be released sooner than planned

OR

Incorrect.

If a new competitive product release is expected, the product would be released sooner than planned.

---Page Break 7---

(Prefer Inaction)

Please list the potential risks involved in speeding up release plans. (You don't have to fill the space, just list the risks that come to mind).

---Page Break 8a---

If you choose to maintain current release plans incorrectly how much will you get paid? ($15/$14/$5)

---Page Break 9a---

That is correct. If you choose to maintain current release plans incorrectly you will be paid $14.

OR

That is incorrect. If you maintain current release plans incorrectly your pay will be docked by $1, and you will get paid $14.

---Page Break 10a---

If you choose to speed up release plans incorrectly how much will you get paid? ($15/$14/$5)

---Page Break 11a---

That is correct. If you choose to speed up release plans incorrectly you will be paid $5.

OR

That is incorrect. If you speed up release plans incorrectly your pay will be docked by $10, and you will get paid $5.

---Page Break 12a---

(Prefer Action)

Please list the potential risks involved in maintaining current release plans. (You don't have to fill the space, just list the risks that come to mind).

---Page Break 8b---

If you choose to maintain current release plans incorrectly how much will you get paid? ($15/$14/$5)

---Page Break 9b---

That is correct. If you choose to maintain current release plans incorrectly you will be paid $5.

OR

That is incorrect. If you maintain current release plans incorrectly your pay will be *docked* by $10, and you will get *paid* only $5.

---Page Break 10b---

If you choose to speed up release plans incorrectly how much will you get paid? ($15/$14/$5)

---Page Break 11b---

That is correct. If you choose to speed up release plans incorrectly you will be paid $14.

OR

That is incorrect. If you speed up release plans incorrectly your pay will be docked by $1, and you will get paid $14.

---Page Break 12b---

Preference manipulation check detailed in Chapters 5.3.3.3. and 7.2.3.3.

---Page Break 13---

Given only the information provided so far...

How confident are you that maintaining current release plans is the best option given the situation?

Please enter a number between 0 and 100, where 0 = not at all confident and 100 = extremely confident.

How confident are you that speeding up release plans is the best option given the situation?

Please enter a number between 0 and 100, where 0 = not at all confident and 100 = extremely confident.

---Page Break 14---

Comments (Optional):

---Page Break 15---

Given only the information provided so far...

How likely is it that DCC will release a competitive new product within 6 months?

Please enter a number between 0 and 100, where 0 = Impossible and 100 = Definite.

---Page Break 16---

You will be provided with a database of information on your competitor, DCC. This information refers to DCC's recent characteristics and actions. Each heading contains information received on this behaviour or characteristic.

Information may reveal that the behaviour or characteristic was present or absent. For example, selecting the heading "Manager on leave" you may find the following information "Examination of DCC's HR records provide no indication that the Manager is, or is intending to take leave." Alternatively, you may find that the manager is currently on leave.

Headings often refer to different people. For example, if one heading is "Manager on leave" and another is "Manager at work", they probably refer to different managers to avoid overlap.

Time is limited so please select information for review carefully. Information about DCC was randomly selected for display, so some information may not be relevant to your task.

Please answer the following questions to check that you understand the task. You can refer to the instructions above if you need to.

True/False questions as per Experiment 1 after Page Break 8 with the following addition:

Headings that appear to be opposite do not actually contain overlapping information (True/False)

---Page Break 17---

Corrections as per Experiment 1 after Page Break 9 with the following addition:

Your answer to question 4 was incorrect. Headings that appear to be opposite do *not* contain overlapping information.

---Page Break 18---

Database operation instructions as per Experiment 2 after Page Break 10.

---Page Break 19---

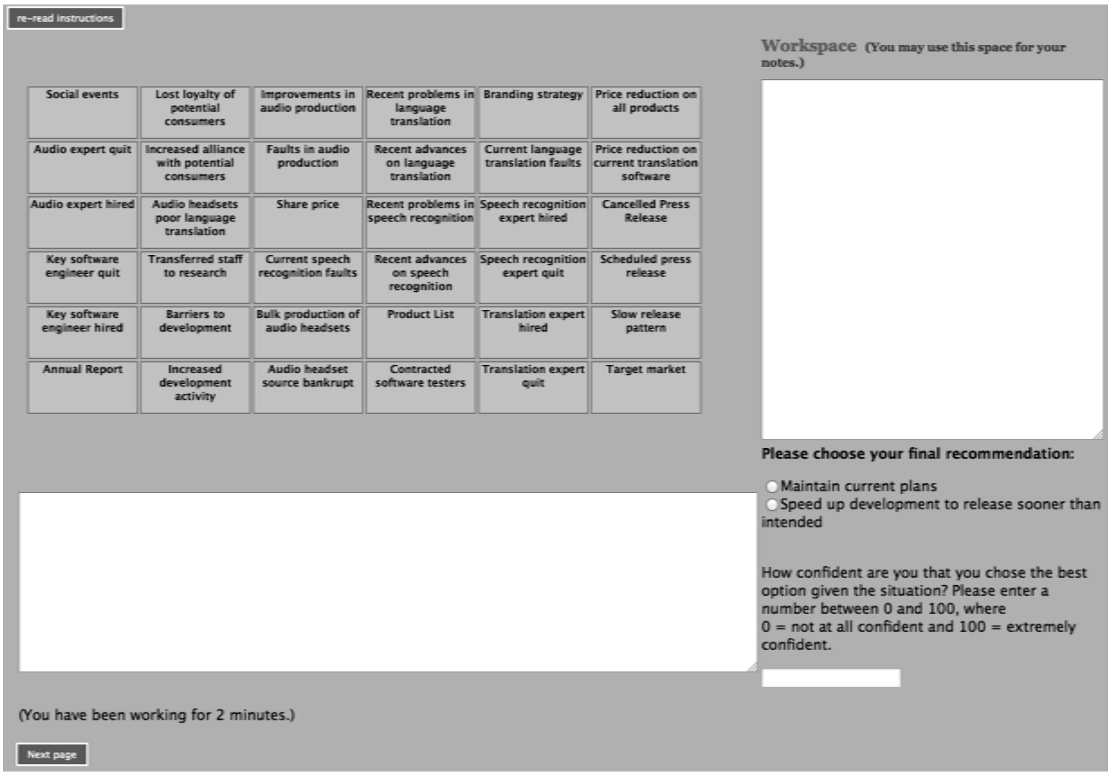
You will be able to click next to go to the database in a minute. Please use this time to plan what information you will examine. Remember some information may not be relevant for your task.

(Screen shot of the information grid. Participants were allowed to click next after 40 seconds.)

---Page Break 20---

Revision of instructions as per Experiment 2 after Page Break 12 without the reference to a timer.

---Page Break 21---



---Page Break 22---

Given the information you have read...

How likely is it that DCC will release a competitive new product within 6 months?

Please enter a number between 0 and 100, where 0 = Impossible and 100 = Definite.

---Page Break 23---

Below are the headings you selected from. Please select the information that most influenced your decision using the checkboxes below.

(Headings displayed in the same order as in the information grid previously used with checkboxes.)

Comments (Optional):

---Page Break 24---

Regardless of the information read about DCC please imagine this alternate scenario:

Imagine that you found that the DCC did have the following characteristics and had taken the following actions.

Remember: Your company, Transmate, is developing real-time translation software. A rival organisation, DCC, is suspected of planning a new product release in direct competition that may beat your product to the market.

For each of the statements please rate *how indicative* it would be of these new competitive product release plans.

Please rate each item individually, irrespective of other items.

This information (below left) indicates that an immanent competitive release is...

Each title is displayed and rated (Impossible/ Very Unlikely/ Unlikely/ Somewhat Unlikely/ No indication either way/ Somewhat Likely/ Likely/ Very Likely/ Definite)

---Page Break 25---

Given the following probabilities that DCC will release a competitive product within 6 months, what action would you take?

