University of Strathclyde

Department of Human Resource Management

Measuring Risk Perception and Risk-taking Behaviour when Driven by Automatic Cognitive Processing: The Development of New Methods.

Tony McCarthy

A Thesis Submitted in Fulfilment of the Requirements
for the Degree of Doctor of Philosophy
2017

Declaration

This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

Signed:

Date:

Acknowledgements

I would like to thank my supervisors, Dr Calvin Burns and Dr Matthew Revie, for their exceptional support and guidance during the PhD process. I would also like to thank the staff and students at the University of Strathclyde for all their help, advice, and friendship.

Without the support of my family and friends it would not have been possible to complete the process so thank you to every one of them. In particular, I would like to thank Lorraine and my parents, along with my niece and nephew (Emily and Ryan), for their support and fantastic distractions.

Abstract

Risk perception and risk-taking behaviour, are often driven by automatic (implicit) thinking, either in isolation or in combination with reasoned, deliberative thinking. This presents research challenges as measuring automatic thinking requires the use of specialized methods. The main original contributions of this thesis are the development of novel methods that aim to measure risk perception and risk-taking behaviour when driven by automatic thought processing.

Drawing on the MODE model and dual process theories of thinking, the thesis presents the development and demonstration of a risk version of the Evaluative Priming Task. This provides an implicit risk attitude measure that can be used as a novel research tool.

In order to measure risk-taking behaviour a modification of a current risk behaviour method (the Balloon Analogue Risk Task) was developed. This version includes a priming component, thus allowing for measurement of changes in risk-taking behaviour based on automatic thought processing. This is the first method that can fulfil this aim.

The final main contribution of this thesis is a demonstration of the 'affect heuristic' at an automatic (implicit) level of processing. This was achieved by using the new methods. Using these methods facilitated such investigation in a more direct manner than has previously been possible.

The development of both methods provides novel research tools for investigation in implicit risk perception and behaviour. Currently, there are limited options for such investigation. The utility of the methods is discussed, including how they could be used in various contexts, such as recruitment or work evaluation. Limitations of the research, suggestions for future research, and the next steps for the further refinement of the methods are discussed.

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Chapter 1: Introduction

1.1 Introduction

When someone perceives a risk, what is driving their perception? Similarly, what drives particular risk-taking behaviours? It may be comforting to believe that such perceptions and behaviours are the consequence of reasoned and rationale thinking. The reality, however, is that risk perception, and risk-taking behaviour, are often driven by thought processing of a very different type. Instead, automatic (implicit) thinking may drive such perceptions and behaviours, either in isolation or in combination with reasoned, deliberative thinking. This raises questions, such as when or how these differing forms of thinking may be dominant. This thesis will consider some of these questions but mainly will tackle a practical challenge. How can you measure the effect of automatic (implicit) thinking on perception or behaviour?

The main original contributions of this thesis are the development of novel methods that aim to measure risk perception or risk-taking behaviour when driven by automatic thought processing. One of these methods (a risk version of the Evaluative Priming Task) is an implicit measure of risk, i.e. it measures automatic risk attitudes (Fazio, Jackson, Dunton, & Williams, 1995). Another version of the Evaluative Priming Task that measures implicit affect attitudes was also developed and used along with the risk version. The other method is a modification of a current risk behaviour method (the Balloon Analogue Risk Task) that includes a priming component, thus allowing for measurement of changes in risk-taking behaviour based on automatic thought processing (Lejuez et al., 2002). The final main contribution of this thesis is a demonstration of the *affect heuristic* at an automatic or implicit level of processing. This was achieved by using the new methods.

1.2 Background and Rationale

Risk attitudes are a form of risk perception. Risk perception can be conceptualized in various ways but for this thesis, risk perception will be considered in terms of the Vernon (1999) definition. Vernon (1999) defines risk perception as a person's attitude and judgement of hazard, and its likelihood. Specifically, this is in terms of the extent of the hazard, and the extent of vulnerability. This is the definition that is most in line with psychological research in this field, and that fits most consistently with the philosophical approach of the thesis: post-positivism.

The most established approach to analysis of risk and conceptualisation of risk perception is the *psychometric paradigm* (Siegrist, Kellers, & Kiers, 2005; Slovic, 2016). This involves the use of psychometric methods in order to quantify risk perception. By definition this means the use of explicit methods, such as questionnaires, that produce data based on deliberative and reasoned thinking. While this has provided much insight into risk perception it is not capable of capturing data based on non-explicit thought processing.

The concept of differing types of thought processing that includes explicit (deliberative) thinking and implicit (automatic) thinking is known as the *dual process theory of thinking* (e.g. Kahneman, 2011). There are several dual process theories (e.g. Chaiken & Trope, 1999; Epstein, 1994; Petty & Cacioppo, 1986; Strack & Deutsch, 2004) and the terminology varies but they tend to make a distinction between slow, effortful, and deliberative processing (explicit) with quick, relatively effortless, and automatic processing (implicit). Explicit measures (e.g. questionnaires or interviews) ask for a deliberative response but different methods are needed to capture responses based on automatic processing. These methods are known as *implicit measures*.

The foundations of implicit measures are suggested to be the associations between valence (in terms of attitude) with the attitude object, and the time taken to make a response (Fazio & Olson, 2003). One example of an implicit measure is the Evaluative Priming Task (Fazio et al., 1995). This task is conducted via computer and involves participants categorizing words that have a natural association with particular categories (e.g. words that will likely be categorized as "good" or "bad").

This measure also uses priming items (attitude objects) that are flashed quickly on screen prior to making the categorizations. If the participant associates an attitude object, the prime, (e.g. sugar) with a specific attitude (e.g. bad) this may influence their response in the task. If the word to be categorized that follows the prime (e.g. sugar) is a naturally positive word (e.g. great), this may slow their response (i.e. they might take longer to categorize the word "great"). If the word that follows the prime is naturally associated with negativity (e.g. terrible), this may speed up their response. Both responses would indicate they hold a negative implicit attitude to sugar. The principle is that the association the participant holds for the prime (the attitude object) puts them in a state of mind (e.g. thinking of negativity) that makes the subsequent categorization easier or more difficult. This difficulty is based on whether the associations between the prime and the categorized word are congruent or incongruent. This measure also relies on timing. If the categorizations are significantly faster or slower than a baseline (where the category words are categorized with no priming items used) this suggests they hold a specific implicit attitude. The responses are also required to be quick, including removing responses below a certain time threshold. The threshold is set so that it is not feasible for the participant to deliberately speed up or slow down their responses (i.e. such instances would be removed from the analyses due to taking too long). This is to ensure that it is implicit or automatic processing that is being measured.

There are various types of implicit measure but one issue that has emerged is that the implicit measures available often fail to provide strong correlations when directly compared (e.g. Bosson, Swann, & Pennebaker, 2000; Fazio & Olson, 2003; Rudman, 2011). This has cast doubt on what is being measured as logically they should produce similar outputs. It has been suggested that in order to clarify just what is actually being measured researchers should avoid simply using the same measure every time (Brand & Schweizer, 2015; Hyde, Doerksen, Ribeiro, & Conroy, 2010). The most commonly used method is the Implicit Association Test (Greenwald, McGhee, & Schwartz, 1998; Johnson & Steinman, 2009). Siegrist, Keller, and Cousin (2006) developed a risk attitude measure based on the Implicit Association Test and also called for more use of implicit measures of risk generally. Given this call for more use of implicit measures in risk research and the separate call for use of differing types of measure, the first research aim of this thesis was to develop a new implicit measure of risk. In order to develop a method that was not similar in its methodological or theoretical foundations to the Implicit Association Test, the measure that was selected for development was the Evaluative Priming Task (EPT) (Spence & Townsend, 2007).

The original Evaluative Priming Task measures valence attitudes but this thesis describes the development of a risk version (along with an affect version). This risk version of the EPT was designed to capture implicit risk attitudes (i.e. attitudes regarding participants' perception of various attitude-objects in terms of risk association). These versions contribute to the field of risk research by providing a new implicit risk attitude measure and also to the field of implicit cognition by providing contrasting measures that can be compared with already existing measures. Notably these contrast with the most commonly used implicit measure (and variants of that measure) so provide an opportunity for comparison that is currently unavailable in terms of implicit measurement of risk attitudes.

While collecting implicit attitudes broadens understanding of thinking it does not clarify how automatic processing may influence behaviour, including risk-taking behaviour. The relationship between attitudes and behaviour has produced mixed results with many studies producing low correlations between stated attitudes and subsequent behaviour (see Ajzen & Fishbein, 2005). In order to capture data on risk-taking behaviour in relation to implicit attitudes, it is normally necessary to separate the attitude measurement from the behavioural measurement. This means, for instance, measuring implicit attitudes using an implicit measure then also collecting risk-taking behaviour data from real world behaviour or from a separate risk-taking measure. This leaves the possibility that relationships that are found may not be direct (e.g. a participant may hold an implicit attitude which is measured and also behave a certain way in a separate task but the connection between these two must be assumed to be related).

In order to provide a means of capturing a direct relationship between automatic processing and risk-taking behaviour, a new risk-taking behaviour method was developed. This new method was designed to measure changes in participants' risk-taking tendency caused by the automatic activation of risk attitudes. This was based on the Balloon Analogue Risk Task (Lejuez et al., 2002) and incorporated a priming component similar to that used in the Evaluative Priming Task. The Balloon Analogue Risk Task is a computer based risk-taking task that involves pumping a set of on screen balloons that can burst at random intervals. The aim for the participant is to pump up the balloons as much as possible but avoid bursting the balloons. The more they pump the balloons or the more balloons they burst, the more risk they have taken. Taking inspiration from the Evaluative Priming Task the developed version included primes (i.e. attitude objects) being shown before each balloon. If participants were primed by their associations to the attitude objects (as in the Evaluative Priming Task) this could cause them to take differing levels of risk based on the types of association present (i.e. whether they associate the attitude objects with high or low risk). This approach also meant that the methodological and theoretical bases of the new risk-taking method were equivalent to the previously developed risk attitude measures. The same attitude objects could be investigated using implicit attitude measures of risk and a risk-taking behaviour method based on automatically activated attitudes. This also meant that the attitudes and behaviour caused by the attitude objects could be compared and contrasted.

This developed version of the Balloon Analogue Risk Task provides a measure of changes in risk-taking behaviour based on automatically activated associations to attitude objects. This makes it possible to measure risk-taking behaviour based on automatic attitudes directly within a single task for the first time. This task also made it possible to investigate a set of attitude objects from the explicit level (via questionnaires and interviews), to the implicit level (via the Evaluative Priming Tasks), to behaviour (via the Balloon Analogue Risk Task). This provided a broad perspective that could be applied to new areas by future risk researchers in a way that would not be possible without the newly developed methods.

Another area of interest for the thesis related to the notion of emotion in implicit processing and risk perception. The role of affect (or emotion) has consistently been cited as important to understanding risk perception (e.g. Lowenstein, Weber, Hsee, & Welch, 2001; Siegrist et al., 2006) and in implicit cognition (e.g. Finucane, Alhakami, Slovic, & Johnson, 2000). The *affect heuristic* was developed as a way of understanding the role of affect (or emotion) in decision making, including risk decisions (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978; Slovic, Finucane, Peters, & MacGregor, 2002). This heuristic suggests that high risk is associated with negative affect and low risk with positive affect. So if someone considers an activity to be high risk they will, on average, tend to think of it negatively, and vice versa. This provides a short-cut for decision making (as with all heuristics) but can also lead to maladaptive scenarios where risk may be over-estimated due to emotional reaction, and so on.

There has been a notable lack of evidence to support the idea that the affect heuristic can (or does) operate at an implicit processing level. Townsend, Spence, and Knowles (2014) found that the affect heuristic was more associated with, and predicted by, deliberative (explicit) attitudes and measures. This was in contrast to their expectations based on the theoretical literature. They did concede, however, that the implicit methods they employed could not fully clarify if the affect heuristic may still operate, to some extent, at an implicit level, or that implicit measures may be predictive. To directly investigate the affect heuristic at an implicit level it is necessary to have implicit measures of risk and affect that can then be directly compared. The newly developed methods within this thesis provided a means of directly investigating the affect heuristic at an implicit (or automatic) level. This was the final aim of the research and provided a clearer conclusion on this issue than has been previously shown.

1.3 Research Contexts

In order to demonstrate the new methods it was necessary to select contexts for investigation. Two contexts were chosen because they are both common every-day issues that are likely to be relevant to almost all participants. These were food nutrition (specifically food nutritional labelling) and cyber-security. They are both related to risk but in notably different ways. Both contexts are topical social concerns that are likely to be of social concern in the long term. They are also both issues that the general public may find difficult to fully understand. They contrast in that cyber risks are more readily thought of as “risks” and there are often worries associated with cyber related issues. Food, however, is generally not thought of in terms of risk as such. Unhealthier foods are arguably thought of as somewhat less “safe” so the likely intensity of risk associations may be lower. Both have become more mainstream concerns in recent times but they contrast in that food has always been a concern but cyber-security is a more recent issue. The rationale for using these contexts also related to the types of sample that were used.

It was decided to use a sample of students for the research. The rationale for this decision was based on various factors which will be explained in Section 3.6 of Chapter 3 (Methodological Approach). The choice of research contexts was influenced by this sampling approach, however, as the contexts had to be of relevance to the samples chosen. They also had to be contexts where younger adults were likely to hold sufficiently strong implicit attitudes that measurement of such attitudes was feasible. Campos, Doxey, and Hammond (2011) conducted a systematic review of nutritional labels (based on 120 articles) and found that among the groups who were more likely to use nutritional labels or consider them important were young adults and women (in comparison to other groups). Given that the samples for this thesis included young adults (normally between 18-24 years) and were predominantly female, this suggested that such a sample may be potentially more likely to hold strong attitudes to nutritional labels. While this did not necessarily mean strong implicit attitudes this potential for strong attitudes generally suggested strong implicit attitudes may be present. Given that the purpose of the research contexts was simply to demonstrate the new methods it was desirable that sufficiently strong implicit attitudes would be present to improve the likelihood of the methods capturing such attitudes. Fazio and Olson (2003) highlighted that the efficacy of implicit measures to capture implicit attitudes is limited by the underlying strength of those attitudes. Weaker implicit attitudes may exist but the methods may not be sufficiently sensitive to capture them.

Attitudes regarding cyber-security have not been particularly well researched and there is limited information regarding demographic variability in attitudes (Allouche & Lind, 2010). Nonetheless there has been some research that has suggested younger people (15-24) were slightly more aware of cyber risks and were more likely to try to be careful with personal information online than older people

(TNS Opinion & Social, 2012). Intuitively it seems reasonable to also presume that younger people (particularly who are more educated) may be more aware of potential online dangers or confident in handling such dangers than many older people. So while there is not as much evidence that may suggest younger participants will hold stronger implicit attitudes in this context (compared with nutritional labels) it still seemed a relevant context to investigate. Additionally cyber-security attitudes have not been particularly well researched. This suggests that collecting data that is specific to a particular section of society would be a contribution to knowledge.

Another reason for choosing these contexts relates to the likelihood that implicit cognition may drive behaviour. It has been suggested that implicit processing will tend to dominate perception and behaviour if time is limited, information is limited, or information is notably complex (Khaneman, 2011). Both contexts could be considered as vulnerable to one or more of these issues. Nutrition labels will often be seen while shopping but this activity is often conducted under time constraints (Grunert, 2006). The information contained in nutrition labels may also be considered relatively complex and will tend to provide a limited degree of information (Cecchini & Warin, 2016). This last issue is especially likely for labels that appear on the front of packaging, which the studies in this thesis used. The specific labels used in this research (food traffic lights) were also designed to be more easily and quickly understood so investigation of automatic attitudes regarding them would provide relevant information that could clarify if accurate but quick processing is likely (Sonnenberg et al., 2013).

Cyber-security could also be vulnerable to the same issues. People may sometimes feel they do not have time to protect themselves online (e.g. to wait for security updates to configure or to download new protective software). It is certainly reasonable to expect that many people will find cyber-security issues or procedures for protecting against cyber threats complex (TNS Opinion & Social, 2012). Similarly many people may often feel they have limited information regarding these issues which makes it difficult to make reasoned decisions. Both contexts fulfil, to some extent, the criteria for scenarios where implicit thinking may be dominant. As such, investigating implicit thinking directly seems relevant in these contexts. While it may seem reasonable to suspect implicit thinking may be of relevance in these contexts in day to day life, there is a separate issue of how likely it will be to capture implicit attitudes via the new methods.

Many of the classic studies in implicit measurement investigated attitudes to race and stereotyping (e.g. Fazio et al., 1995; Greenwald et al., 1998). Part of the rationale for differences that were found between explicit and implicit results in these studies was social desirability bias. This bias leads people to sometimes override their initial response due to feeling pressure to conform to socially acceptable opinions (van de Mortel, 2008). The likelihood of similarly strong biases in the contexts of food nutrition or cyber-security is low but there have been suggestions of social desirability biases being present in both contexts. Koenigstorfer, Groeppel-Klein, and Kamm (2014) suggested consumers with low levels of self-control were influenced by the colours used in food traffic lights nutritional labels when social desirability was reduced. This suggested that while not directly equivalent to the race or stereotyping context (where social desirability biases are expected to be present) nutritional labels can result in such biases and that these may impact the influence that they have. Haltinner et al. (2015) also suggested that participants sometimes displayed social desirability bias when providing responses regarding risk perception towards cyber-security issues. While this was not considered a key issue it appeared that some participants felt a need to profess higher levels of concern regarding cyber-security than was possibly actually the case. Another issue is that explicit measures can be subject to social desirability biases in general. In a study investigating nutritional labels the tendency to over-emphasize the strength of concerns when providing self-reports was explained (Grunert, Wills, & Fernandez-Celemin, 2010).

The research contexts were therefore considered appropriate as they are notable and common areas of societal concern. They can both be considered in terms of risk but also contrast in how related to risk they would be for some participants. They were relevant contexts for investigation given the types of samples that were used. They were likely to be subject to the conditions that suggest implicit processing may be particularly influential in perception and behaviour. They also shared some limited similar characteristics to other contexts that have shown dissociation between explicit and implicit measures in previous research. As such, there was a reasonable possibility that measuring these contexts via implicit measures would provide data that might contrast with explicitly measured data.

With the research contexts clarified, the following section provides the research goal, research aims, and research objectives.

1.4 Research Goal, Aims, and Objectives

To contribute to the fields of risk research and implicit cognition research by developing and demonstrating new methods that can be used as research tools for investigating attitudes and behaviour driven by automatic thought processing.

Research Aim 1

To develop and demonstrate two novel versions of an implicit attitude method (the Evaluative Priming Task) based on risk and affect attitudes.

Research Aim 2

To develop and demonstrate a novel version of a risk-taking behavioural method (the Balloon Analogue Risk Task) that provides a measure of changes in risk-taking behaviour driven by automatic processing (via priming).

Research Aim 3

To investigate the affect heuristic at an implicit (automatic) level of processing.

Research Objectives

1. Data sets will be generated containing words associated with either high risk or low risk for use as 'target words' in the new versions of the Evaluative Priming Task, and for use as 'priming items' in the Balloon Analogue Risk Task.

2. Data sets will be generated containing words associated with either positive affect or negative affect for use as ‘target words’ in the new versions of the Evaluative Priming Task.
3. Data sets will be generated containing food products and nutrition labels for use as ‘priming items’ in the new versions of the Evaluative Priming Task and Balloon Analogue Risk Task.
4. Data sets will be generated containing cyber-security terms for use as ‘priming items’ in the new versions of the Evaluative Priming Task and Balloon Analogue Risk Task.
5. The Evaluative Priming Task methods will be designed, refined, and demonstrated in the food nutrition and cyber-security contexts.
6. The Balloon Analogue Risk Task method will be designed and demonstrated in a domain independent context (risk-related words), and two domain dependent contexts (food nutrition context and cyber-security context).
7. The new versions of the Evaluative Priming Tasks will be tested for relationships to discern if an affect heuristic effect is evident at an implicit level.
8. The new version of the Balloon Analogue Risk Task that provides a measure of changes in risk-taking behaviour driven by automatic processing (via priming) will be tested for relationships with explicit measures of affect (via questionnaire) to discern if an affect heuristic effect is evident.

The Research Objectives 1, 2, 3, 4, and 5 combine to meet the demands of Research Aim 1. Research Objectives 1, 3, 4, and 6 combine to meet the demands of Research Aim 2. Research Objectives 7 and 8 combine to meet the demands of Research Aim 3. See Figure 1.1 for a schematic that shows how each research objective meets the demands of each research aim. Table 1.1 also clarifies the nature of each study (e.g. which measures were used and which research contexts were investigated).

Figure 1.1: Schematic showing the relationship between the studies conducted (in white), research objectives (in yellow), and research aims (in blue).

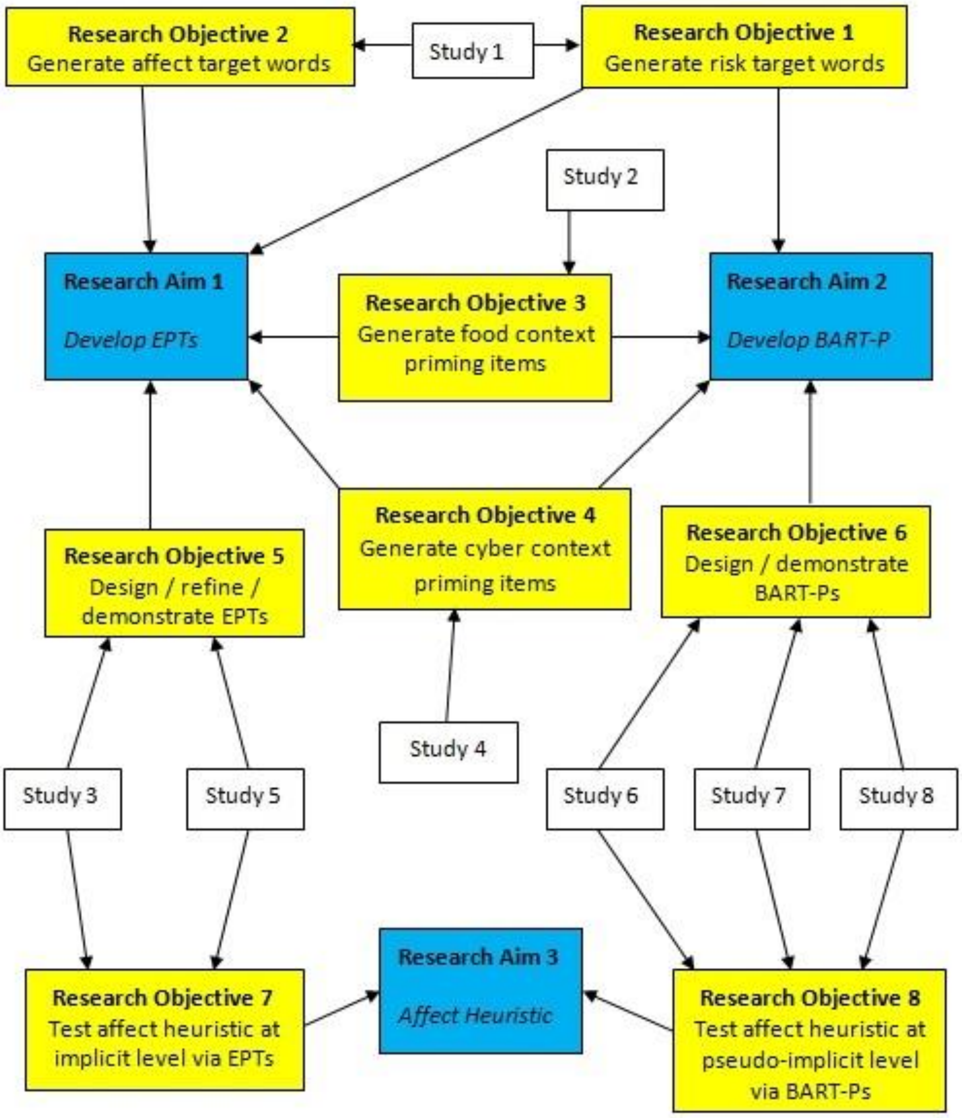


Table 1.1: List of studies clarifying which tests were included and which contexts were investigated.

Study	Questionnaire	Interview	EPT	BART-P	Food context	Cyber context
1	YES					
2	YES				YES	
3	YES	YES	YES		YES	
4	YES					YES
5	YES	YES	YES			YES
6	YES	YES		YES		
7	YES	YES		YES	YES	
8	YES	YES		YES		YES

1.5 List of Studies

The following section provides a list of the studies (and the chapters in which they appear) that were conducted and how these seek to meet the demands of the research objectives. All studies (bar Study 2) also included data regarding the affect heuristic at an explicit level (via questionnaire ratings) which complimented the implicit data (in relation to Research Aim 3). This data was sometimes used for comparison with the implicit data when investigating the affect heuristic but the collection of this data did not constitute a specific research objective in itself.

Studies in Chapter 4:

Study 1:

This was a questionnaire study and involved no other methods. The primary aim of this study was to generate a set of words that were rated as notably high risk or low risk, while also being significantly familiar to participants. This was done by having participants rate a large set of risk-related words from which a set could be selected that met demands. This resulted in a systematic and quantified approach to material generation. The risk Evaluative Priming Task (EPT) study required words consistently rated as either high risk or low risk that could be used as ‘target words’. These words were categorized by participants during the EPT. Study 1 met the demands of Research Objective 1. This study also described the process that was used for selecting the words that were used for a similar purpose in the affect version of the EPT. This met the demands of Research Objective 2.

Study 2:

This was a questionnaire study and involved no other methods. The primary aim of this study was to generate a set of food product images (i.e. packaging), along with the associated nutritional labels, for use as priming items in the EPT studies. This was done by having participants rate a large set of food product images from which a set could be selected that met demands. This resulted in a systematic and quantified approach to material generation. The food nutrition EPT study (the first EPT study) required priming items that would be flashed on screen prior to the categorization of the target words generated from Study 1. The purpose of the EPTs was to discern if these priming items influenced the speed of categorization which would then suggest participants held automatically activated attitudes to the items (i.e. the food product packages and nutrition labels). This met the demands of Research Objective 3.

Study 3:

This study described the development and provided the first demonstration of the new EPTs. This study also included a questionnaire and interview. The context for investigation was food nutrition. The target words and priming items generated from Studies 1 and 2 were combined for the new EPTs. The EPTs also involved some other modifications from the original design that will be explained in Study 3 (Section 4.4). The main modification was that the two EPTs captured implicit attitudes towards risk and affect. This study met the initial demands of Research Objective 5. Using the implicit risk and affect measures (EPTs) this study also met the initial demands of Research Objective 7 by investigating the affect heuristic at an implicit level.

Studies in Chapter 5:

Study 4:

This was a questionnaire study and involved no other methods. The primary aim of this study was to generate a set of cyber-security terms, for use as priming items in the EPT studies. This was done by having participants rate a large set of cyber-security terms from which a set could be selected that met demands. This resulted in a systematic and quantified approach to material generation. This study was equivalent to Study 2 but generated priming items relating cyber-security rather than food nutrition. The purpose was the same, however. This met the demands of Research Objective 4.

Study 5:

This study described the further development and provided the second demonstration of the new EPTs. This study also included a questionnaire and interview. The context for investigation was cyber-security. The target words and priming items generated from Studies 1 and 3 were combined for the new EPTs. The EPTs also involved some other modifications from the original design, and refinements from the versions used in Study 3, that will be explained in the Study 5. Following Study 3, this study met the final demands of Research Objective 5. Using the implicit risk and affect measures (EPTs) this study also completed the demands of Research Objective 7 by investigating the affect heuristic at an implicit level.

Studies in Chapter 6:

Study 6, Study 7, and Study 8:

These three studies all described the development, and provided demonstrations of the new Balloon Analogue Risk Task (BART), that incorporated priming. These studies also included questionnaires and interviews.

Study 6 used a selection of the risk-related words generated in Study 1 (for use as target words in the risk EPTs) and used these as priming items. This provided a domain independent context for the first demonstration of the priming version of the BART (BART-P).

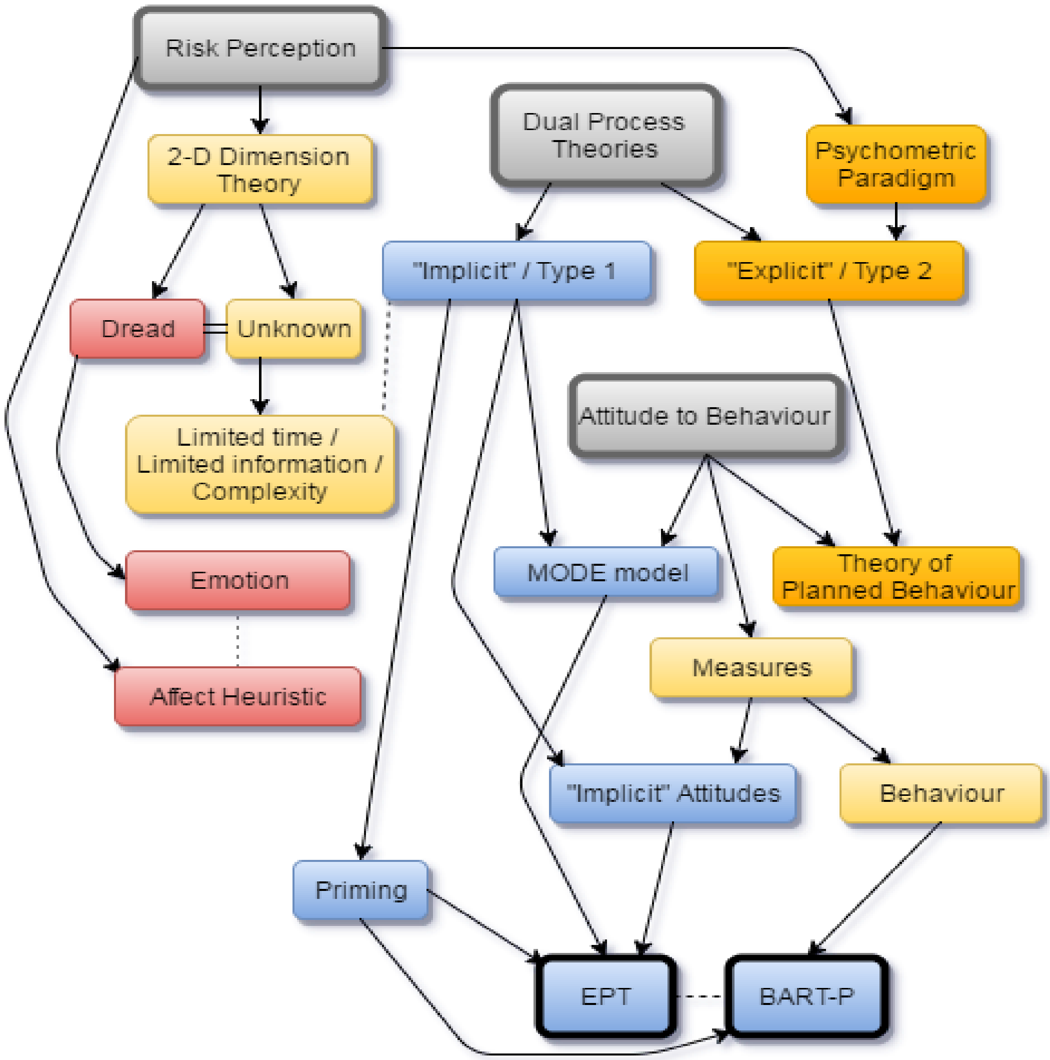
Study 7 used the same food nutrition priming items as used in Study 3 (food nutrition EPT study).