0% chance (No chance that DCC will release a competitive product within 6 months) (Maintain current plans/ Speed up development)

10% chance (Maintain current plans/ Speed up development)

…100% chance

---Page Break 26---

If your choice was *incorrect*, how much money do you expect to receive? ($15, $14, $5)

---Page Break 27---

If your choice was *correct*, how much money do you expect to receive? ($15, $14, $5)

---Page Break 28---

How disappointed would you be if you were incorrect?

- I wouldn't care at all
- I wouldn't care much
- I would be somewhat disappointed
- I would be extremely disappointed

---Page Break 29---

How disappointed would you be if you received only $14?

- I wouldn't care at all
- I wouldn't care much
- I would be somewhat disappointed
- I would be extremely disappointed

---Page Break 30---

How disappointed would you be if you received only $5?

- I wouldn't care at all
- I wouldn't care much
- I would be somewhat disappointed
- I would be extremely disappointed

---Page Break 31---

If you have any comments on the scenario task please enter them here.

---Page Break 32---

Demographic and individual difference questionnaires from Experiment 2 Page Break 17.

10.3.4. Experiment 4

<table>
<tr><th>Page</th><th>Treatment</th><th>Control</th></tr>
<tr><td>1</td><td>Information and consent form</td><td>Information and consent form</td></tr>
<tr><td>2</td><td>What to Expect:
You will be presented with a specific work scenario, given the opportunity to gather information on this scenario, and asked to use this information to make a decision. You will proceed through a number of stages as follows:

1. Read Scenario
2. Answer questions to check that you understand the scenario
3. Read information database instructions
4. Revise all Instructions
5. Gather information and decide
6. Answer scenario-related questions
7. Answer questions about you
8. You will then be taken to a separate survey that will request your contact details to confirm payment.

First I'd like to check that we share an important definition. Please click 'next'.</td><td>What to Expect:
You will be presented with a specific work scenario, provided with some information on this scenario, and asked to rate each item of information. You will proceed through a number of stages as follows:

1. Read Scenario
2. Read and rate items of information
3. Answer scenario-related questions
4. Answer questions about you

You will then be asked whether you would like to complete a few questions for a different study that takes 5 minutes, you will be free to accept or decline this offer.
Both studies should take you no more than 1 hour to complete if you choose to.
You will then be taken to a separate survey that will request your contact details to confirm payment (whether or not you choose to complete the second study).
First I'd like to check that we share an important definition. Please click 'next'.</td></tr>
<tr><td>3</td><td colspan="2">Definition question and correction as per Experiment 1 Page Break 1-3</td></tr>
<tr><td>4</td><td>Preference condition specific scenario as per Appendix B.</td><td>Control group specific scenario as per Appendix B.</td></tr>
<tr><td>5</td><td>Questions as detailed below</td><td>Information from Yoked control as detailed in Chapter 8.2.3.2</td></tr>
</table>

---Page Break 4---

Manipulation check questions as detailed in Chapters 5.3.3.3. and 7.2.3.3.

---Page Break 5---

Given only the information provided so far...

Action: At this point which action seems most appropriate?

Maintain current release plans

Speed up release plans

Confidence (50-100): How confident are you that this would be the best action to take given the situation?

Please enter a number between 50 and 100, where 50 = a complete toss up and 100 = absolutely certain.

---Page Break 6---

Given only the information provided so far...

Likelihood (0-100): How likely is it that DCC will release a competitive new product within 6 months?

Please enter a number between 0 and 100, where 0 = Impossible and 100 = Definite.

---Page Break 7---

Instructions as per Experiment 3 Page break 16-19 with the following addition:

After each box you open, you will be asked 4 questions. I apologise for the annoyance. Please be patient and provide considered answers each time.

Below is an image of the questions. Once you have answered them all you will be able to return to the investigation by clicking "return to experiment".

Please consider ONLY the most recent item of information.

This information indicates that a competitive new product release from DCC within 6 months is...

( ) 1) Impossible
( ) 2) Very Unlikely
( ) 3) Unlikely
( ) 4) Somewhat Unlikely
( ) 5) No indication either way
( ) 6) Somewhat Likely
( ) 7) Likely
( ) 8) Very Likely
( ) 9) Definite

Please consider all the information so far.

Action: At this point which action seems most appropriate?

( ) Maintain current release plans
( ) Speed up release plans

Confidence (50-100): How confident are you that this would be the best action to take given the situation?
Please enter a number between 50 and 100, where 50 = a complete toss up and 100 = absolutely certain.

Likelihood (0-100): How likely is it that DCC will release a competitive new product within 6 months?
Please enter a number between 0 and 100, where 0 = Impossible and 100 = Definite.

return to experiment

Click next now for a preview of the database.

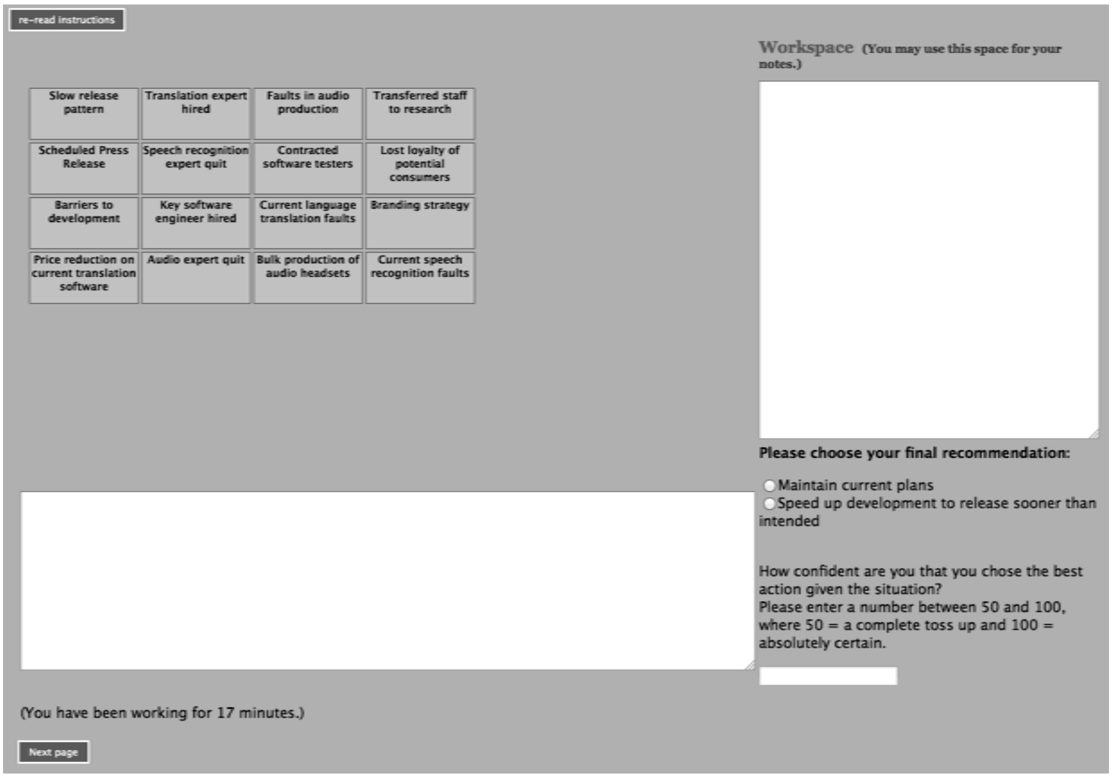
---Page Break 8---

Preview of information grid as displayed in Chapter 8.2.3.2. Instructions as per Experiment 3 after Page Break 9.