Study 8 used the same cyber-security priming items as used in Study 5 (cyber-security EPT study).

Studies 7 and 8 provided domain dependent contexts for the second and third demonstrations of the BART-P. These two studies also provided an opportunity to compare the results from the EPT studies (attitude measure) and the BART-P studies (behavioural measure) directly for both research contexts. The three studies in this chapter met the demands of Research Objective 6. Using the BART-P results and explicit affect attitude ratings these studies also met the demands of Research Objective 8 by investigating the affect heuristic. This objective was not specifically investigating the affect heuristic at an implicit level due to the absence of implicit affect data but it nonetheless provided complimentary data to the findings from the EPT studies in a behavioural context.

1.6 Theoretical Framework

Figure 1.2: Theoretical framework.



This thesis brings together risk perception, dual process theories, and attitude to behaviour models, to create novel research and to develop new methods for future research. Figure 1.2 displays a graphical representation of the theoretical framework of the thesis. As can be seen the schematic is colour coded. The boxes in grey are the main over-arching themes of the thesis (Risk Perception, Dual Process Theories, and Attitude to Behaviour). These three areas provide the theories and approaches of relevance and the overall aims are met by combining these three areas. Specifically, the thesis uses dual process theories to highlight the need for the use of implicit measures, which will be used in the context of risk perception, with the aim of providing novel insights into the attitude to behaviour process (at an implicit level).

The boxes in blue are aspects of the framework that come under the category of *implicit* cognition or measurement. This is the key area of interest in the thesis. The boxes in orange represent the *explicit* related items. These are relevant to the research but also necessary to include as they form the explicit components of the dual process theories. The boxes in red are related to emotion or affect. This is also a key interest of the thesis, with the demonstration of the *affect heuristic* at an implicit level being one of the main aims. The other boxes in yellow are not themed but provide important additional information in order to make sense of the framework. While a broad perspective is given in Figure 1.2, the boxes in grey, blue, and red can be seen as the specific components of the theoretical framework for the research.

As mentioned, one of the over-arching themes of the thesis is risk perception. This area of research has notably developed since the 1980s (Slovic, 2010a). The predominant approach to risk perception research has been the *psychometric paradigm*, which is fundamentally an explicit measurement approach (Slovic, 2016). One key theory that has emerged from this approach has been the 2-D dimensional theory. This theory places all risks within a 2-D space where each risk is placed on a continuum between high or low *dread* levels, and simultaneously between high or low levels of *unknown*. The dread dimension refers to people having feelings of dread towards risk objects, while the unknown dimension is how well someone knows or understands the risk. These dimensions are also considered to encompass other relevant factors such as familiarity, or feelings of control.

Although the dread dimension includes other factors within it, it can also be seen as directly related to emotional response. This issue of emotional response has become a key area of risk perception research (e.g. Traczyk & Zaleskiewicz, 2015). As well as investigating the affect heuristic, this is also relevant for the thesis as emotional response is largely automatic and is often considered to be important in implicit cognition. The affect heuristic is a mental short-cut that allows people to make risk judgements even when making such a decision is difficult. The idea is that positive emotions are associated with low risk perceptions, and negative emotions are associated with high risk perceptions (Slovic, Finucane, Peters, & MacGregor, 2007). This has been shown using explicit measures many times but there is a lack of evidence showing it at an implicit level. Achieving this is the third main aim of the thesis.

The *unknown* dimension of the 2-D theory could arguably be said to relate to the notion of having limited time, limited information, or overly complex information that is difficult to process. By definition, if a risk is not well known or understood it will be difficult to process. In some scenarios this may mean the information is complex, or that it is lacking, with time constraints sometimes of relevance. The contexts within which the research is conducted (food nutrition / nutritional labels and cyber-security) are both relatively new risk issues. They are also both risks that often involve technical information or where it can be difficult to gather relevant information. As such, one or more of the three conditions could reasonably be expected to apply for many people with these risk issues. This is important because when time is limited, information is lacking, or information is notably complex, implicit cognition is thought to dominate processing (Khaneman, 2011).

Implicit processing can be described using several terms (albeit not always meaning exactly the same thing). A common term that is used is System 1 which means fast, relatively effortless, and automatic thinking (Khaneman, 2011). This contrasts with System 2 which is slower, more effortful, and deliberative. Many traditional research methods (such as questionnaires) are explicit measures as they involve participants consciously deliberating before providing responses. In order to capture implicit cognition the use of implicit measures is required. These methods are often complex to design and make data collection more complicated. The first two aims of this thesis were to develop two implicit (or “pseudo-implicit”) methods that could measure both risk perception and risk-taking behaviour. Behavioural measures of this sort are currently lacking and there is limited scope to measure risk perception using current implicit attitude measures.

The other over-arching theme of the thesis is the relationship between attitude and behaviour. The *theory of planned behaviour* is a prominent theory of explicit processing in this regard (Ajzen, 1991). This theory suggests that intention is the key driver of behaviour but that this is influenced by various other factors, and is ultimately moderated by control. In this sense there is a presumption that processing operates at an explicit level. The dual process theories and related literature, however, suggest that thought processing often operates at an implicit level so this theory cannot explain all scenarios. If faced with a scenario where explicit attitude formation is not possible there must be some form of implicit processing. A prominent theory for how this implicit level attitude to behaviour process operates is the MODE model.

The MODE model is founded on the dual systems theory and defines implicit and explicit thinking as separate (Fazio & Olson, 2003). Nonetheless this model allows for consideration of interactions between the types of thinking and considers both to represent the two extremes of a continuum. The MODE model would suggest that priming (for risk-seeking or risk aversion) automatically activates associations in memory. Once automatically activated, these associations affect decisions or behaviours which individuals make spontaneously, out with conscious control.

The development of the MODE model was made through the use the Evaluative Priming Task (EPT). This is an implicit measure that captures automatically activated attitudes via associations in memory. It uses small differences in reaction times during a categorization task to capture implicit attitudes. The attitude object that is being measured is briefly flashed on a screen in a form of priming paradigm. This priming procedure provokes associations in memory to make changes to responses. The version of the EPT developed for this thesis follows broadly the same design as the original EPT but it measures risk (or affect) attitudes rather than valence attitudes.

The other method developed for the thesis was a risk-taking measure; the Balloon Analogue Risk Task (BART). This is a computer based gambling game that measures risk propensity. Normally, the BART measures stable risk tendencies of participants. Extending the MODE model principle, the newly developed method includes a priming component. This priming object sometimes causes a change in risk-taking tendency at that moment which is captured via performance on the

BART. This provides a novel pseudo-implicit measure of risk-taking behaviour, or of changes in risk-taking behaviour.

The development of these two new methods (both involving priming), along with the use of these to measure the affect heuristic at an implicit level, constitute the main aims of the thesis. All of this is founded on the basis of the MODE model, which is an attitude to behaviour model related to implicit cognition. The affect heuristic is an emotionally motivated effect regarding risk perception and can be seen as somewhat an implicit effect in itself.

1.7 Thesis Structure

Chapter 2 reviews the theoretical and conceptual ideas of relevance to the thesis. This includes a summary of research into risk perception and other risk related issues, and coverage of research regarding the psychometric paradigm, and dimensional theories of risk perception. Details regarding dual process theories of thinking are provided, and then the concept of implicit cognition. This leads to discussion of attitude to behaviour processing. There is also discussion of the various implicit measures that are currently available, including discussion of the how these compare and contrast. These methods are designed to measure automatic processing and contrast with explicit measures (such as questionnaires) where reasoned deliberation is employed by participants. This chapter also includes background of the theoretical basis for these methods (and thus for the methods developed in this thesis) including the MODE model, and other related theories that describe the dual processing concept. This provides the additional basis and necessary details to place the new methods in a theoretical context. Finally literature is discussed regarding investigation of the affect heuristic at an automatic level of processing.

Chapter 3 describes in detail the methods used within the thesis. This includes description of the basic methods, such as questionnaires. It also includes descriptions of the standard versions of the Evaluative Priming Task (implicit attitude measure) and the Balloon Analogue Risk Task (risk-taking measure). Further, this chapter explains how these methods were developed in order to meet the demands of the thesis.

Chapter 4 reports the findings from Study 1, Study 2, and Study 3. These are the initial questionnaire studies (Studies 1 and 2) used for generating materials, for use in the EPT and BART studies. Then Study 3 provides the first study using the new risk and affect versions of the EPT. The data generated from Studies 1 and 2 are used in the development of the methods for Study 3. This chapter includes investigation of the affect heuristic at an implicit level (via Study 3). This chapter meets the demands of Research Objectives 1, 2, 3, 5, and 7. As such, it also meets the demands of Research Aim 1 and Research Aim 3.

Chapter 5 reports the findings from Study 4 and Study 5. Study 4 is an initial questionnaire study used for generating materials, for use in the EPT and BART studies. Study 5 provides the second study using the new risk and affect versions of the EPT. Along with the data from Study 4, the data generated from Study 1 (in Chapter 4) is also used for developing the methods in Study 5. This chapter includes investigation of the affect heuristic at an implicit level (via Study 5). This chapter meets the demands of Research Objectives 4, 5, and 7. As such, it also meets the demands of Research Aim 1 and Research Aim 3.

Chapter 6 reports the findings from three studies that used the newly developed priming version of the risk-taking behaviour measure the BART (Studies 6, 7, and 8). Data generated from Studies 1, 2, and 4 are used as priming items for the new methods within this chapter. The behavioural risk data is compared with explicit affect data in this chapter to investigate the affect heuristic. This provides complimentary data to the implicit data regarding the affect heuristic collected via the EPT studies. This chapter meets the demands of Research Objectives 6 and 8. As such, it also meets the demands of Research Aim 2 and Research Aim 3.

Chapter 7 begins by clarifying the rationale for the research before summarizing the findings. The research aims and objectives are discussed followed by implications of the research. Limitations in the research are identified and suggestions for future research explained.

Figure 1.3: Flowchart displaying the structure of the thesis' chapters.

Chapter 1: Introduction
Provides the rationale and purpose of the thesis. Clarifies the problem and aims.

↓

Chapter 2: Literature Review
Provides more detailed background on risk perception, implicit cognition, and implicit measurement. Provides detail for all relevant concepts and research that will be used in the thesis.

↓

Chapter 3: Methodological Approach
Provides a detailed description of the methods that were used. Detailed description of how these other methods were modified for the thesis.

↓

Chapter 4: Evaluative Priming Task – Food Nutrition
Reports Study 1 (questionnaire study that generated target words for use in EPTs), Study 2 (questionnaire study that generated priming materials for food nutrition context), and Study 3 (EPT study that investigated implicit risk and affect attitudes to food nutrition).

↓

Chapter 5: Evaluative Priming Task – Cyber-security
Reports Study 4 (questionnaire study that generated priming materials for cyber-security context), and Study 5 (EPT study that investigated implicit risk and affect attitudes to cyber-security). Includes discussion of both EPT studies.

↓

Chapter 6: Balloon Analogue Risk Task – Priming Version (BART-P)
Reports of Study 6, Study 7, and Study 8. These three studies provide demonstrations of the new priming version of the BART (BART-P), developed for the thesis. Study 6 used the BART-P in a domain independent context (using risk-related words). Study 7 and Study 8 used the BART-P in a domain dependent context (using food nutrition images and cyber-security terms).

↓

Chapter 7: General Discussion
Overview and summary of findings.

Chapter 2: Literature Review

2.1 Introduction

This chapter provides a literature review of the relevant fields to this thesis. Given that the aims of this thesis include investigating risk perception with a focus on how it relates to implicit cognition it is necessary to initially provide some background on the history of risk perception research and how it has often been conceptualised and investigated. This will then provide the rationale for using implicit measures to investigate risk perception.

The chapter will begin by providing a definition and conceptualisation of what is meant by risk perception. From this, several risk theories will be discussed, including the 2-D model of Slovic and colleagues. This will lead to a discussion of the psychometric paradigm, which has dominated risk research, before explaining why this approach is limited and why other approaches are required. The following sections provide discussion of dual process theories of thinking, implicit processing, and the attitude to behaviour relationship. Implicit measurement and the theoretical basis will also be explained. This chapter will also explain and discuss the affect heuristic. Investigation of the affect heuristic using implicit measures is one of the main aims of the thesis.

2.2 Defining Risk Perception

Before considering what is meant by the term *risk perception*, it is necessary to clarify what is meant by the term *risk*. There are varying ways that risk itself can be defined, and this is particularly true when considering the differing approaches across academic disciplines (e.g. Rosa, 2003). Two key concepts when thinking about risk are *reality* and *possibility* (Rayner & Cantor, 1987). This refers to the idea that there are hazardous effects which can occur (reality) and a relative probability of these effects occurring (possibility). Risk was first described in terms of a probability that can be measured by Knight (1921), while uncertainty could be thought of as describing situations where probabilistic potential was lacking. Despite this, the tendency to conceptualise risk in terms of probability did not become the norm until the 1960s when research on the risks associated with nuclear technology developed (e.g. Starr, 1969). This approach led to a distinction being made between *risk* and *hazards*. Specifically, a hazard is described as the negative effect while risk means the probability of that effect. This conceptualisation of risk can also be described as the interaction of likelihood and consequence (Aven, 2009).

The probabilistic model is not the only conceptualisation of risk, however. One example is the *contextualist* approach. This approach suggests that probabilities are important but that there are other factors that combine with this, such as the differing meaning that may be attributed to hazards by different groups or people (Thompson & Dean, 1996). In this approach there are differing values that are assigned to specific outcomes which may be based on individual morals or other factors of individual importance. This approach could be seen as a divergent approach rather than opposing as the probability of hazard is still considered a key factor (Jackson, Allum, & Gaskell, 2006). A related conceptualisation also considers risk as existing on a spectrum from objective risk (tangible and real) to socially constructed (Zinn, 2008). This approach, however, is grounded in constructivist research philosophy and this thesis is grounded in the post-positivist approach. While it is relevant to mention these alternate approaches it is not in line with the overall foundations of this research. Rather the objective/subjective distinction is more readily understood in terms of actual risk compared with perceived risk.