---Page Break 9---

Revision of instructions as per Experiment 3 after Page Break 20

---Page Break 10---



After a title was opened and closed the process tracing questions were asked as detailed in Chapter 8.2.3.3., and displayed under Experiment 4 Page Break 4 above.

---Page Break 11---

Questions as per Experiment 3 Page Break 22 onwards with the following alterations in the Control group. (Alterations in the control compared to treatment group are <u>underlined</u>).

---Page Break 22---

<u>Remember that:</u>

<u>Your company is developing real-time translation software to be released 6 months from now. Rival organisations are suspected of planning new product releases in direct competition that may beat your product to the market. As a Market Analyst, you have been asked to head up an investigative team to examine your potential competition.</u>

In response your organisation might:

- Maintain current plans or
- Speed up development to release sooner than intended

Imagine that all the information you just read was about a single company called DCC.

Action: At this point which action seems most appropriate?

Maintain current release plans

Speed up release plans

Confidence (50-100): How confident are you that this would be the best action to take given the situation?

Please enter a number between 50 and 100, where 50 = a complete toss up and 100 = absolutely certain.

---Page Break---

Given the information you have read...

How likely is it that DCC will release a competitive new product within 6 months?

Please enter a number between 0 and 100, where 0 = Impossible and 100 = Definite.

---Page Break 23---

Question regarding selection of information not applicable for the control group.

---Page Break 24---

Regardless of the information read about DCC please imagine this alternate scenario:

Imagine that you found that the <u>companies</u> did have the following characteristics and had taken the following actions.

Remember: Your company, Transmate, is developing real-time translation software. <u>Rival organisations are</u> suspected of planning a new product release in direct competition that may beat your product to the market.

For each of the statements please rate *how indicative* it would be of these new competitive product release plans.

Please rate each item individually, irrespective of other items.

This information (below left) indicates that a competitive new product release from this company within 6 months is...

Each title is displayed and rated (Impossible/ Very Unlikely/ Unlikely/ Somewhat Unlikely/ No indication either way/ Somewhat Likely/ Likely/ Very Likely/ Definite)

---Page Break 25---

No changes

---Page Break 26-31---

Questions regarding financial penalties not applicable to the control group.

10.4. Appendix D: Manipulation Checks for Experiments 1 to 5

10.4.1. Preference Manipulation

Differences between action attraction and inaction attraction across conditions was examined using a repeated measures GLM with action attraction and inaction attraction as the within participants variables and preference condition as the between participants variables. All results were in the expected direction with higher action attraction and lower inaction attraction in the Prefer-Action condition compared to the Prefer-Inaction condition. As shown in Tables D1 and D2, Experiments 3 and 4, which included financial incentives, had greater impact than Experiments 1, 2, and 5, which did not include financial incentives.

Table D1: Degree to which Preference Condition produced Attraction to Inaction and Action in all Experiments

Experiment	Prefer-Inaction				No-Preference				Prefer-Action			
	Inaction Attraction		Action Attraction		Inaction Attraction		Action Attraction		Inaction Attraction		Action Attraction	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
1 (*N* = 85)	4.41	1.58	2.89	1.06	4.54	1.76	4.18	1.75	3.50	1.32	4.72	1.31
2 (*N* = 111)	4.42	1.47	3.17	0.94	4.54	1.57	4.20	1.25	3.04	1.44	4.85	1.16
3 (*N* = 111)	5.73	0.91	3.40	1.22					3.16	1.50	5.73	0.94
4 (*N* = 168)	5.62	0.90	3.24	1.22					3.10	1.44	5.99	0.89
5 (*N* = 49)	5.31	0.83	3.59	0.97	4.22	1.40	4.72	1.44	3.77	1.36	5.59	0.93

Table D2: Significance and Effect Size of the Impact of Preference Condition on Attraction to Inaction and Action in all Experiments

Experiment	Multivariate test results			
	Wilks' Lambda	*F*	*df*	Partial η^2
1	0.84	8.06***	2, 82	16%
2	0.74	19.40***	2, 108	26%
3	0.37	185.76***	1, 109	63%[a]
4	0.34	157.46***	1, 82	66%[a]
5	0.65	12.21***	2, 46	35%

Note: [a] Effects were stronger in the experiments with preference-based financial incentives.

* $p < .10$, ** $p < .05$, *** $p < .01$

10.4.2. Title Perception

In Experiments 1 to 3 and 5, title perception was examined using a mixed model analysis to regress title perception on title type (release-consistent, neutral, release-inconsistent) within individuals, controlling for the number of selected titles, preference, and information condition where appropriate at the individual level.

In Experiment 4 title perception was examined using a four-level nested generalised linear mixed model analysis with titles nested within individuals, nested within groups, nested within the order of title selection shared by yoked control-experimental pairs. This model was used to regress title perception on title type at the title level, information condition and selected titles at the individual level, and group at the group level.

As shown in Tables D3 and D4 the perceived difference in implication between release-consistent and release-inconsistent titles remained fairly stable across experiments.

Table D3: The Degree to which Titles were Perceived as Indicative of a Competitive Release on a 9-point scale

Experiment	Release-Consistent [a]		Neutral		Release-Inconsistent [b]	
	M	*SD*	*M*	*SD*	*M*	*SD*
1 (*N* = 85)	6.71	1.38	6.34	1.57	3.78	1.62
2 (*N* = 111)	6.35	1.36	5.58	1.42	4.17	1.57
3 (*N* = 111)	6.28	1.48	5.53	1.45	4.30	1.85
4 (*N* = 166)[c]	6.35	1.51			4.35	1.76
5 (*N* = 49)	6.55	1.32			4.59	1.65

Note: [a] Scores are consistently above the mid-point (5). [b] Scores are consistently below the mid-point (5).
[c] Two participants did not respond to the title perception question

Table D4: Significance and Effect Size of the Influence of Title Type on Title Perception

Experiment	Title Type Significance in Full Model		Release-Consistent vs. -Inconsistent Titles	
	df	*F*	*t*	95% CI
1[a]	2, 1427	558.29***	32.88***	2.66, 3.00
2	2, 3990	951.02***	43.31***	2.08, 2.28
3 [b]	2, 3988	622.12***	35.10***	1.87, 2.09
4 [d]	1, 2645	1168.45***	20.77***	1.55, 1.87
5	1, 777	356.56***	18.88***	1.76, 2.17

Note: All analyses controlled for number of selected titles and preference condition. The impact of number of selected titles on title perception was significant in Experiments 1, 2, 3, and 5.[a] Participants rated only the titles they had selected. [b] Also controlling for information condition and age. [d] Also controlling for information condition, group, and interactions of information condition and heading type with group. Qualified by significant title type by group and group by information condition interactions detailed in Chapter 8.3.1.

* $p < .10$, ** $p < .05$, *** $p < .01$

Experiments 1, 2, and 3 found that participants who selected more titles perceived headings as less indicative of release than participants who selected fewer titles. Experiment 4 found no effect of selected titles on title perception, and Experiment 5 found that participants who selected more titles perceived headings as more indicative of release than participants who selected fewer titles.

To explore these observations further, the interaction between selected titles and title type was examined in all experiments. It was predicted that participants who selected more titles might perceive release-consistent and release-inconsistent titles as more similar, given that both provide release-consistent and release-inconsistent information, compared to participants who selected fewer titles. This pattern would be predicted in sequential (Experiments 2 to 4) but not simultaneous information search (Experiments 1 and 5) conditions.

Accordingly, the title type by selected titles interaction was significant in Experiments 2, 3, and 4 but not Experiments 1 or 5, as shown in Table D5. In addition, the three-way title type by selected titles by group interaction effect was significant in Experiment 4, F (1, 2643) = 6.65, p = .010. As predicted, as the number of selected titles increased, release-consistent and release-inconsistent title perception converged in Experiment 3 and the Treatment group in Experiment 4, but remained close to parallel in Experiments 1, 5, and the Control group in Experiment 4. Contrary to predictions, heading perception diverged with more titles selected in Experiment 2.