Vernon (1999) defines risk perception as a person's attitude and judgement of hazard, and its likelihood. Specifically, this is in terms of the extent of the hazard, and the extent of vulnerability. People often do not perceive risks or behave in risk situations according to laws of probability or in statistically rational ways (Kahneman, 2011). Biases are often evident and lead to heuristics. Investigations of these biases, particularly in terms of how experts and laypeople differ in risk estimations, were a driving force behind risk perception research. Classic studies showed that while experts often used probabilistic analysis to judge risk estimations, laypeople were often influenced by many other factors. Tversky and Kahneman, (1974) showed that people have difficulty making risk judgements in a rational manner due to the cognitive demands involved. This leads to people using heuristics, or mental short-cuts, in order to cope with these demands. For instance, the *availability heuristic* suggests people will rate a risk as higher if they can more easily bring examples of that risk to mind (Tversky & Kahneman, 1973). So if someone can easily remember, for example, several plane crashes they will consider the risk of similar crashes as higher than other risks of which they cannot easily think of examples.

For this thesis, risk perception will be considered in terms of the Vernon (1999) definition. This is the definition that is most in line with psychological research in this field, and that fits most consistently with the post-positivist approach. This does not mean that the research cited in the following sections will always conceptualise risk perception in the same way but where there is a notable divergence this will be pointed out. With the definition in place the next section will discuss some of the varying theories of how risk perception operates.

2.3 Risk Perception Theories

Research into the perception of risk can be traced back to the late 1950s with the work of Paul Slovic and colleagues (see Slovic, 2016). This early work focused primarily on monetary gambling scenarios and subsequent decision making. It was soon realized, however, that this focus limited the scope and research broadened to investigate behaviour and perception in relation to hazards more generally. It also became clear that the work of Tversky and Khaneman (into biases and heuristics) pointed to gaps in the developing field due to the often non-rational nature of human behaviour (e.g. Tversky & Kahneman, 1974).

The focus on perception, and how this can vary, further developed in the 1970s with many prominent articles published in the 1980s. For instance, Slovic (1992) laid the foundations of what would become known as the *psychometric paradigm*. This approach will be discussed in more detail later but has dominated the field in the years since this early pioneering work. Other strands of risk perception research also focused on individual differences. Zuckerman (2002) investigated the importance of personality factors, while Bandura (1997) investigated cognitive style including self-efficacy. These strands of research were concerned with how individual differences interacted with varying hazards and risks. This thesis will take such issues into consideration with the inclusion of personality questionnaires, and analyses of individual differences, such as age or gender. While research into individual differences has produced some varying theories, processing of risk information can also vary in several other ways.

There are various separate (although sometimes related) theories of how risk information is processed. A summary of four significant theories was provided by Covello and Sandman (2001). These include *Risk Perception Theory*, which highlights a number of factors that can impact on the nature of the perception. These factors tend to increase or decrease the person's concern. For instance, if a risk is involuntary, controlled by others, poorly understood, of human origin, covered extensively by the media, of unclear benefit, unfamiliar, or evokes dread, this tends to increase concern (Covello & Sandman, 2001). The opposite trend is evident when the factors are reversed, such as if the risk is familiar or within the person's own control.

Among the other theories discussed by Covello and Sandman, is the *Mental Noise Theory*, which suggests that when someone is highly concerned or feels under threat, the emotions felt result in mental noise (Covello, 1998). This means that they have increasing difficulty processing information effectively or efficiently. Covello and Sandman (2001) also described the *Negative Dominance Theory*, which suggests that people are more affected by, and pay more attention to, negative information rather than positive. It has also been suggested that it is important for the purveyor of risk information to be trusted. This *Trust Determination Theory* suggests that people need to feel the source of information exhibits appropriate attributes, such as competency, commitment, honesty, and empathy (Covello & Sandman, 2001). These theories tend to highlight emotional response as significant. This may be in terms of feeling threat, focusing on negative reaction, or what feelings are felt towards the information source. This reliance on emotion, or susceptibility to emotionally driven influences, highlights the need for an objective perspective. One way that research has sought to investigate risk when objectivity is more likely to dominate thinking, and subjective or emotional reactions are likely to be less influential, is by using experts.

Much of the research into risk perception looked at the contrast between experts and laypeople. For instance, research investigating mortality rates from varying causes found that experts and laypeople differed on how much importance they placed on different pieces of information. Experts tended to primarily base their perceptions on objective data relating to actual mortality rates whereas laypeople would be relatively more influenced by factors such as controllability, voluntariness, and future effects (Schmidt, 2004). This variation in risk perception was explained by Sjoberg, Moen, and Rundmo (2004) in that laypeople, while relatively good at predicting deaths from factors such as disease or natural disasters, nonetheless over or under-estimated due to factors such as the emotional salience of some factors. This did not mean that experts were not also prone to biases but this tended to be constrained by a relatively more rational and data led analytical approach.

Many different factors have been identified as influential in driving risk perceptions (particularly in relation to laypeople judgements). There will not be the scope to cover all of these in detail but it is worth clarifying some of the most frequently cited. It should be noted, however, that this thesis is predominantly concerned with the implicit processing of risk perceptions, how they can be measured, and the role of emotion. Nonetheless, some coverage of these factors is necessary to provide a sufficiently broad understanding of the varying ways that risk perception can be influenced.

Controllability is one factor that can influence risk perception (Sjoberg, 2000). This refers to the extent to which someone perceives risks as being within their own control. Generally people are reluctant to take risks when they are beyond their control, preferring at least some level of control. If we can alleviate at least the most negative aspects (relative to our own desires) this increases the extent to which we perceive we have control over the situation. An important aspect of this is that people may perceive that they have control when this is not actually the case. For instance, people on average tend to perceive their personal risk to be lower than that for the population as a whole, largely based on perceived control (Sjoberg, 2000). This is logically not possible and can be linked to the *better than average* effect where people tend to perceive themselves as higher than average for factors such as intelligence (Brown, 2012). This tendency shows that subjective perception often runs contrary to objective logic.

Another commonly cited factor in risk perception research is voluntariness (Covello & Sandman, 2001). This idea suggests that people will perceive risks to be greater in situations where they did not voluntarily expose themselves to the risks (e.g. Renn, 1992). This does not depend on any qualitative difference being present in terms of the actual risks involved but instead is driven by the relative sense of choice involved. This can even result in situations where people perceive risks that are involuntary as many times more risky than those that are voluntary regardless of other specific details (Schmidt, 2004). The principle behind this effect is that people feel they have more scope to avoid specific risks that they wish to avoid and that, by comparison, the taken risks are more desirable than other options. In this thesis, the areas of food nutrition and cyber-security were investigated. It could be suggested that both of these are relatively imposed risks rather than voluntary. People have little choice about eating the available food or using the internet and technology. As such, while we can at times maintain some level of control or voluntariness, we have no choice but to accept some risks in these areas of our lives. While these risk contexts (food or using the internet and technology) may be familiar to most people, it is also relevant that the specific risks involved may not be so familiar (e.g. the amount of salt intake that can be considered healthy, or the best strategy for protecting against computer viruses).

Familiarity is a factor that can influence risk perception more generally (Covello & Sandman, 2001). One aspect of this influence of familiarity is that we tend to habituate to risks once they become common or longstanding (Slovic, 2010a). If we are unfamiliar with a risk (such as a newly emerged risk) we feel that it is more likely to result in adverse results than when we are used to the risk. This links with both controllability and voluntariness in that we often feel a lack of control and a lack of choice when faced with unfamiliar risks. If we did not even know the risk existed we have no way of controlling it or choosing it. As with these other factors generally, it is important to clarify that this means in terms of subjective perception. We may have means to cope with unfamiliar risks in reality but we will initially feel that we are unequipped to cope. This links directly with the two research contexts (food nutrition and cyber-security) in that both of these include some level of unfamiliarity for most people. While we are used to eating and using technology, we are nonetheless often unsure on how we might, for instance, specifically eat more healthily or be safer online. Food nutrition information or cyber-security information is ever changing, and often technical, so for many people there is a continual (perceived) gap in knowledge. We may be familiar with some aspects but are then provided with new dilemmas or information that means we become unfamiliar with the specific risks involved.

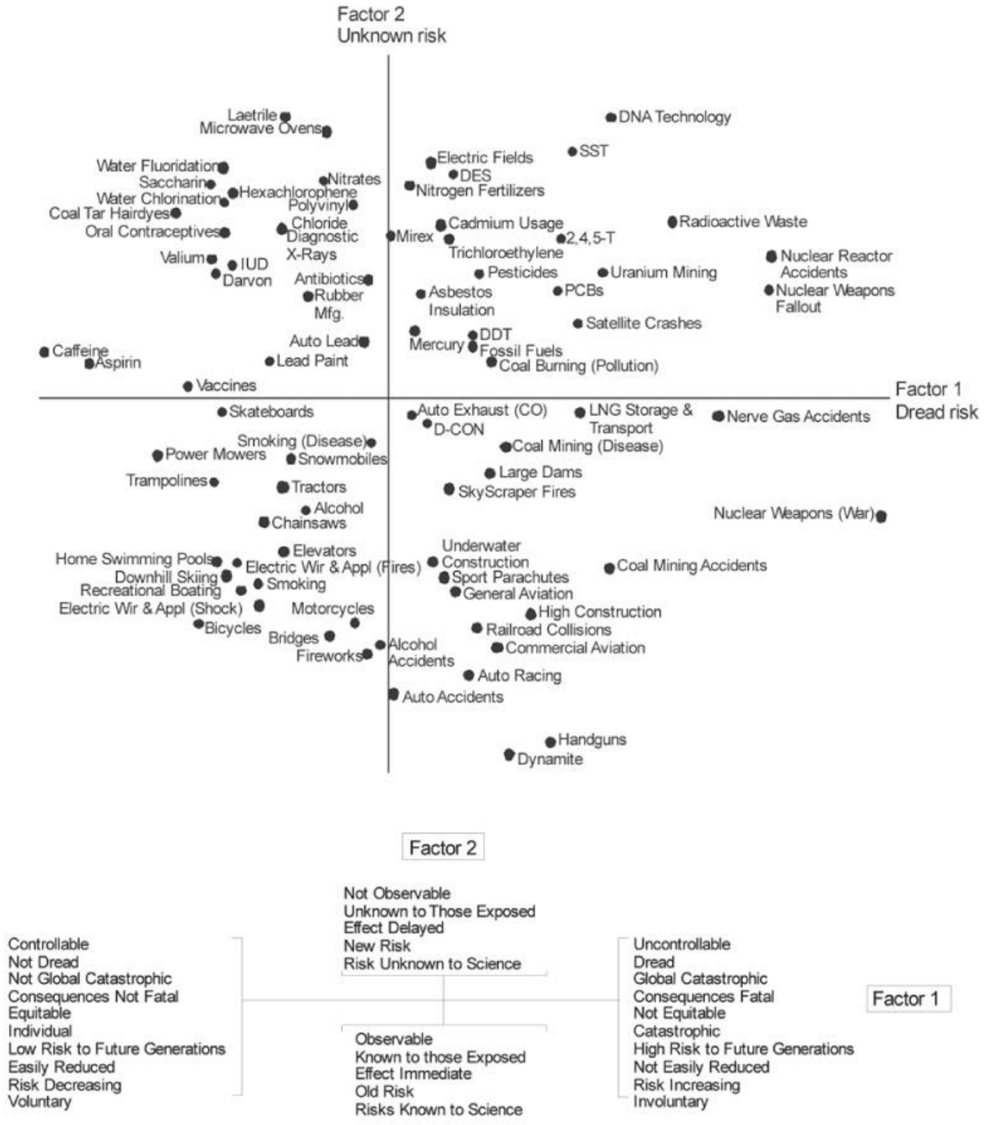
There are several other factors that are often cited, such as trust in the information source, the role of the media, the contrast between man-made and natural risks, and others. These varying factors can often interact but may play differential roles in perception. It is clear, however, that it is not possible to include all factors when investigating risk perception. As such, the research within this thesis will only consider some of these factors as and when it is most appropriate. Otherwise, the focus will be on a broader conception of risk perception. Rather than attempting to clarify specifically what factors may be driving perception, investigation is focused on how that perception differs in terms of cognition, and how this can be measured. Initially this requires an understanding of which approach has dominated risk research.

2.4 The Psychometric Paradigm

The most established approach to analysis of risk and conceptualisation of risk perception is the *psychometric paradigm* (Siegrist et al., 2005; Slovic, 2016). The routes of this approach are based in work from the late 1970s onwards (e.g. Fischhoff et al., 1978). This involved the use of psychometric methods in order to quantify risk perception. The key benefit of this approach was that it made it possible to generalize across samples and populations in order to find patterns in how people perceived risks. For instance, the differences that were found when comparing experts with laypeople were uncovered by using this psychometric approach. Systematic tendencies were revealed and risk perceptions could be predicted. This also led to the suggestion that risk perception is fundamentally subjective (Slovic, 1992).

A prominent component of the psychometric approach was the conceptualisation of a factor space. This involved participants providing judgements of many different risk objects (e.g. diseases, natural disasters, risky behaviours, and so on). Using factor analysis this revealed that there were over-arching factors that influenced perception. This allowed for the placing of different risks within a 2-D or 3-D space. For instance, Slovic (1987) produced the information contained in Figure 2.1 which places a variety of risks within a 2-D space based on *Dread* and *Unknown* factors. As can be seen in Figure 2.1, this shows that some risks (e.g. radioactive waste) are high in dread and are relatively unknown. This means they provoke feelings of dread and the risks involved are poorly understood. Other risks (e.g. bicycles) are relatively low for dread and are more known. So these risks provoke little feelings of dread and are well understood. As such, this approach allows for many risks to be placed within this 2-D space with each risk placed along the continuums of *dread* and *unknown* to varying levels.

Figure 2.1: Dread/Unknown 2-D dimension space (psychometric paradigm) with several risks included (Source: Slovic, 2010a, p.736).



This factor space model has been well established and developed over time (e.g. Slovic, Monahan, & MacGregor, 2000; Sjoberg, et al., 2004). A key assumption behind this model is that the varying factors (such as controllability or familiarity) are sub-factors of these over-arching factors. For instance, factors such as controllability and voluntariness are considered to be items within the broader factor of dread. The unknown factor is the over-arching factor for others, such as whether the risk is new or familiar. While the 2-D model is the most commonly used there can also be a third factor included of who is affected by the risk, such as whether it is people now or in the future. Laypeople risk perceptions are found to be most influenced by the dread factor (Slovic, 1987). When feelings of dread (or the sub-factors) are high, laypeople tend to consider the risks as high and wish to reduce those risks. This issue of the emotional influence on risk perception will be discussed later in this chapter and forms a key interest for this thesis. Specifically, the way that emotion drives risk perception automatically is critical to the aims of this thesis.

While the psychometric paradigm has provided an elegant and logical approach to risk perception research it is not without issues. There has been criticism in terms of how the data is analyzed with a particular issue around data smoothing and the extent to which random errors are ignored (Sjoberg, 2000). The use of principal component analysis means using aggregated data. It has been claimed that this means potentially important individual differences cannot be discerned (Siegrist et al., 2005). Another issue with the psychometric paradigm is that due to the methods that are used only certain aspects of cognition are being measured.

This last point relates to the fact that people will be influenced by different aspects of thinking. Sometimes this will be numerical information, or tangible data, but at other times it will be more intuitive. In order to measure this latter aspect of thinking it is necessary to be more flexible in how methods are used than is possible in the psychometric paradigm. This may be because the participant is not aware that there are intuitive or automatic factors influencing their perception. It may also be that they are not providing accurate information due to dishonesty, confusion, social desirability, or other influences.

The use of questionnaires is the predominant method used in the psychometric paradigm but this can only capture conscious, deliberative information. In order to investigate beyond the limitations of the psychometric paradigm approach it is necessary to use other (implicit) methods. These methods capture intuitive responses based on automatic cognition. Before considering implicit perception or measurement, however, it is first necessary to clarify this distinction of differing types of thought processing. This will be discussed in the next section.

2.5 Dual Process Theories of Thinking

This section will discuss the concept of differing types of thought processing, with a particular focus on implicit or automatic processing. Many aspects of human behaviour, such as breathing, are automatic and involve little awareness or effort. This automatic behaviour is not limited to physiological processes, however. One example is the ‘fight or flight’ response that is an automatic cognition universal to all humans. In every-day life it is not always possible or efficient to rationally deliberate on which course of action to take. This is why we rely on automatic processing, or take mental short-cuts (i.e. heuristics).

Dual process theories of thinking can be used to explain how people make decisions, including risk decisions (Kahneman, 2011). System 1 processing consists of quick, relatively effortless, and intuitive responses that can often be associated with emotion. In contrast, System 2 processing is slower, effortful, and involves conscious (deliberative) reasoning. While these systems are likely to both be involved in most decisions, it is claimed that in situations where time is constrained, information is complex, or information is lacking, System 1 processing will tend to dominate (Khaneman, 2011).

There are several theories of dual systems of thought processing that suggest that there are two main types of thinking. These are variably defined but can be most simply described as *implicit* and *explicit* processing. Alternatively the terms System 1 and System 2 are used as mentioned above. Khaneman (2011) summarized these two types of thinking as either ‘fast’ or ‘slow’ since implicit thinking is relatively fast and explicit thinking relatively slow. Additionally, implicit thinking is considered as less effortful, somewhat non-conscious (or outside of awareness), and automatic, whereas explicit thinking requires more effort, is more of a conscious process, and requires more rational deliberation.

Research in thought processing has often placed more (or even all) emphasis on the explicit system (Greenwald & Banaji, 1995). This approach means, for instance, asking participants to consciously and deliberately describe how they feel about an attitude object, or what attitudes they hold. Clearly this approach is limited since it will only ever provide information regarding the explicit or deliberative type of processing. It has also long been known that when asked to describe their attitudes to an attitude object, participants will often not use rational or logical techniques to decide on their opinions (Zajonc, 1980).

Affect is often the initial reaction that someone will have when trying to rationalize or formulate an attitude response (Zajonc, 1980). It has also been suggested that memory associations are automatically triggered when forming attitudes (Fiske & Pavelchak, 1986).

Often theories of dual processing classify the two types of thinking (implicit and explicit) as distinct and separate processes (e.g. Chaiken & Trope, 1999). The implicit processing is considered to occur first as this is relatively quicker and less effortful with the explicit processing following. In this sense the implicit processing can perhaps be expected to influence explicit processing rather than the other way round but there is not consistent agreement about this. One contrasting view is that, at least in some situations, implicit and explicit processes are simply separate and driven by differing factors. What seems reasonable to suggest is that explicit processing is likely influenced by context and task demands (Fazio & Olson, 2003).

Related but separate theories include the attitude change model that defines *heuristic* and *systematic* processes as the two distinct types of processing (Petty & Cacioppo, 1986). These two types of processing are largely similar to the implicit/explicit differences previously mentioned but systematic processing (akin to explicit) does not necessarily have to be formulated rationally.

Another dual process theory model classifies each type of processing as *experiential* and *analytical* which are somewhat equivalent to implicit and explicit processing respectively (Epstein, 1994). Along with differences in the level of conscious awareness (as with the previously described implicit/explicit distinctions) these types are also considered to differ in that experiential processing is passive while analytical processing is active. As such, this model has much in common with the previously described dual system theory that clarifies differences of automatic or deliberative processing.

This thesis employs the MODE model (which will be discussed in Section 2.8 later in this chapter) and this model suggests that responses are based on automatic memory associations. Given this suggestion, the model developed by Smith and

DeCoster (2000) is worth noting. Their model is concerned with differing memory processes but they also identify two distinct forms of that processing; *associative* and *rule based*. Associative processing helps to form an intuitive response easily and quickly (i.e. automatic memory associations), while the rule based system is a more deliberative process. This provides evidence that the theoretical and conceptual foundations of the MODE model are supported across differing domains and that memory systems can be somewhat considered as equivalent.

While many theories suggest that the implicit and explicit (or equivalent) processes operate in sequence (e.g. implicit initially), there are models that suggest they operate in parallel (e.g. Strack & Deutsch, 2004). This model identifies *impulsive* and *reflective* processes with each following broadly similar tendencies to other models (e.g. impulsive processing requiring little cognitive effort). This system also suggests that the impulsive system (equivalent to implicit) does not necessarily operate through affective association but rather is often driven by associated memory. As such, while not specifically part of the basis of the MODE model this model shares certain characteristics.

In a meta-review, Hofmann, Gawronski, Gschwendner, Le, and Schmitt (2005) found that correlations were often low based on comparisons of implicit and explicit attitudes. One explanation for low correlations between implicit and explicit attitudes is that people do not have conscious awareness or access to their implicit attitudes (e.g. Greenwald & Banaji, 1995). This lack of correlation is not always present but the consistent tendency leads to a key concern of this thesis. If implicit findings often diverge from explicit findings this highlights that explicit measurement will often miss important information. While the various dual systems vary somewhat they still share the foundational idea that people think in more than one way. Specifically, much of thinking does not happen in a reasoned or deliberative manner. Ideally, research should endeavour to investigate and measure all types of thinking and that is the purpose of the newly developed methods that form the bulk of this thesis. Measuring deliberative (explicit) processing is relatively straightforward but in order to measure automatic (implicit) processing more complex methods are needed.

Risk perception can be measured in many ways but the use of implicit measures has been highlighted as of great importance (e.g. Siegrist et al., 2006; Visschers, Meertens, Passchier, & de Vries, 2007). A study investigating risk impressions of individuals, in terms of perceived HIV risk, found that there were some clear differences in brain activity when comparing implicit and explicit ratings (Schmalzle, Schupp, Barth, & Renner, 2011). This study used EEG and found that both types of rating (implicit or explicit) shared some ERP modulation characteristics but that there were also specific modulations that were only present in the explicit condition. The two conditions were distinguished based on participants viewing faces with no mention of HIV (implicit condition) and another condition where they provided estimations of HIV risk in a set of faces (explicit condition). In this way they specified implicit processing to mean automatic processing out with the context of specific risk. This paper concluded, using brain imaging methods, that there was evidence to support an implicit form of risk perception that is distinct and separate from explicit risk perception, albeit with some shared components.

Of key interest for the current research are the approaches that can be taken to measure implicit risk processing or perception. One way that perception in general can be investigated is via attitudes. This has led to the development of various implicit attitude measures.

2.6 Implicit Attitudes

It is important to clarify and recognize that implicit measures do not necessarily capture ‘implicit attitudes’. In reality, they only capture the measure output. This is an important distinction due to the often found lack of correlation across different implicit measures (Fazio & Olson, 2003), and debate around what exactly is being measured with each method. This contrast and lack of clarity across different implicit measures is one of the key reasons for using the particular attitude measure that was developed within this thesis (the Evaluative Priming Task). This will be explained in more detail later but it is still worth clarifying at this point that there remains uncertainty as to what is actually measured regardless of which implicit measure is used.

The terms ‘implicit’ and ‘explicit’ when describing differing thought processes, or risk attitudes, are not always favoured. As mentioned, there are various other terms that are sometimes favoured instead. Over the course of this thesis different terms will sometimes be used (particularly ‘implicit’ and ‘explicit’) but in the current context these should be understood as meaning either ‘automatic’ or ‘deliberative’. The most valid and consistent distinction to make from the new methods developed within the thesis (and any findings from using them) are founded on the principle that some processing happens due to conscious, deliberative thinking while some processing happens automatically, and to some extent outside of conscious awareness.

Before discussing implicit measurement techniques in more detail it is important to consider the issue of how attitudes relate to behaviour. A key interest for this thesis was how implicit attitudes may compare with behaviour driven by automatic processing. Initially, however, it is necessary to consider the broader issue of the attitude to behaviour relationship. This will be discussed in the following section.

2.7 Attitude to Behaviour

Attitudes are subjective and largely guided by past experiences. Attitudes operate as evaluative operators of objects in our environment, and thus influence how we behave in relation to these objects. For instance, if we hold the attitude that a particular activity is dangerous (e.g. flying in an aeroplane) we are more likely to avoid flying. One way to conceptualize this idea is that positive attitudes encourage approach behaviours, while negative attitudes result in more avoidance behaviours (e.g. Elliot & Covington, 2001).

While there are differing views on how to best conceptualize an ‘attitude’, the most commonly held definition that it is a form of evaluation and this was used in this thesis (e.g. Ajzen & Fishbein, 2000). This approach considers that attitudes exist along a dimension of positive or negative evaluation and that affect or emotional response is separate, albeit with an influence over attitudes. This conceptualization of an attitude presumes that attitudes will develop based on new information.

Often attitudes will be thought of in terms of deliberative or reasoned construction but the retrieval and processing of attitudes is often relatively effortless and automatic (Fazio, 2001). As with heuristics, this automaticity allows for multiple attitudes about varying stimuli in our environment without the prohibitive cost to time or cognitive resources. This distinction of automatically activated attitudes, in contrast to attitudes requiring deliberation and effort, is a key concept for this thesis. The main aims of this thesis are all related to the measurement of automatic risk attitudes or behaviour, and how these compare with deliberative risk attitudes or behaviour.

The relationship between attitudes and behaviour has produced mixed results with many studies producing low correlations between stated attitudes and subsequent behaviour (see Ajzen & Fishbein, 2005). One approach that produced stronger correlations was to include moderating variables, such as self-monitoring. These breakthroughs came at a price, however, as they required the use of more complex methods.

A key issue here is that of *compatibility*. If a specific attitude is compared to a compatible single behaviour, the relationship between the two can be more readily assessed (e.g. Kraus, 1995). For instance, if investigating the relationship between attitudes and behaviour in terms of food nutrition labels, it is important to collect these details specifically using labels rather than collecting attitudes or behavioural data towards food health more generally. This is because there will inevitably be varied attitudes and behaviours towards different food health issues which may differ to attitudes about labelling. Similarly, attitudes regarding nutrition labels may not predict behaviour regarding food health issues beyond labelling specifically.

Other key factors in explaining the attitude to behaviour relationship are perceived control and intention. This has led to development of the *theory of planned behaviour* (Ajzen, 1991). This theory suggests that intention is the key driver of behaviour but that this is influenced by various other factors, and is ultimately moderated by control. The factors of influence include subjective attitudes towards the behaviour, subjective norms (attitudes towards the various attitude objects of relevance beyond the behaviour itself), and perceived behavioural control (perception of possible outcomes and ability to control these outcomes).

This theory presumes that behaviour is the product of reason and deliberate intention. As will be explained there are many scenarios where reasoned behaviour is either not possible or is otherwise not what transpires. As such, this theory helps place the studies of this thesis in a wider context but it is important to realize that the purpose of this thesis is to investigate attitudes and behaviour in the implicit context. In other words, the context is one where attitudes and behaviours are not the product of reasoned and deliberative thinking, at least not fully. It is also worth noting, however, that even the reasoned type of thinking within the model does not presume rationality.

While models such as the theory of planned behaviour can explain some situations they cannot explain other situations. Dual processing models have long shown that attitudes can often exist in the absence of deliberation or reasoned thinking. Research in automatic thinking has questioned the consistency that is suggested in the theory of planned behaviour. The most obvious reason for this is that humans are not capable of deliberative, reasoned thinking in many circumstances (e.g. if time is constrained or information is prohibitively complex). Attitudes have been shown to sometimes activate quickly and effortlessly by simply observing attitude objects (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). This will sometimes be necessary and suggests that theories of behavioural outcomes must consider this type of processing.

This issue of automatically activated attitudes and how these may influence behaviour (particularly in terms of risk) is critical to the aims of this thesis. This not only requires specialised methods but also requires a different theoretical framework to the theory of planned behaviour. The model that was developed for this purpose and that influenced the method development in this thesis was the MODE model.

2.8 The MODE Model

A related group of models to the dual system models are integrative models. These models are fundamentally similar from a theoretical perspective but aim to account for, and provide greater evidence for, the interaction of implicit and explicit processes. The most notable of these in terms of attitude to behaviour is the MODE model.

The MODE (Motivation and Opportunity as Determinants of the attitude to behaviour process) model was developed by Fazio (Fazio, 1990) using a social psychology perspective. This model is founded on the dual systems theory and defines implicit and explicit thinking as separate. Nonetheless this model allows for consideration of interactions between the types of thinking and considers both to represent the two extremes of a continuum. The MODE model would suggest that priming (for risk-seeking or risk aversion) automatically activates associations in memory. Once automatically activated, these associations affect decisions or behaviours which individuals make spontaneously, out with conscious control.

Part of the basis of this model is that the extent to which behaviour is determined through implicit or explicit processing will vary depending on motivation and context. The MODE model suggests that behaviour will be more driven by automatic attitude activations in some circumstances and more driven by deliberative processing in other situations. This does not mean that behaviour is either driven by one or the other but rather that the processing will likely be some combination of the two, albeit that one type of processing may be particularly dominant in certain circumstances.

Fazio suggested that most behaviour in every-day life is in fact automatic and relatively effortless (Fazio & Olson, 2003). This is in line with the research of Zajonc (1980) who also suggested that behaviour often requires no conscious deliberation. This notion is intuitive given the many different behaviours that people have to make on a daily basis, and the relatively limited time or cognitive resources that are available.

As the model name suggests, motivation is a key issue in determining which type of processing dominates. If someone has strong motivation (e.g. a strong reason to deliberate), they may be able to override the automatic processes or attitudes. As such, automatically activated attitudes will not necessarily drive behaviour. It is also important to recognize, however, that regardless of the context there will be situations where the person is simply incapable of rational or deliberative thinking. This concept ties in with the notion that System 1 thinking (i.e. implicit) will dominate when information is prohibitively complex, lacking in detail, or when time is limited (Khaneman, 2011). This means that even when motivation is present there may be other characteristics to the situation that mean a reliance on implicit processing seems inevitable.

The MODE model has often been used to investigate controversial domains, such as racial attitudes or stereotyping. This has led to studies that have shown low correlations for implicit and explicit attitudes (e.g. Fazio et al., 1995; Greenwald et al., 1998). In these situations there is a motivation to ensure behaviours or stated attitudes are socially acceptable, and therefore deliberation can somewhat override automatically activated attitudes. It should be noted that when the domain is less controversial implicit and explicit attitudes tend to be more highly correlated although biases may still be present in relatively non-controversial domains.