Table D5: Significance and Effect Size of the Influence of the Title Type by Selected Titles Interaction on Title Perception

Experiment	Title Type by Selected Titles Interaction Significance in Full Model		Change in the Difference between Release-Consistent and Release-Inconsistent Title Perception (9-point scale) for every Ten Titles Selected.		
	df	*F*	*M Difference*	*SE*	95% CI
1	2, 1425	0.60	0.08	0.10	-0.12, 0.29
2	2, 3988	9.17***	0.37***	0.09	0.20, 0.54
3	2, 3986	9.02***	-0.20***	0.06	-0.32, -0.08
4 Treatment	1, 1337	15.47***	-0.79***	0.20	-1.18, -0.40
4 Control	1, 1305	0.26	-0.10	0.19	-0.47, 0.28
5	1, 776	0.53	0.27	0.37	-0.46, 0.10

Note: * $p < .10$, ** $p < .05$, *** $p < .01$

10.4.3. Impact of Manipulations on Action Decision

As shown in Table D6, the difference in action decision between preference conditions increased between Experiments 2 and 3 when financial incentives were introduced. The number of Prefer-Inaction participants choosing action increased from Experiment 3 to 4, possibly due to the stronger Release condition that contained no information contrary to release in Experiment 4. In Experiment 4, the stronger Release and No-Release conditions are also evidenced by the shifts towards action and inaction respectively, compared to Experiment 3.

Table D6: The Percentage of Participants who Chose Action over Inaction within Preference and Information Conditions across Experiments 2 to 4

Experiment	Percentage of Participants who Chose Action				
	Prefer-Inaction	Prefer-Action	No-Release	Mixed	Release
2 (*N* = 111) [a]	21	34			
3 (*N* = 111)	14	61	26	30	57
4 Treatment (*N* = 84)	41	67	11	67	82
4 Control (*N* = 84)	NA	NA	26	73	93

Note: [a] Participants chose from 4 possible actions, two of which involved speeding up release plans (action options).

10.4.4. Impact of Information Condition on Final Release Probability

The shift to stronger No Release and Release information conditions is evidenced by the decrease in final release probability in the No-Release, but increase in final release probability in the Release condition between Experiments 3 and 4 (Table D7). However, this shift is much more pronounced in the Treatment than in the Control group of Experiment 4 (Table D7).

Table D7: Final Release Probability across Information Conditions in Experiments 3 and 4

Experiment	No Release		Mixed		Release		Information condition		
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	*df*	*Partial* η^2
3 (*N* = 111)	41.21	21.21	56.08	21.57	69.09	15.83	18.37***	2, 108	25%
4 Treatment (*N* = 84)	26.67	15.99	69.47	19.06	86.70	13.61	95.39***	2, 81	70%
4 Control (*N* = 84)	49.78	20.25	68.00	15.12	76.48	21.90	13.72***	2, 81	25%

Note: * $p < .10$, ** $p < .05$, *** $p < .01$

10.5. Appendix E: Experiment 5, Replicating the Frame-Based Effect on Selection

Experiment 5 aimed to replicate the finding of frame-based positive test strategy (PTS) behaviour in a simultaneous information search task. Experiment 1 (Chapter 5.4.2) found that, on average, participants selected significantly more release-consistent than release-inconsistent titles. This frame-based PTS was evident when participants were asked to choose the information they would need to make an informed decision (simultaneous information search; Chapter 5), but not in subsequent experiments (Chapters 6 to 8) where participants were able to read the selected information prior to selecting the next item of information (sequential information search). The information space from Experiment 4 (Chapter 8.2.3.2) is used to check that the frame-based PTS observed was not peculiar to the information display used in Experiments 1 to 3. The frame-based PTS hypothesis as per Experiment 1 is as follows.

Hypothesis 1 Frame-Based Selection: *Participants will display frame-based selection in that they will select more release-consistent than release-inconsistent titles.*

As found in Experiment 2 (Chapter 6.2.2) frame-based PTS is expected to be greater in simultaneous information search condition than the sequential information search conditions. To replicate this result, frame-based PTS is compared across Experiments 4 and 5 because they used the same information space, but Experiment 4 required sequential information search whereas Experiment 5 required simultaneous information search.

H2 *Frame-based PTS will be greater in simultaneous information search conditions compared to sequential information search conditions*

10.5.1. Methods

10.5.1.1. Participants

First year psychology students participated online for course credit. Participation took a maximum of 1 hour. Of 49 participants, 71% were female, 57% were pursuing a

Psychology degree, and the other 43% came predominantly from other Human Sciences, Business and Economics faculties, with a few participants from Arts and Science faculties. Participants ranged from 18 to 51 years of age with an average age of 21.90 (SD = 7.73).

10.5.1.2. Design

The design was the same as Experiment 1 (Chapter 5.3.2). There were 17 participants in the Prefer-Action condition, and 16 participants in each of the No-Preference and Prefer-Inaction conditions.

10.5.1.3. Apparatus and materials

Scenario

The scenario and preference conditions were the same as those used in Experiments 3 and 4 (Chapters 7.2.3.1 and 8.2.3.1), except that the incentives were not included. The No-Preference condition was the same as Prefer-Action and Prefer-Inaction conditions, except without the blurb about potential costs of actions.

Information environment

Experiment 5 used the same 4 by 4 grid, with the same counter-balanced display order as in Experiment 4 (Chapter 8.2.3.2).

Self-report measures

Self-report measures were the same as those from Experiment 1 (Chapter 5.3.3.3).

Behavioural measures

Behavioural measures were the same as Experiment 1 (Chapter 5.3.3.4).

10.5.1.4. Procedure

Participants signed up to the study via the Macquarie participant pool website. Upon clicking the survey link they were transferred to a Qualtrics survey. After reading the information and consent form, agreeing to participate, and agreeing that they had an hour of uninterrupted time, participants progressed to the definition of "real-time translation software” as per Experiments 1 to 4. Participants were then presented with the scenario, condition-specific manipulation, and follow up questions as per Experiments 3 and 4 but without reference to financial incentives. Participants then answered manipulation check questions, before progressing to the main selection task.

Participants were provided with instructions on the information grid, asked related questions, and corrected as necessary as per Experiment 4. As in Experiment 1 the instructions for information selection asked that participants select only the information required to make an informed decision. Participants could then select any number of titles from the 4 x 4 matrix (Experiment 4, Chapter 8.2.3.2).

The procedure was otherwise the same as Experiment 1.

10.5.2. Results

10.5.2.1. Manipulation checks

Manipulation checks were conducted as detailed in Chapter 5.4.1. The results are provided in comparison to other experiments in Appendix D.

As shown in Appendix D, the preference manipulation from Experiments 3 and 4 without the financial incentives used in this experiment had only slightly greater impact on attraction to action and inaction than the preference manipulation in Experiments 1 and 2, and much less impact than the manipulations with financial incentives in Experiments 3 and 4.

In addition to the observed difference in title perception detailed in Chapter 5.4.1 and Appendix D, average title perception was greater, or more consistent with release, for participants in the No-Preference compared to the Prefer-Action preference condition, in the Prefer-Action compared to the Prefer-Inaction preference condition, for participants who selected more titles, and younger participants.

10.5.2.2. Frame-based PTS

Hypothesis 1 Frame-Based Selection: *Participants will display frame-based selection in that they will select more release-consistent than release-inconsistent titles.*

A repeated measures GLM analysis with release-consistent and release-inconsistent title selection as the within participants variable supported Hypothesis 1. On average, participants selected about one (M =1.06, SE = 0.51, 95% CI 0.04, 2.08) more release-consistent (M = 4.41, SD = 2.08) than release-inconsistent titles (M = 3.35, SD = 2.44), Wilks' Lambda = 0.92, F (1,48) = 4.38, p = .042 accounting for 8% of the variance in title selection.