The MODE model does not suggest that either type of processing (implicit or explicit) is more predictive of behaviour per se. There is also no suggestion that implicit attitudes are essentially the “real” attitudes with explicit attitudes simply an expression of what the person wishes others (or themselves) to believe. The context will determine which type of processing dominates, or what balance of each is involved.

Fazio et al. (1986) described how attitudes can be produced automatically and that this was based on association in memory. A person observes the attitude object then the association in memory to that object produces the automatically activated attitude. This attitude from memory is claimed to be necessary for the attitude to then influence behaviour. An important detail was that Fazio suggested only some attitude objects would produce a strong automatic association in memory. This means that an automatic attitude will only be produced in certain circumstances, or for some attitude objects.

The MODE model does not directly dispute the claims of the theory of planned behaviour but rather provides an explanation for when this deliberative type of thinking may occur, and by extension will not occur. The fundamental principle is that people will only deliberate (explicit processing) when they are both motivated to do so and have the opportunity to do so. Motivation to deliberate may be due to many factors, such as a strong desire to avoid making a mistake. This is likely to often be the case in risk-related scenarios albeit this will depend on how high risk the scenario is considered to be. Opportunity, however, is something that is often beyond our control. If we lack time, lack information, or have difficulty adequately processing the relevant information, this will limit our opportunity to deliberate. It is worth noting that the MODE model does not suggest that the influence of attitudes on behaviour will necessarily be based on only one of the two types of processing (deliberative or automatic). In many cases there will be a mix of both, albeit with one of them tending to have more influence.

Fazio and colleagues developed the MODE model by using Evaluative Priming Tasks (EPT) (e.g. Fazio et al., 1995). These are a type of implicit measure and provide much of the basis for the newly developed methods within this thesis. In order to measure implicit cognition some form of implicit measure must be used but while the EPT is favoured for the purposes of this thesis there are several other types. In order to place the EPT in context it is necessary to discuss some of these implicit measures.

2.9 Implicit Measures

Measures such as those developed for this thesis can be described using various terms, such as implicit or automatic. It is important to recognize that the measure is not the same as the cognitive process. One other way of labelling the measurements is therefore as direct or indirect. Direct measurement involves participants deliberating on their response (e.g. as with a questionnaire) and an indirect measure prevents such deliberation while still capturing relevant data (e.g. via response time thresholds). It is also important to recognize that the results of these measures will depend on the specifics of how the measure was administered. For instance, if a priming component is administered subliminally this can be described as non-conscious but if the priming component is not administered subliminally no such presumption can be made. This can cause some confusion when using terms such as “implicit” as this can include non-conscious processing, uncontrolled processing, and so on. For the studies that will be shown within this thesis it is generally more reasonable to say that the results were from automatic processing. This does not necessarily mean they were not also, for instance, non-conscious but any such claim would be speculative.

Dual process theories and integrative models such as the MODE model highlight the issues around explicit measures, and the need to use alternative methods to investigate implicit cognition. Unfortunately, the move from theory to practice in this regard is not straightforward. While methods have been developed in order to measure implicit cognition there remains debate about what exactly is being measured. Some methods have received criticism and specific methods are preferred depending on the research demands. While a full discussion is beyond the scope of this thesis it is necessary to discuss some of the more commonly used methods in order to understand the various issues.

The foundations of most implicit measures are in the associations between valence (in terms of attitude) and the attitude object. This valenced association is related to an emotional response albeit in terms of positive and negative rather than specific emotions. The implicitness of the measurement is based on the principle that the cognition is fast, requires little effort, and is automatic. While these measures are described as “implicit” this terminology can cause confusion. They are actually an indirect measure attempting to capture implicit cognition. Participants are not asked to provide attitudes but rather they perform a task and assumptions are made based on their performance. This is the same for all implicit measures. Physiological measures (e.g. skin conductance) can be thought of as implicit measures but there are issues around individual differences and interpretation. In order to assume that a physiological response suggests a particular automatic association or attitude the connection between the two must have already been prior established. Implicit attitude measures are not as vulnerable to these issues, at least not to as great an extent.

One of the most commonly used implicit measures is the Implicit Association Task (IAT). Greenwald et al. (1998) designed this method and it measures associations between pairs of items. One item is a valenced item and the other is a target concept. Stimuli (words or images) are presented on a monitor as two sets of pairs in each corner of the screen. Initially participants will be presented with a word or image (e.g. the face of a black or white person) and are asked to categorize it based on target concepts (e.g. good or bad). They also make similar categorizations where, in the example described, they would categorize the faces as e.g. black or white. The main parts of the task would then involve seeing a face and choosing between pairs of categorizations. Participants then press one of two buttons to choose one or other pair. For example, one pair may be the word "good" paired with the word "black", while the other pair shows the word "bad" with the word "white". They would see various faces and be asked to make the categorizations as quickly as possible. Over the course of the trials the pairings would also be reversed (e.g. good with white, and bad with black). The response time is measured in order to measure associations based on congruence. For instance, if a participant is quicker at categorizing a black face when the word black is paired with bad than when it is paired with the word good, this suggests they hold an implicit association between black faces (i.e. black people) and the concept bad.

If the response is sufficiently quick this suggests that it is an implicit association whereas if they take longer this may be deemed as an explicit response. As with most implicit measures there are timing thresholds enforced (i.e. responses that are too slow are discarded) to ensure that the responses can reasonably be claimed to be implicit. The effect sizes found using the IAT can vary greatly depending on the design characteristics (e.g. Nosek, Greenwald, & Banaji, 2005). Similarly, the level of correlation between implicit measures from the IAT and explicit measures varies depending on what factors are used. For instance, one study found that these correlations were high for some factors but almost zero for others (Nosek & Smyth, 2007). Although it has been used extensively the IAT has still been criticized.

The specific context and nature of the items used can produce biased responses. When the items used in the IAT are similar (but beyond semantic similarity as the test is supposed to operate), this can bias responses (e.g. De Houwer, Geldof, & De Bruycker, 2005). The cognitive effort required to switch between pairing types has led to suggestions that the first pairing type will often produce faster responses (Messner & Vosgerau, 2010). While there have been contrasting findings (e.g. Banse, Seise, & Zerbes, 2001; Egloff & Schmukle, 2002), there have also been suggestions that the IAT can be susceptible to faking by participants (e.g. Fielder & Bluemke, 2005; Kim, 2003; Steffens, 2004; Wallaert, Ward, & Mann, 2010). Siegrist et al. (2006) developed an Implicit Association Test (IAT) to measure automatically activated risky and safe associations for cell phone base stations vs. power lines. They pointed out that the IAT is limited because it is a relative measure (i.e. they could only compare implicit risk perceptions of cell phone base stations relative to power lines, and not to any other attitude objects).

The IAT could be described as a measure of relative difference between attitude objects. For instance, if one type of food nutrition label were to be more associated with positive evaluation than another type of food label this would only reveal that the first label is evaluated more positively than the second rather than specifically that either is generally evaluated positively or negatively. Some of these criticisms have led to the development of variants of the IAT, such as the Single-Category IAT (SC-IAT) (Karpinski & Steinman, 2006). Whereas the IAT has been criticized for being limited to category level comparisons (i.e. relative comparisons), the SC-IAT can be used to measure individual exemplars rather than categories. While more flexible than the IAT the SC-IAT is still based on the same theoretical principles as the IAT. Given that part of the reasoning behind developing new methods was the dissociation that often occurs when comparing different implicit measures (Fazio & Olson, 2003), developing a new risk version of the SC-IAT did not seem of value. There are already risk versions of the IAT (e.g. Siegrist et al., 2006) so a version based on the SC-IAT would not provide a particularly contrasting method.

The Go / No Go Task (GNAT) (Nosek & Banaji, 2001) is another variant of the IAT where the issue of relative evaluation between different attitude objects is not so problematic. However, there are also potential issues in how the results are interpreted with this measure, which also apply to the IAT. De Houwer et al. (2005) pointed out that the set-up of these methods means that participants must categorize in both congruent and incongruent scenarios. For instance, a participant may hold positive evaluations towards a specific food label but would also have to complete trials where that label was paired with the word "negative" or equivalent. When the pairing is congruent (e.g. the label with the word "positive") the participant can code both the word "positive" and the image of the label as meaning "positive", but this is not possible in the incongruent trials. This means that differences in reaction times across the range of trials can sometimes be potentially driven by issues of how this coding operates rather than differences in strength of associations. One way to understand this is that the measure can cause cognitive delays that are not related to the associations despite the measurement of these associations being the aim. This creates some potential confusion in terms of how best to interpret the data.

Another strand of implicit measures that uses priming as the basis is the Evaluative Priming Task (EPT). Fazio and colleagues developed the MODE model by using EPTs (e.g. Fazio et al., 1995). The EPT uses reaction times to measure the strength of any pre-conscious associations between a prime (the name or image of a thing like "nuclear power") and a target word (e.g. "good"). On each trial of an EPT, a prime is flashed briefly on a computer screen before the participant categorizes a subsequently presented target word as either "good" or "bad" by pressing a button. If, for example, a participant is able to classify the target word as "bad" quicker when primed with "nuclear power" than when no prime is given, then the prime (nuclear power) has facilitated responding to the target word (bad). This facilitated responding indicates an association between nuclear power and negative evaluation stored in memory which has become activated automatically / pre-consciously. A more detailed description of the EPT procedure is provided in Chapter 3 when the thesis' methods are described.

One key principle of the EPT is that the prime and target words/images are facilitated when they are congruent. If the participant feels similarly positively (or similarly negatively) to both priming item and target word then they will categorize more quickly. When associations are strong it is expected that this will produce greater reaction time differences. It should be expected then that some primes that are used in an EPT study may not produce strong automatic attitude activations. Rather than this simply being due to a lack of sensitivity of the measure this can be due to the person not holding a sufficiently strong association in memory to that prime.

The effects that Fazio and colleagues found were only present for relatively short response times which were too quick for deliberative processing to have been possible. Further support that the EPT measured automatic processing, that could not have been the consequence of deliberation, was shown in studies where the prime was presented below conscious awareness (e.g. too quickly to be processed consciously) (Greenwald, Klinger, & Schuh, 1995). Since it was not possible for the primes to have been consciously processed this showed that the effect (in these examples at least) must be the product of automatic processing.

Mental processes are not simply deliberative or automatic but rather they exist on a spectrum between the two, or are a mixture of both. Nonetheless the EPT has been used in a variety of studies with the aim of clarifying that it meets the conditions necessary to be considered a measure of automatic processing, or at least that it can measure this type of processing specifically. It has been shown that effects can be found when cognitive capacity has been limited (e.g. Hermans, Crombez, & Eelen, 2000), when conscious perception is not possible via subliminal priming (e.g. Hermans, Spruyt, & Eelen, 2003), and when deliberation was not feasible due to control responses based on reaction time thresholds (e.g. Hermans et al., 2003; also see Wentura & Degner, 2010).

2.10 Rationale for using the EPT

While there were various options for which implicit measure could be modified for the thesis aims, the EPT was the one that was chosen. The rationale for this decision follows. The various implicit measures available often lack strong correlations when directly compared and it has been suggested that in order to clarify just what is actually being measured researchers should avoid simply using the same measure every time (e.g. Bosson et al., 2000; Brand & Schweizer, 2015; Hyde et al., 2010). The IAT is the most widely used but this could lead to the problem that there is a lack of contrasting data using other methods. The EPT has still been used extensively so it is not a method that is lacking in representation. It is also definitively based on different procedures than the IAT whereas some other methods, such as the SC-IAT, and GNAT, are directly related to the IAT. A key difference between IAT related measures and the EPT is that the mechanism in the EPT is more akin to spontaneous evaluative reaction (Brand & Schweizer, 2015; Gawronski & De Houwer, 2014). Given that the aims of the thesis are based on finding just such a reaction in a new domain the EPT seemed more readily flexible.

The EPT, via the MODE model, has a clear and consistent theoretical basis and relatively straightforward process for interpreting results. While many of the earlier issues with the IAT have been alleviated through developments there remains some lack of clarity (Fazio & Olson, 2003). The set-up for this thesis required the collection of data based on individual exemplars rather than categories. The classic IAT (being a category based method) would not be suitable. Even the variants, such the SC-IAT, would not so readily suit the specific requirements despite being capable of measuring individual exemplars. A key reason why the EPT was the best option for this research was that the aim was to not only develop a risk based automatic attitude measure but also a related risk-taking behaviour measure. Given that the approach taken was to use brief exposure priming along with an established risk-taking method this naturally led to the use of the EPT. Indeed, the behavioural measure developed was essentially a hybrid of the EPT with the risk-taking measure (the Balloon Analogue Risk Task). If, for instance the IAT had been used, it would not have been possible to directly compare the results from the two types of method. This would also have meant using two methods that are not directly based on similar theoretical bases. The behavioural measure (as will explained in Chapter 3) is only a pseudo-implicit measure but a version that used the principles of the IAT instead of the EPT (or other IAT related methods) would not produce even a pseudo-implicit method but rather an elaborate explicit measure. The specific aspect of the EPT that was included within the newly developed behavioural method was priming, which is key to the EPT.

2.11 Priming

Priming is a concept which refers to a response being influenced by a separate stimulus. This is generally considered to be an implicit memory effect which is somewhat out with conscious awareness (Kirsner, 1998). An example of priming could be speeded recognition of an associated term after another term has been presented. For instance if shown the word "Salt", you should be able to recognize the word "Pepper" more quickly than a word with no specific association with "Salt".

It was in the classic studies of Bargh and colleagues that priming became more widely known (Bargh, Chen, & Burrows, 1996). These studies showed that priming not only affected processes such as recognition but also that primes could impact behaviour. For instance, participants primed with terms associated with elderly people walked more slowly from the testing area than participants who were primed with neutral stimuli (Bargh et al., 1996). Bargh has continued to demonstrate the effects of priming across a variety of contexts. For example, in one study participants carried either a hot or cold drink as they walked to the testing area (Williams & Bargh, 2008). Participants who carried a hot drink produced more favourable appraisals of prospective job candidates (during the testing session) than participants who carried a cold drink. This effect was proposed to be due to positive associations of "warmth" primed by the hot drink leading participants to judge the prospective job candidates more positively. Other researchers have also demonstrated priming effects. Studies have shown increases in pro-social behaviour when exposed to religious primes (Shariff, Willard, Andersen, & Norenzayan, 2016), improved performance in job interviews when primed for "power" (Lammers, Dubois, Rucker, & Galinsky, 2013), and increased pro-social behaviours and creativity when primed with cleanliness and order (Vohs, Redden, & Rahinel, 2013).

In a study of similar design to some of Bargh's classic studies, participants were primed subliminally with associations of either a sports hooligan or a professor (Dijksterhuis & Van Knippenberg, 1998). Performance on a subsequent quiz was better when primed with "professor" than "hooligan". This again showed that simply activating associations could influence behaviour despite the participants being unaware of the effect. It is also worth noting that this priming effect was relatively brief which suggests that the associative activation, and attitude to behaviour influence, may often dissipate quickly. While the priming procedure used in the studies of this thesis is qualitatively different from that used in this priming study it also shows signs of being relatively short-lived. As will be explained later this is actually a necessary characteristic for the new methods that were developed.