H2 *Frame-based PTS will be greater in simultaneous information search conditions compared to sequential information search conditions*

To test Hypothesis 2 a repeated measures GLM analysis was used to compare within-participant selection of release-consistent and release-inconsistent titles across Experiments 4 and 5 controlling for participant age. As predicted, participants showed frame-based PTS, in that they selected more release-consistent than release-inconsistent titles, in the simultaneous information search experiment (Experiment 5) but not in the sequential information search experiment (Experiment 4), as shown in Figure E1. The difference between the differences was statistically significant, Wilks' Lambda = 0.96, F (1,130) = 5.34, p = .022 and explained 4% of the variance.

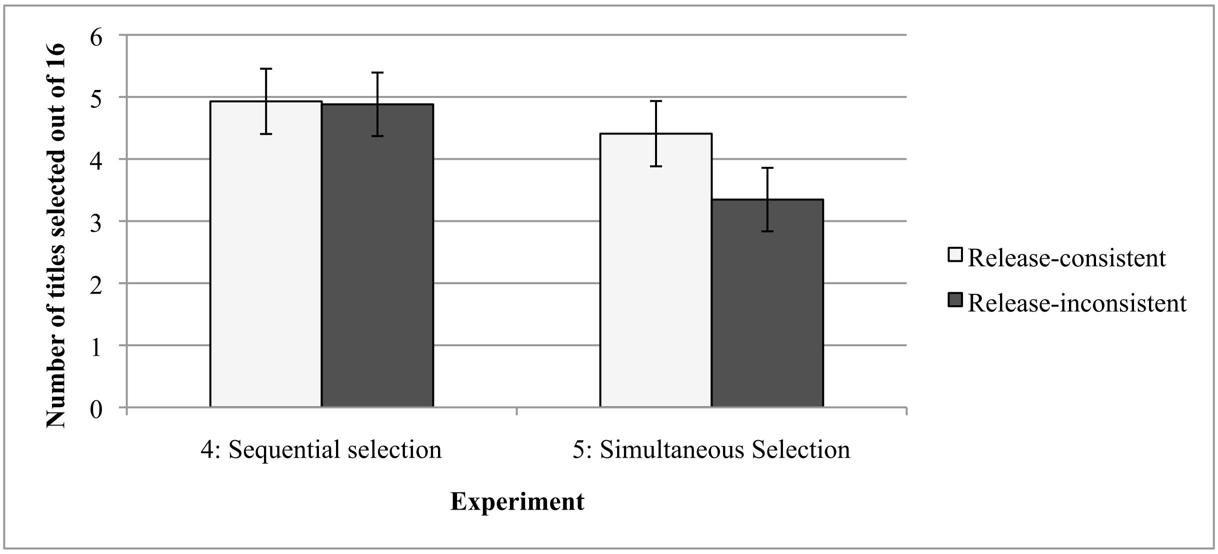


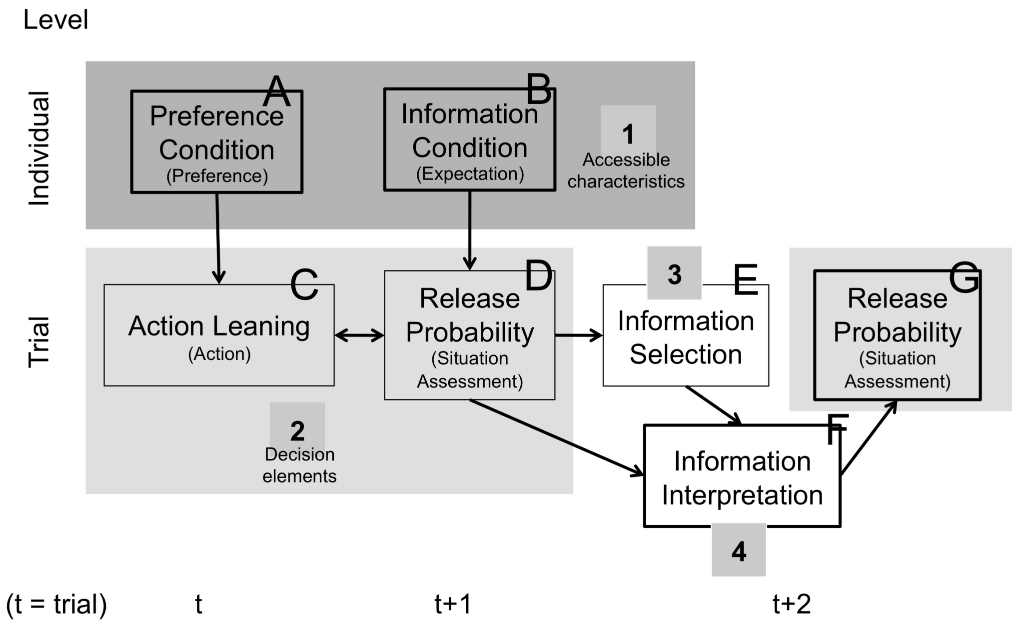
Figure E1: Participants selected more release-consistent than release-inconsistent titles in the simultaneous (N = 49) but not sequential (N = 84) information search experiment. Error bars represent 95% CI.

10.5.3. Discussion

Experiment 5 replicated the results from Experiments 1 and 2. Specifically, frame-based PTS in the same four by four information grid was found in a simultaneous information search situation (Experiment 5) but not in a sequential information search situation (Experiment 4). The difference in frame-based PTS between experiments was significant. This result is the same as found in Experiments 1 and 2 with a six by six information grid. There were two main differences between this replication and the original results. Firstly, participants selected fewer titles overall in the four by four compared to the six by six information spaces. This is not surprising given that there were 20 fewer headings available in the four by four compared to six by six information grid. Secondly, participants selected more titles in the simultaneous (Experiment 1) than the sequential information search condition (Experiment 2) in the six by six information grid, but more titles in the sequential (Experiment 4) than the simultaneous (Experiment 5) information search condition in the four by four grid. This may be explained by the fact that the sequential information search condition with the six by six grid had a time limit, whereas none of the other experiments did.

10.6. Appendix F: Details of Multi-level Analyses used in Chapter 7

A series of multi-level mediation analyses were used to test the following model:



All analyses used a first order autoregressive correlation structure. This specifies a suitable correlation structure for repeated measures over time. Specifically, that correlations are expected to be high between measurements taken at adjacent trials and reduce across trials that are further apart (Littell, Pendergast, & Natarajan, 2004). All explanatory variables were grand-mean centred as recommended by Hox (2010).

The full multilevel equations are provided below. For simplicity, only equations for the full model including all independent variables and mediators will be provided. Mediational analyses controlled for other hypothesised influences on the outcome variable included in the model. For example, the impact of preference condition on release probability via action leaning controlled for information condition because it was predicted to directly impact release probability.

10.6.1. Dependent Variable: Release Probability

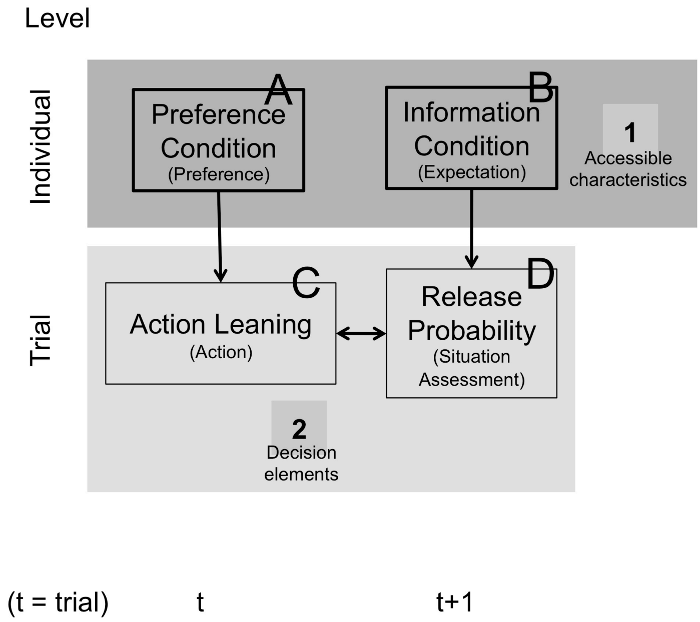


Figure F1: Predictors of Release Probability based on the DHT model.