There are a limited number of studies that have investigated the effects of risk priming. Erb, Bioy, and Hilton (2002) primed participants to be risk seeking or risk averse. They found that participants primed to be risk seeking showed greater preferences for a risky option in a vignette than those primed to be risk averse, and concluded that priming affects pre-conscious risk preferences. Following the replication crisis in psychology (e.g. Doyen, Klein, Pichon, & Cleeremans, 2012), Newell and Shaw (2016) replicated (and extended) the findings of Erb et al. (2002) but questioned the extent to which the effects of priming (using procedures similar to Erb et al., 2002) operate outside conscious awareness. Erb et al. (2002) had argued that priming affects pre-conscious risk-preferences.

Another study involving risk priming (Fischer, Guter, & Frey, 2008) produced similar findings to those described above. Fischer et al. (2008) found that when exposed to risk-related media, participants expressed more favourable attitudes to risk-taking, and exhibited greater risk-taking behaviour. They argued that risk-promoting media increased the cognitive accessibility of risk-related cognitions leading to increased risk-taking, but were not interested in investigating the extent to which the effects of priming operate pre-consciously.

Within this thesis one aim was to develop an implicit (or rather pseudo-implicit) risk-taking behaviour method. The current behavioural method that was used was the Balloon Analogue Risk Task (BART). This is a form of gambling game and will be described in detail in Chapter 3 and Chapter 6. In order to incorporate an implicit type component to the BART a priming component was used. By using the same priming procedure that is used in the EPT this meant the new BART could be based on similar MODE model principles, as well as comparing the attitude and behaviour measures across the studies.

The first two aims of the thesis relate to the development of these measures that used priming. With the EPT methods in particular this presented an opportunity to investigate affect or emotion, which is often cited as an important factor in implicit cognition. As mentioned above, affect also plays an important role in risk perception formation. Given that there would be implicit measures of risk and affect this provided the opportunity to investigate the affect heuristic at an implicit level. This has not been achieved in such a direct manner previously. This also provided a focus for part of the demonstrations of the new methods. In order to clarify this heuristic and the relevance of emotion generally the following section covers these topics.

2.12 The Affect Heuristic

The significant influence of affect on risk decision making has been shown in many previous studies (e.g. Slovic et al., 2007; Blanchette & Richards, 2010; Traczyk & Zaleskiewicz, 2015). The end of the 20th Century saw an increasing focus in risk research towards the interaction of risk and emotion (Breakwell, 2014). It was increasingly understood that cognitive processing, attitudes, and beliefs were not enough to fully explain risk perception and risk-taking behaviour. This has led to the idea that risk estimations are largely a product of emotional reaction (Slovic, 2010b). This may often be in contrast to rational judgements. While this line of research has seen progress in more recent years it is not a new component of risk research.

Early research in risk perception found that the feeling of dread was influential (e.g. Fischhoff et al., 1978). It was also found that risk and benefit tend to be perceived as negatively correlated despite the fact that in actuality they tend to be positively correlated (Fischhoff et al., 1978). This finding led the way towards the development of the *affect heuristic* which places affect at the heart of risk perception. Lowenstein et al. (2001) also described the *risk as feelings* hypothesis which states that risk perception is largely a product of feelings or emotion at the moment of decision making. The *risk as feelings* hypothesis has developed in part from and also influenced other theories including dual process theories of information processing (e.g. Epstein, 1994). A connection can be found here with some of the theories described by Covello and Sandman (2001), particularly the Risk Perception Theory and Mental Noise Theory.

Lowenstein et al. (2001) suggested that people can feel emotions of varying levels of intensity and that this can influence their risk propensity. Specifically, higher intensity emotions, such as anger, can often lead to greater risk-taking behaviour. This is in contrast with relatively low level emotions, such as boredom, but does not account for high intensity emotions like fear which tend to lead to risk-averse behaviour. In their hypothesis, people are considered to imagine the consequences of a risky scenario and are then driven by how that imagined scenario makes them feel. This association with emotion and imagination has some parallel with the memory associations within the MODE model which will be discussed in the next chapter. As such, this hypothesis is in line with the theoretical framework of this thesis.

The risk theory that includes emotion which is of more obvious interest, however, is the *affect heuristic*. Slovic and colleagues developed the affect heuristic, which describes how evolution led humans to use every day emotional feelings in a rational and often useful way (Slovic et al., 2007). Slovic and colleagues suggest that contrary to earlier suggestions, the role of affect or emotion in risk perception (and behaviour) is not maladaptive but rather has been crucial to survival throughout evolution (Slovic et al., 2007). Knowing when to 'fight or flight' was necessary in our ancient past but since formal risk analysis techniques were not available, this relied on 'gut instinct'. Part of the foundation of the affect heuristic is the claim that affective reactions are the earliest in processing, occur automatically, and then influence perception. The affect heuristic is similar in certain respects to the risk as feelings hypothesis of Lowenstein et al. (2001), and links with the dual process theories of information processing formulated by among others, Epstein (1994).

The basis of the affect heuristic is that positive affect is associated with low risk, and negative affect is associated with high risk. So even if other items of information provide clear guidance to relative risk levels, this risk/affect relationship will often influence perception. As with other heuristics this often provides a mental short-cut to processing. Affective responses are not cognitively demanding and are relatively automatic so when faced with a difficult risk related problem using this affect heuristic influence eases cognitive load. This is not a reasoned choice, however, but rather a process that tends to occur in an automatic (or relatively automatic) manner.

The intensity of emotions in this context can vary, and includes mood or relatively low levels of emotion, which may be termed 'affect' (Slovic et al., 2007). While emotion has been studied extensively, there remains much debate over how it works, and how it should be conceptualised. Some researchers consider emotions a product of reward and punishment, while others suggest that they are based on a readiness to act via conscious or non-conscious appraisals of events (Rolls, 2005). Within the emotion literature there are two main strands of thinking. These are the discrete or basic emotion approach, and the dimensional approach (Oatley, Keltner, & Jenkins, 2006). The discrete emotion approach is categorised by a description of emotions as separate and distinct. Among several variations of just what these 'basic emotions' are, one example is that of Ekman. He suggests the six basic emotions of happiness, sadness, anger, fear, surprise, and disgust (Ekman, 1992). The normal interpretation is that other emotions subsequently derive from variations and interactions of these basic emotions.

Despite the continued preference for this conceptualisation of emotion among some researchers, the very notion of such foundation emotions has been challenged (Russell, 2003). For instance, any distinction between basic emotions and 'non-basic' emotions is claimed to have no objective basis (Ortony & Turner, 1990). There is evidence for an evolutionary perspective that might logically conclude some emotions, such as fear, may be 'hard wired' (Damasio, 2006), but the argument for an all encompassing set of emotions that provide the basis for the emotional experience is less convincing. A simple example of the confusion that may arise when considering emotions this way is that the distinction of happiness and joy may be more a semantic issue than necessarily anything revealing about how emotion is actually perceived.

The other main approach (the dimensional approach) is not as vulnerable to the issues mentioned. This approach has routes going back to Wundt in the early 20th Century, who proposed that three contrasting pairings of feeling could be combined to describe any emotion (Gendron, 2010). This idea developed over time, so that the concept became that any given emotion can be described as existing somewhere along three dimensions in 3-D space (Russell & Mehrabian, 1977). There are some variations within this approach but the most prevalent is that these dimensions consist of pleasure (or valence), arousal (or emotional intensity), and dominance (or control) (Russell & Barrett, 1999). There have been suggestions that two dimensions are sufficient (missing out dominance), but this is challenged with the example of comparing fear and anger (Fontaine, Scherer, Roesch, & Ellsworth, 2007). These two emotions are both considered low in valence and high in arousal, with the only way to distinguish between them being the differential levels of dominance. Specifically, fear is considered an avoidance emotion (i.e. the wish for flight), while anger is an approach emotion (i.e. the desire for fight).

Although debate continues, the dominant dimensional theory is the PAD theory (pleasure, arousal, and dominance) developed by and Russell and Mehrabian (1977). The current research will largely focus on the impact of valence in regards to risk perception, as this aspect has most consistently been implicated (e.g. Slovic et al., 2007). This is also a pragmatic decision as a more complex conceptualisation of affect would make for prohibitively time-consuming study lengths. Clearly this limits the scope of the findings and this will be discussed as appropriate but this compromise position is sensible given the variety of thesis aims.

Part of the foundation of the affect heuristic is the claim that affective reactions are the earliest in processing, occur automatically and influence perception (Slovic et al., 2007). Furthermore, some researchers (e.g. Finucane et al., 2000) have suggested that affect plays a more important role in implicit attitudes than explicit attitudes. This suggestion that the intuitive side of cognition is more influenced by emotion is also important for the main aims of this thesis as part of the purpose for the method developments is to investigate the affect heuristic at an implicit level. Finucane et al. (2000) also suggested that the affect heuristic is specifically an associative process, and that this is an analogous processing type to those described in dual process theories. The argument is that the characteristic negative correlation between perceptions of risk and benefit is stronger when time is limited. Time pressure (or limited time availability) has been cited as one of the conditions where implicit processing tends to dominate (Khaneman, 2011). Theories that consider affect as a form of information that can potentially influence perception also suggest that, when considered relevant, emotions can also influence risk-taking behaviour (Lowenstein et al., 2001). Traczyk and Zaleskiewicz, (2015) also showed that negative affect via risk associations could influence willingness in risk-taking behaviour.

There has been a notable lack of evidence to support the idea that the affect heuristic can (or does) operate at an implicit processing level. Townsend et al. (2014) in one study found that the affect heuristic appeared to be more driven by deliberative (explicit) processing rather than associative (implicit). This was in contrast to their expectations based on the theoretical literature. It should noted, however, that there are potential issues regarding their method for assessing the affect heuristic and their initial aim was to investigate whether the heuristic was solely associative. They did not conclude that their findings meant there were no affect heuristic effects at an associative level (particularly when considering the theory), but simply that their study lacked such evidence and emphasized the importance of explicit processing.

Townsend et al. (2014) claimed that there have been no studies at all empirically supporting the affect heuristic at an associative level. They acknowledge that there have been many studies that have supported the importance of associative level processing on risk perception and risk communication, as well as studies that have investigated the role of affect. This thesis aims to investigate this issue via the newly developed methods.

2.13 Summary

This section summarises the key points that emerged from the literature to identify the research gaps. These are split into four clusters: the concept of dual processing theories of thinking; the use of implicit attitude methods; the attitude to behaviour relationship; and the importance of emotion in risk perception. The first of these clusters provides the theoretical basis for the thesis, including the concept of implicit processing. The second cluster concerns how implicit attitudes can be measured with a particular focus on measuring risk attitudes. The third cluster relates to how implicit attitudes may influence behaviour and how these implicit attitudes can be measured. The fourth cluster concerns how emotion can influence risk attitudes, in particular how the affect heuristic manifests at an implicit level of processing. The following paragraphs will explain how these clusters led to the research gaps and thus the research aims.

Dual processing theories provide an explanation of how we think (e.g. Kahneman, 2011). This can be explicit processing where deliberation and conscious thought is conducted or implicit processing which is automatic and requires little effort. Research suggests risk perception can be driven by emotion and/or implicit processing (e.g. Slovic et al., 2007; Visschers et al., 2007). The dominant approach in this area, the psychometric paradigm (Slovic, 2016), has tended to focus on explicit processing so the use and development of alternative implicit methods is necessary to fully investigate risk perception.

There are several ways of measuring implicit attitudes (or perception) (e.g. Fazio et al., 1995; Greenwald et al., 1998), but limited options for measuring implicit risk attitudes (e.g. Traczyk & Zaleskiewicz, 2015). Siegrist et al. (2006) states that more research in risk perception should be conducted using implicit measures. There has been debate, however, regarding the validity of implicit measures due to dissociations that are often found when comparing different implicit measures (e.g. Fazio & Olson, 2003). There are also concerns that certain implicit measures (particularly the IAT) are dominating research which compromises any efforts to clarify why such dissociations sometimes occur (Brand & Schweizer, 2015). A research gap that naturally emerged from this is the need for a new alternative implicit risk attitude measure. This led to the formulation of Research Aim 1 (To develop and demonstrate two novel versions of an implicit attitude method (the Evaluative Priming Task) based on risk and affect attitudes).

In order to achieve Research Aim 1, several Research Objectives were formulated. Research Objectives 1 and 2 involved generating risk and affect words that could be used as target words in the EPT tasks. Further materials were required for use as priming items in the EPT tasks. Research Objectives 3 (food nutrition items) and 4 (cyber-security items) involved generating these items for use as primes.

Finally Research Objective 5 involved combining the generated items in order to design the new EPT tasks, thus achieving Research Aim 1.

A key issue in implicit attitude research is how it relates to behaviour (Fazio & Olson, 2003). The MODE model provides an approach to understanding the attitude to behaviour relationship in terms of implicit cognition. Currently, however, the relationship between implicit cognition and behaviour requires the use of separate perception and behaviour data sources. This suggests that there is a gap in the field relating to measuring risk-taking behaviour directly when driven by automatic processing. This led to the formulation of Research Aim 2 (To develop and demonstrate a novel version of a risk-taking behavioural method (the Balloon Analogue Risk Task) that provides a measure of changes in risk-taking behaviour driven by automatic processing (via priming)).

In order to achieve Research Aim 2, several Research Objectives were formulated (or needed). The BART studies did not require target words but did require priming items. The priming items generated via Research Objectives 3 (food nutrition items) and 4 (cyber-security items) were incorporated. Research Objective 1 involved generating risk words that could be used as target words in the EPT tasks. A selection of these words were used as priming items for another (context independent) BART study. Finally Research Objective 6 involved combining the generated items in order to design the new BART tasks, thus achieving Research Aim 2.

Emotion is often cited as an important driver of risk perception and one key theory in this context is the affect heuristic (e.g. Slovic et al., 2007). This heuristic has been demonstrated at an explicit level many times but evidence is lacking or limited when considering implicit processing (Townsend et al., 2014). This highlights a gap in knowledge that can be investigated due to the characteristics of the new methods. This led to the formulation of Research Aim 3 (To investigate the affect heuristic at an implicit (automatic) level of processing).

In order to achieve Research Aim 3, two Research Objectives were formulated. Research Objective 7 involved testing the affect heuristic via the EPT methods, thus testing the heuristic at an implicit level. Research Objective 8 involved testing the affect heuristic using the BART method. While not an implicit test as such this provided additional data for the investigation of the affect heuristic. Both of these objectives relied on the previously developed methods, and thus achieved Research Aim 2.

This chapter provided a literature review of the relevant fields to this thesis in order to identify gaps in the literature. This led to the formulation of three main research aims. The aims are to develop and demonstrate novel measures of risk. One method aims to measure implicit risk attitudes (Research Aim 1), while another method aims to measure risk-taking behaviour changes when driven by automatic processing (Research Aim 2). Research Aim 3 of the thesis is to investigate the affect heuristic at an implicit level (by using the developed methods). While this chapter provided background on the literature and theoretical bases of the research, the specific methodological approach is of particular relevance since the first two aims of the thesis are based on method development. The following chapter provides the methodological approach and this includes some more detail regarding the background and discussion regarding the field of implicit measurement.