Level 1 (Trial Level) (Equation 1.1):

Release $\text{Probability}_{(t+1)i} = \beta_{0i} + \beta_{1i}(\text{Action Leaning})_{ti} + \beta_{2i}(\text{Release Probability})_{ti} + \beta_{3i}(\text{Trial})_{(t+1)i} + e_{(t+1)i}$

Release $\text{Probability}_{(t+1)i}$ is the individual *i*'s rating of release probability on trial *t+1*. At level 1 it is predicted that the individual *i*'s release probability at trial *t+1* will be predicted by action leaning at trial *t* after controlling for release probability on trial *t*, trial number, and random error.

Level 2 (Individual Level) (Equation 1.2):

$\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Preference Condition})_i + \gamma_{02}(\text{Information Condition})_i + u_{0i}$

At level 2 it is predicted that the individual's average release probability (β_{0i}) will higher for individuals in the Prefer-Action compared to Prefer-Inaction condition, and higher for individuals in the Release compared to the No-Release information condition.

$\beta_{3i} = \gamma_{30} + \gamma_{31}(\text{Information Condition})_i + u_{3i}$

An interaction is also predicted. Release probability is predicted to increase across trials in the Release information condition, and decrease across trials in the No-Release condition.

No further predictions are made about slopes:

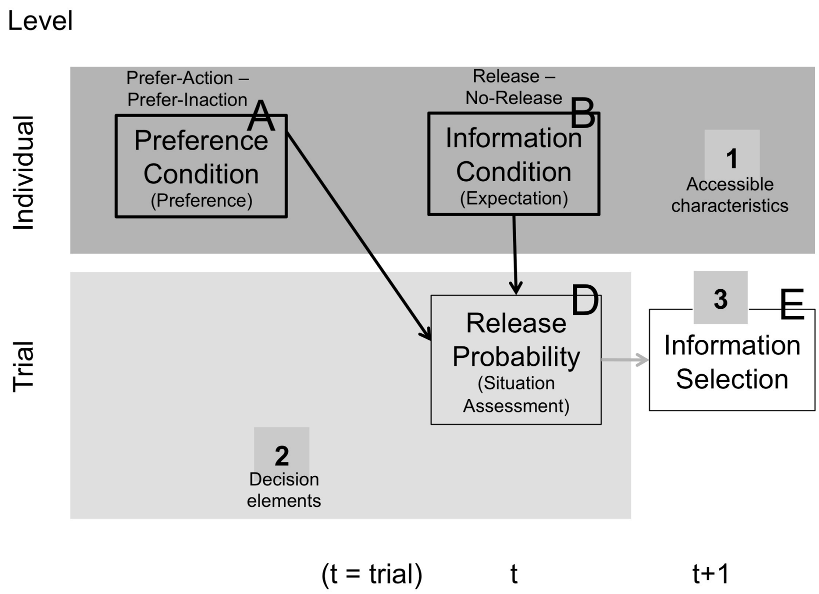
$\beta_{1i} = \gamma_{10} + u_{1i}$; $\beta_{2i} = \gamma_{20} + u_{2i}$;

Full Equation (Equation 1.3):

Release Probability$_{(t+1)i}$ = γ_{00} + γ_{01}(Preference Condition)$_i$ + γ_{02}(Information Condition)$_i$ + γ_{10}(Action Leaning)$_{ti}$ + γ_{20}(Release Probability)$_{ti}$ + γ_{30}(Trial)$_{(t+1)i}$ + γ_{31}(Information Condition)$_i$*(Trial)$_{(t+1)i}$ + u_{1i}(Action Leaning)$_{ti}$ + u_{2i}(Release Probability)$_{ti}$ + u_{3i}(Trial)$_{(t+1)i}$ + u_{0i} + $e_{(t+1)i}$

As detailed above and displayed in Figure F1, a main effect is expected for preference, information condition, which may disappear or reduce after the inclusion of action leaning on the previous trial, and an interaction effect is expected for information condition by trial, after controlling for release probability on the previous trial.

10.6.2. Dependent Variable: Information Selection



Note: The direct path from A to D replaces the indirect path in Figure F1 based on results from Chapter 10.6.3.

Figure F2: Predictors of information selection based on the DHT model.

Level 1 (Trial Level) (Equation 2.1):

$\log(P_{(t+1)i}/1\text{-}P_{(t+1)i}) = \beta_{0i} + \beta_{1i}(\text{Release Probability})_{ti} + \beta_{2i}(\text{Trial})_{(t+1)i} + \beta_{3i}(\text{Release-consistent titles selected})_{(t+1)i} + e_{(t+1)i}$

$\text{Log}(P_{(t+1)i}/1\text{-}P_{(t+1)i})$ is the log odds of selecting a release-consistent, rather than a release-inconsistent, cell at trial *t+1* for individual *i*. At level 1 it is predicted that the odds will increase as release probability on the previous trial increases, and decrease as the number of release-consistent titles already selected increases.

Level 2 (Individual Level) (Equation 2.2):

$\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Preference Condition})_i + \gamma_{02}(\text{Information Condition})_i + u_{0i}$

At level 2 it is predicted that the individual's average ratio of release-consistent to release-inconsistent titles selected (β_{0i}) will be higher for individuals in the Prefer-Action compared to Prefer-Inaction condition, and higher for individuals in the Release compared to the No-Release information condition.

$\beta_{2i} = \gamma_{20} + \gamma_{21}(\text{Information Condition})_i + u_{2i}$

The odds of selecting a release-consistent title are predicted to increase across trials in the Release information condition, and decrease across trials in the No-Release condition. The slope between trial and information selection should be neutral in the Mixed information condition.

No further predictions are made about slopes:

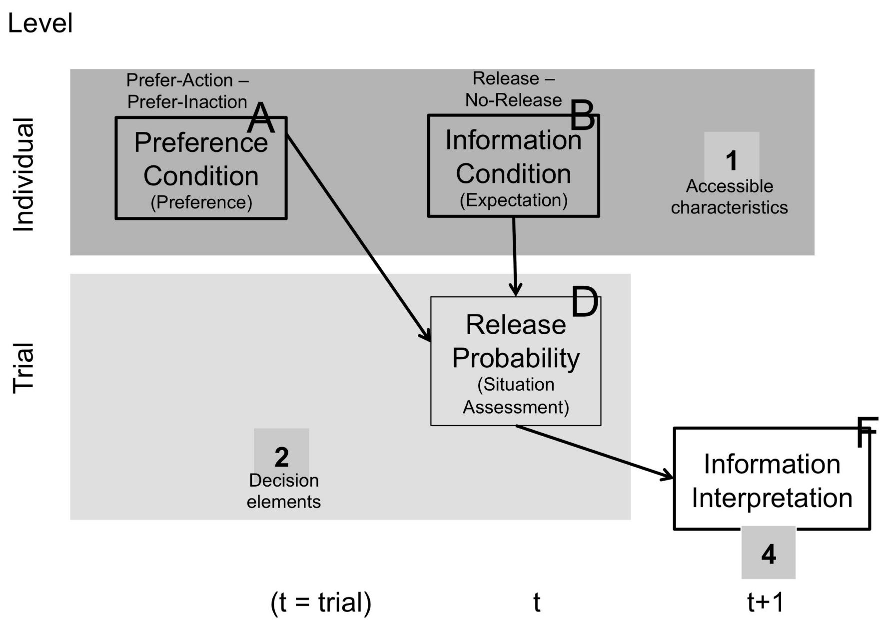
$\beta_{1i} = \gamma_{10} + u_{1i}$; $\beta_{3i} = \gamma_{30} + u_{3i}$

Full Equation (Equation 2.3):

$\log(P_{(t+1)i}/1\text{-}P_{(t+1)i}) = \gamma_{00} + \gamma_{01}(\text{Preference Condition})_i + \gamma_{02}(\text{Information Condition})_i + \gamma_{10}(\text{Release Probability})_{ti} + \gamma_{20}(\text{Trial})_{ti} + \gamma_{21}(\text{Information Condition})*(\text{Trial})_{(t+1)i} + \gamma_{30}(\text{Release-consistent titles selected})_{(t+1)i} + u_{1i}(\text{Release Probability})_{ti} + u_{2i}(\text{Trial})_{(t+1)i} + u_{3i}(\text{Release-consistent titles selected})_{(t+1)i} + u_{0i} + e_{(t+1)i}$

As detailed above and displayed in Figure F2, a main effect is expected for preference and release probability on the previous trial and an interaction effect is expected for information condition by trial after controlling for release-consistent titles already selected.

10.6.3. Dependent Variable: Information Interpretation



Note: The direct path from A to D replaces the indirect path in Figure F1 based on results from Chapter 10.6.3.

Figure F3: Predictors of information interpretation based on the DHT model.

Level 1 (Trial Level) (Equation 3.1):

Information $\text{Interpretation}_{(t+1)i} = \beta_{0i} + \beta_{1i}(\text{Release Probability})_{ti} + \beta_{2i}(\text{Trial})_{(t+1)i} + e_{(t+1)i}$

Information $\text{Interpretation}_{(t+1)i}$ is the individual *i*'s rating of the degree to which the information received on trial *t+1* is perceived as suggestive of a competitive release. At level 1 it is predicted that information interpretation at trial *t+1* will be predicted by release probability at trial *t* after controlling for trial number, and random error.

Level 2 (Individual Level) (Equation 1.2):

$\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Preference Condition})_i + \gamma_{02}(\text{Information Condition})_i + u_{0i}$

At level 2 it is predicted that the individual's average *information interpretation* (β_{0i}) will be more consistent with release for individuals in the Prefer-Action compared to Prefer-Inaction condition, and individuals in the Release compared to the No-Release information condition.

$\beta_{3i} = \gamma_{30} + \gamma_{31}(\text{Information Condition})_i + u_{3i}$

An interaction is also predicted. Information interpretation is predicted to become more supportive of release across trials in the Release information condition, and less supportive of release across trials in the No-Release condition. This prediction is based on the distorting effect of expectation.

No further predictions are made about slopes:

$\beta_{1i} = \gamma_{10} + u_{1i}$; $\beta_{2i} = \gamma_{20} + u_{2i}$;

Full Equation (Equation 1.3):

$\text{Information Interpretation}_{(t+1)i} = \gamma_{00} + \gamma_{01}(\text{Preference Condition})_i + \gamma_{02}(\text{Information Condition})_i + \gamma_{10}(\text{Release Probability})_{ti} + \gamma_{20}(\text{Trial})_{(t+1)i} + \gamma_{31}(\text{Information Condition})_i{*}(\text{Trial})_{(t+1)i} + u_{1i}(\text{Release Probability})_{ti} + u_{2i}(\text{Trial})_{(t+1)i} + u_{0i} + e_{(t+1)i}$

As detailed above and Displayed in Figure F3, a main effect is expected for preference, information condition, which may disappear or reduce after the inclusion of release probability on the previous trial, and an interaction effect is expected for information condition by trial, which may also disappear or reduce after the inclusion of release probability.

10.6.4. Dependent Variable: Final Release Probability

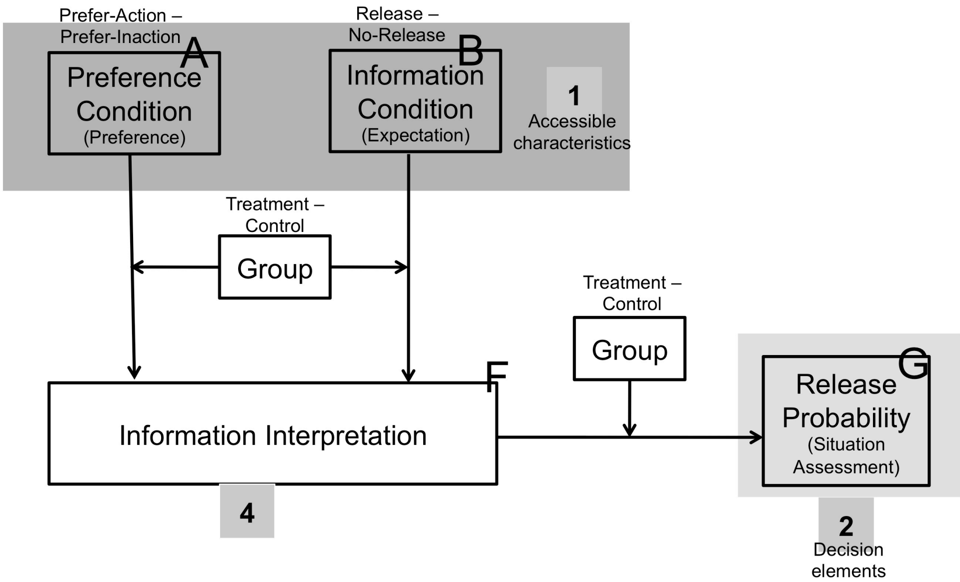


Figure F4: Moderation by group of the mediated model predicting final release probability based on the DHT Model.

Level 1 (Individual level) (Equation 4.1):

Release Probability$_{igo}$ = π_{0go} + π_{1go}(Preference Condition)$_{igo}$ + π_{2go}(Information Condition)$_{igo}$ + π_{3go}(Information Interpretation)$_{igo}$ + π_{4go}(Preference Condition)$_{igo}$(Information Condition)$_{ig}$+ e_{igo}

Release Probability$_{igo}$ is the individual *i*'s final release probability within group *g* (treatment or control) and order of information viewed *o* (usually containing a single pair of yoked treatment and control participants). At level 1 it is predicted that final release probability will be predicted by preference and information condition, mediated by information interpretation controlling for random error. The possibility of an interaction between preference and information condition is controlled for. However, the interaction with group at Level 2 is of primary interest.

Level 2 (Group Level) (Equation 4.2):

$\pi_{0go} = \beta_{00o} + u_{0go}$

$\pi_{1go} = \beta_{10o} + \beta_{11o}(\text{Group})_{go} + u_{1go}$

A preference condition by group interaction is predicted. Final release probability is predicted to be higher in the Prefer-Action condition compared to the Prefer-Inaction condition in the treatment group, but not yoked control group.

$\pi_{2go} = \beta_{20o} + \beta_{21o}(\text{Group})_{go} + u_{2go}$

An information condition by group interaction is predicted. Final release probability is predicted to be higher in the Release condition compared to the No-Release condition and this difference is predicted to be greater in the treatment compared to the control group.

$\pi_{3go} = \beta_{30o} + \beta_{31o}(\text{Group})_{go} + u_{3go}$

An information interpretation by group interaction is predicted. The positive relationship between information interpretation and final release probability is predicted to be higher in the treatment compared to the control group.

$\pi_{4go} = \beta_{40o} + \beta_{41o}(\text{Group})_{go} + u_{4go}$

The possibility of a group by information condition by preference condition interaction is controlled for.

Level 3 (Order Level) (Equation 4.3):

$\beta_{00o} = \gamma_{00} + u_{0o}$, $\beta_{10o} = \gamma_{10} + u_{1o}$, $\beta_{20o} = \gamma_{20} + u_{2o}$, $\beta_{30o} = \gamma_{30} + u_{3o}$, $\beta_{40o} = \gamma_{40} + u_{4o}$

No main or interaction effects are expected for order. Inclusion of the order level acts to keep yoked control and treatment participants together within a single order.

Full Equation (Equation 4.4):

Release $\text{Probability}_{igo} = \gamma_{00} + \gamma_{10}(\text{Preference Condition})_{igo} + \gamma_{20}(\text{Information Condition})_{igo} + \gamma_{30}(\text{Information Interpretation})_{igo} + \gamma_{40}(\text{Preference Condition})_{igo}(\text{Information Condition})_{ig}$ + $\boldsymbol{\beta_{11o}(\textbf{Preference Condition})_{igo}(\textbf{Group})_{go}}$ + $\boldsymbol{\beta_{21o}(\textbf{Information Condition})_{igo}(\textbf{Group})_{go}}$ + $\boldsymbol{\beta_{31o}(\textbf{Information Interpretation})_{igo}(\textbf{Group})_{go}}$ + $\beta_{41o}(\text{Preference}$

$\text{Condition})_{igo}(\text{Information Condition})_{ig}(\text{Group})_{go} + u_{0o} + u_{1o}(\text{Preference Condition})_{igo} + u_{2o}(\text{Information Condition})_{igo} + u_{3o}(\text{Information Interpretation})_{igo} + u_{4o}(\text{Preference Condition})_{igo}(\text{Information Condition})_{ig.} + u_{0go} + u_{1go}(\text{Preference Condition})_{igo} + u_{2go}(\text{Information Condition})_{igo} + u_{3go}(\text{Information Interpretation})_{igo} + u_{4go}(\text{Preference Condition})_{igo}(\text{Information Condition})_{igo} + e_{igo}$

As detailed above the cross-level interaction effects in bold are of greatest interest.

HS Ethics Final Approval - Ref No.5201000943

From: **Ethics Secretariat** <ethics.secretariat@mq.edu.au>

Date: Wed, Sep 22, 2010 at 1:12 PM

Subject: Ethics application reference- 5201000943- Final approval

To: Dr Colin Wastell <colin.wastell@mq.edu.au>

Cc: Miss Nicole Weeks <nicole.weeks@mq.edu.au> Dear Dr Wastell

Re: "Dynamic hypothesis testing: Mechanisms that drive decisions under uncertainty - Survey 1 2010" (Ref: 5201000943)

The above application was reviewed by the Human Research Ethics Committee. Final Approval of the above application is granted, effective 22nd September 2010, and you may now commence your research.

The following personnel are authorised to conduct this research:

Dr Colin Wastell- Chief Investigator/Supervisor Miss Nicole Weeks- Co-Investigator

Please note the following standard requirements of approval:

1. The approval of this project is conditional upon your continuing compliance with the National Statement on Ethical Conduct in Human Research (2007).

2. Approval will be for a period of five (5) years subject to the provision of annual reports. Your first progress report is due on 22nd September 2011.

If you complete the work earlier than you had planned you must submit a Final Report as soon as the work is completed. If the project has been discontinued or not commenced for any reason, you are also required to submit a Final Report for the project.

Progress reports and Final Reports are available at the following website:

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/forms

3. If the project has run for more than five (5) years you cannot renew approval for the project. You will need to complete and submit a Final Report and submit a new application for the project. (The five year limit
on renewal of approvals allows the Committee to fully re-review research in an environment where legislation, guidelines and requirements are continually changing, for example, new child protection and privacy laws).

4. All amendments to the project must be reviewed and approved by the Committee before implementation. Please complete and submit a Request for Amendment Form available at the following website:

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/forms

5. Please notify the Committee immediately in the event of any adverse effects on participants or of any unforeseen events that affect the continued ethical acceptability of the project.

6. At all times you are responsible for the ethical conduct of your research in accordance with the guidelines established by the University. This information is available at the following websites:

http://www.mq.edu.au/policy/

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/

This information is available at the following websites:

http://www.mq.edu.au/policy/

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/policy

If you will be applying for or have applied for internal or external
funding for the above project it is your responsibility to provide the

Macquarie University's Research Grants Management Assistant with a copy of this email as soon as possible. Internal and External funding agencies will

not be informed that you have final approval for your project and funds

will not be released until the Research Grants Management Assistant has received a copy of this email.

If you need to provide a hard copy letter of Final Approval to an external organisation as evidence that you have Final Approval, please do not hesitate to contact the Ethics Secretariat at the address below.

Please retain a copy of this email as this is your official notification of final ethics approval.

Yours sincerely

Dr Karolyn White

Director of Research Ethics

Chair, Human Research Ethics Committee

HS Ethics Final Approval - Ref No.5201100069D

Ethics Secretariat <ethics.secretariat@mq.edu.au>

To: Dr Colin Wastell <colin.wastell@mq.edu.au>

Cc: Nicole.weeks@mq.edu.au

Dear Dr Wastell,

Re: "Dynamic hypothesis testing: Mechanisms that drive decisions under uncertainty - Experiment 1a 2011"

The above application was reviewed by The Faculty of Human Sciences Human Research Ethics Sub-Committee. The Sub-Committee wishes to thank you for a thorough and well prepared application. Approval of the above application

is granted and you may now proceed with your research.

The following personnel are authorised to conduct this research:

Dr Colin Wastell Miss Nicole Weeks

Please note the following standard requirements of approval:

1. The approval of this project is conditional upon your continuing compliance with the National Statement on Ethical Conduct in Human Research (2007).

2. Approval will be for a period of five (5) years subject to the provision of annual reports. Your first progress report is due on 24th February 2012.

If you complete the work earlier than you had planned you must submit a Final Report as soon as the work is completed. If the project has been discontinued or not commenced for any reason, you are also required to submit a Final Report for the project.

Progress reports and Final Reports are available at the following website:

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/forms

3. If the project has run for more than five (5) years you cannot renew approval for the project. You will need to complete and submit a Final Report and submit a new application for the project. (The five year limit

on renewal of approvals allows the Sub-Committee to fully re-review research in an environment where legislation, guidelines and requirements are continually changing, for example, new child protection and privacy laws).

4. All amendments to the project must be reviewed and approved by the Sub-Committee before implementation. Please complete and submit a Request for Amendment Form available at the following website:

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/ human_research_ethics/forms

Thu, Feb 24, 2011 at 2:01 PM

5. Please notify the Sub-Committee immediately in the event of any adverse effects on participants or of any unforeseen events that affect the continued ethical acceptability of the project.

6. At all times you are responsible for the ethical conduct of your research in accordance with the guidelines established by the University. This information is available at the following websites:

http://www.mq.edu.au/policy

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/ human_research_ethics/policy

If you will be applying for or have applied for internal or external funding for the above project it is your responsibility to provide the Macquarie University's Research Grants Management Assistant with a copy of this email as soon as possible. Internal and External funding agencies will not be informed that you have final approval for your project and funds will not be released until the Research Grants Management Assistant has received a copy of this email.

If you need to provide a hard copy letter of Final Approval to an external organisation as evidence that you have Final Approval, please do not hesitate to contact the Ethics Secretariat at the address below.

Please retain a copy of this email as this is your official notification of final ethics approval.

Yours sincerely,

Dr Katey De Gioia

Acting Chair

Faculty of Human Sciences Ethics Review Sub-Committee Human Research Ethics Committee

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