Chapter 3: Methodology

3.1 Introduction

The main research goal of the thesis was to develop and provide a demonstration for two novel methods that can measure automatic (implicit) processing in relation to risk attitudes, and risk-taking behaviour. These were modified versions of the Evaluative Priming Task (EPT) that measures attitudes, and the Balloon Analogue Risk Task (BART) that is a behavioural measure of risk-taking. The foundation of the newly developed methods was the use of priming in order to capture either automatic (implicit) risk perceptions or automatic risk-taking behaviour via priming. Using these methods data was collected about specific risk areas (food health and cyber-security). Providing these demonstrations of the methods also shows their potential for use in future research.

The new versions of EPT and BART methods were designed to measure implicit processing (or "pseudo-implicit" processing for the BART) but it was also necessary to gather sufficient data on explicit processing. This meant that explicit methods were also used within the research. In order to ensure that the explicit measurements were comprehensive (particularly in relation to implicit/explicit comparisons) the approach that was used was a mixed model methodology. The overall approach was dominated by quantitative methods but the inclusion of a qualitative component was useful in this context. This provided a broader picture and allowed for comparisons to be made between the implicit and explicit methods.

There were four main methods that were used within the present research. Three studies (Studies 1, 2, and 4) used only a questionnaire while five studies (Studies 3, 5, 6, 7, and 8) used a combination of multiple methods. Studies 1, 2, and 4 were conducted in order to generate materials that were required for designing the new methods (EPT and BART variants). These materials included 'target' words that were needed for the EPTs. These target words were categorized by participants during the EPTs in terms of either risk or affect and needed to be consistently categorized in the same way (e.g. as high risk or low risk). The EPT and BART methods also required priming words, terms, or images that were likely to elicit particular risk associations. Using questionnaires provided a systematic process to generate these materials and increased the likelihood that participants would tend to have similar risk or affective attitudes towards them. It also increased the likelihood that participants would be sufficiently familiar with the materials. For Studies 3, 5, 6, 7, and 8, the novel methods were used (EPT or BART variants) while also including a questionnaire and interview. The questionnaire provided the more comprehensive information regarding explicit processing or attitudes but this was also bolstered by the addition of the short semi-structured interview.

The two main methods used were an implicit attitude measure, and a risk-taking behavioural measure that incorporated priming. The implicit measure was a new variant of the Evaluative Priming Task (EPT). The EPT typically measures valence but a risk version was developed along with a modified version that specifically measured affect. The behavioural measure was a new variant of the Balloon Analogue Risk Task (BART) that included a priming component. The following sections provide the research philosophy, and the rationale for using the various methods, and describe how they were mixed in order to meet the research aims. After these sections, the technical details of each method are explained.

3.2 Research philosophy

Historically, risk research has tended to be grounded in positivist research philosophy (Crichton, Candlin, & Firkins, 2016). This refers to the belief that there is an objective, external nature to the reality of risk perception and that it is possible to measure objectively. It has been claimed that data integrity is higher when using a positivist approach meaning research characteristics that impact errors and biases are more controlled (Hussey & Hussey, 1997). The positivist approach presumes there are laws of cause and effect that can be measured and that behaviour and perception are subject to these laws. This is in contrast to a phenomenological approach which tends to emphasize context and subjective perspective (Howell, 2013). Hermansson (2012) suggests that there are three aspects of risk which have promoted a tendency towards an opposing subjective perspective. These are value judgements, the framing of risks, and emotions. These are used as arguments for the variability and non-predictive effects of many risk associated information objects. The contrary argument, however, is that objectivity does not need to be value free or unbiased (Hermansson, 2012). This notion from feminist epistemological theory argues for a, "situated concept of objectivity, that is, a concept that includes values and emotions and that is sensitive to context" (Hermansson, 2012, p. 20).

One way to conceptualize these issues is that the methods (or how they are used) rather than the philosophical positions may be crucial. The notion of an objective reality and empirical epistemology can be reconciled with the undoubted variation that exists among people in relation to risk perception. There is in fact more flexibility that is inherent in a (willing to compromise) positivist approach than might sometimes appear to be the case. The positivist approach tends to be associated with quantitative methods while a phenomenological approach will more likely lead to the use of qualitative methods (Hussey & Husssey, 1997). The key point in this distinction is actually the aim of the research, however. This is the balance between collecting data that can be quantified and being able to directly compare data from different people, with the desire to appreciate how perception and behaviour will still be unique to each individual. In order to maintain this balance, the approach taken in this research was a mixed models methodology.

In philosophical terms, balancing the positivist and phenomenological approach objectives leads to the post-positivist position (Howell, 2013). This approach rejects the idea that subjective perspective means generalisability is impossible but also accepts that experience exists via differing constructions and meanings (Trochim, 2006). The post-positivist tradition contends that only an approximation of reality is possible albeit with an acceptance of that reality (Denzin & Lincoln, 2005). Much of this debate centres on the differing characteristics of quantitative and qualitative data with one issue being that quantitative data may be too restrictive in uncovering sufficient "truth" about perception or attitudes. It has also been suggested that the use of qualitative data should not be seen as incompatible with a positivist approach (Michell, 2003).

The research aims of this thesis were based on the ability to capture consistent characteristics in risk attitudes and behaviour. This basis is necessary in order to develop new research methods that measure implicit risk attitudes or risk-taking behaviour (the main aim). Nonetheless, attitudes and behaviour are by definition individual so an acknowledgement of this was also necessary. Given the use of mixed methods and acceptance that neither positivist nor phenomenological approaches would be adequate, this research sits more appropriately within the post-positivist tradition (Howell, 2013).

3.3 Methodological Rationale

The mixed method approach involves the use of both quantitative and qualitative methods. While the research aims of the thesis are primarily focused on the role and measurement of implicit processing, it was also necessary to measure explicit processing. This is in order to investigate the relationship between implicit and explicit measurement findings. If these different types of measurement findings did not correlate this would suggest that they are capturing differing types of processing, and would bolster the argument for using implicit measures.

Using mixed methods balances the relative strengths and weaknesses of quantitative and qualitative approaches (Coolican, 2009). For the purposes of this thesis the use of quantitative methods was the most appropriate approach as these methods can be used to test hypotheses and provide arguably more versatile descriptive data, at least in terms of analysis for this research (Harwell, 2011). Nonetheless, the inclusion of interviews allowed for collection of additional information that may not be captured via quantitative methods. For instance, a participant could highlight an aspect of the task administration that caused a problem which may go unreported unless they are given the opportunity to describe it. Such a scenario may not have been included within the questionnaire items but would be relevant in terms of method development. In many cases qualitative data is used to explore an issue in order to know how to focus theory or further research. This, for instance, can be used as the first step in developing a questionnaire or as a separate flexible form of research that is less constrained by the limits of current theory.

In this research the questionnaires were used to collect data regarding risk attitudes, affective attitudes, or familiarity towards several risk related exemplars. This meant that the design of the questionnaires was relatively straightforward. Questionnaire items included a set of exemplars which were rated in terms of risk, affect, and familiarity rather than a set of different questions which had to be systematically generated and revised. Rather than being used to aid in the questionnaire design, the interviews were added to clarify attitudes and provide scope for open expression after the main tasks were complete.

The approach was dominated by quantitative data collection since this provided numerical data that could then be more readily analyzed, particularly in terms of comparing different measures (e.g. comparing the explicit and implicit measurement outputs). The addition of a qualitative component (interviews), however, provided important additional information regarding participants' perceptions, and helped clarify any practical issues they encountered. This made it possible to clarify details, provide a broader perspective on explicit attitudes, and ensured participants understood instructions and adequately performed the tasks. This led to collection of a comprehensive data set and provided a mixture of data for discussion. This helped in terms of discussing findings and evaluating the novel methods that had been developed. The following sections will describe the rationale for using each method.

3.3.1 Questionnaires

Questionnaires provide several benefits for capturing explicit attitudes. It is possible to collect large amounts of data efficiently and quickly, while also producing data in a standard format that is more flexible in terms of statistical analysis. The use of questionnaires meant that explicit attitudes to several words, phrases, or images were collected. Since the data was in numerical form (based on rating scores) it was then possible to compare this data with the numerical data collected via the main tasks. The questionnaires were also useful for conveniently collecting demographic information, along with other details of interest, such as eating habits, as appropriate to the given study.

As discussed in the literature review, the most established approach to analysis of risk and conceptualisation of risk perception is the psychometric paradigm (Siegrist et al., 2005; Slovic, 2016). This involves the use of psychometric methods in order to quantify risk perception. It is logical to include equivalent measurement for the current research in order to place the findings within the wider literature. This also allows for direct comparisons with implicit measurement findings. A key benefit in this research was that questionnaires allowed for large data collection. This was important as large sets of exemplars were needed in order to select target or prime words for the main tasks (the EPT and BART variants). This would likely have been a time-consuming and complicated process using any other method. As mentioned earlier, however, it was also useful to supplement the questionnaire data with interview data.

3.3.2 Interviews

The interviews followed a semi-structured format. This provided useful additional data that could then be combined with more comprehensive questionnaire data in order to provide a fuller picture of the explicit attitudes. The interviews provided a more flexible way of gauging how participants coped with the implicit tasks than the questionnaires, including some reflection on whether they realized those methods were attempting to capture implicit processing. Subsequently, these not only provided additional data but also assurances that participants had understood the instructions, and were relatively ignorant to the way the implicit tasks operated. This was important as participants who guessed the aim of the implicit tasks may not have provided responses that could reasonably be considered as natural.

One weakness of questionnaires is that you can only get answers to questions you ask. For this research the requirements were mostly to simply collect ratings for sets of exemplars but having this capacity to collect information beyond the questionnaire items was a logical research approach. It has been argued that using interviews, even short interviews, can enhance the value of data collected from smaller samples (e.g. Guest, Bunce, & Johnson, 2006). While the samples were sufficient in the current research this insurance perhaps suggests inclusion of interviews should be made whenever possible.

3.3.3 Evaluative Priming Task (Implicit Attitudes)

The main aims of the thesis were in developing new implicit methods, and using these to investigate the affect heuristic at an implicit level. As mentioned previously, many attitudes and behaviours do not require deliberative reasoning, and sometimes this is not even possible (e.g. when time is prohibitively limited). This ties into the conceptualization of thinking as consisting of different processing streams; dual processes (e.g. Khaneman, 2011). Although descriptions can vary, these can generally be seen as either slow and deliberative in nature (explicit), or fast and automatic (implicit). The methods described above (questionnaires and interviews) can capture explicit processing but other methods are needed to capture implicit processing.

This has led to the development of several implicit measures. These measures tend to be based on measurement of reaction time with short time thresholds indicating that responses have been too quick to be driven by explicit processing. Most implicit measures also use association as a key component. This varies somewhat among the various measures but for the measure used within this research (the EPT) it is based on automatic activation of associated memory. In the EPT a prime word, phrase, or image is initially flashed on screen then a subsequent target word is categorized (e.g. as good or bad). If the participant already holds an associated memory of the prime as e.g. good or bad, their response in categorizing the target word will be influenced. If the association is with e.g. good they will categorize the target word as “good” more quickly, and the target word as “bad” more slowly. The target words are always naturally categorized as belonging to one or other category (although the categories themselves can vary).

The implicitness of the measurement is based on the principle that automatic cognition is fast, requires little effort, and is automatic. Implicit measures are arguably not technically “implicit” measures at all but rather indirect measures that attempt to capture implicit cognition. Participants’ implicit attitudes are interpreted based on assumptions following their performance on the task (e.g. that differences in response reaction times were so small that they could not have been caused deliberately). The key advantage is that, while more complicated than e.g. questionnaires, in terms of design, administration, and analysis, they can nonetheless capture implicit attitudes. The EPT was used as the basis for developing new implicit attitude measures that could then be used to investigate the affect heuristic at an implicit level, and to compare with the explicit measures.

The original version of the EPT measures valence but this research was based on measuring risk perception and affect. This meant that new target and prime words, phrases, or images had to be generated in order to create two new versions of the EPT. One version was a minor modification that focused on affect specifically rather than valence. The main version of interest was a version that used risk related words as target terms for categorization. This meant that participants would categorize the prime words or images as either high risk or low risk, via several risk related target words. This was a novel modification of the EPT that captured implicit risk attitudes, while still following the same established theoretical basis as the original EPT. The data collected, however, could be used to investigate the affect heuristic at an implicit level (given that it allowed for implicit attitude capture of risk perception and affect), and also for risk attitudes to be compared across implicit and explicit levels. The next method developed was driven by the desire to also measure automatic processing in risk-related behaviour.

3.3.4 Balloon Analogue Risk Task (Automatic Risk-taking Behaviour)

It has long been understood that attitudes can impact on behaviour, including implicit attitudes (e.g., Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997; Fazio et al., 1995; Spalding & Hardin, 1999). How this process operates or how best to describe this relationship has led to differing views, however (e.g. Spence & Townsend, 2007). For this thesis one area of interest was the attitude to behaviour relationship, particularly in terms of automatic processing. In order to investigate this issue it was necessary to develop a risk-taking behaviour measure. To do this an existing risk-taking behaviour measure was selected; the Balloon Analogue Risk Task (BART) (Lejuez et al., 2002). This is a computer based gambling game that captures stable risk propensity or impulsivity.

To develop this measure to capture risk-taking behaviour based on automatic processing it was necessary to modify the original version of the BART. The previous implicit risk attitude measure (the modified EPT) that formed the basis for the first set of studies used priming as a key component. Taking inspiration from this use of priming, a similar approach was used when modifying the BART. This provided a practical solution and meant using an approach that has been shown to work, albeit in an implicit attitude measure rather than a behavioural measure. This had the additional benefit of meaning the theoretical bases of both new methods were related.

The eventual modified BART incorporated the priming component using the same principles as the EPT. This involved flashing a prime on screen with the data collected then being the BART responses rather than the categorization responses. This made the new BART a hybrid of the EPT and the original BART. It was then possible to collect risk-taking behaviour data using the same primes as were used with the new versions of the EPT, so comparison could be made between the implicit attitude measure and the behavioural measure. As will be explained in more detail later, this new BART was arguably a “pseudo-implicit” measure as it did not include the time threshold component that is used in most implicit measures as a means of clarifying implicit cognition.

By including this behavioural measure it meant that the research could discuss the findings from explicit attitudes, to implicit attitudes, then to risk-taking behaviour. This flow provides a crucial over-arching perspective that could be achieved due to using the newly developed methods.

The following sections provide more technical details on each method that was used, including details regarding design specifics, administration, and analyses. This initially requires consideration of the task of measuring risk perception.

3.4 Measuring Risk Perception

A particular focus on risk perception within risk research began to emerge in the 1970s with several prominent articles published in the 1980s (e.g. Slovic, 1987; Slovic, 2016). Slovic was a key researcher in the development of the psychometric paradigm in risk research which has been an influential movement within the field. This approach allows for quantification and indexing of individual differences in risk perceptions to a hazard. Typically the psychometric paradigm uses explicit measures, such as questionnaires, to gather data regarding an individual's perceptions of risks and hazards. This method provides conscious and deliberative measures of someone's attitudes but is limited in scope since risk perception is likely, at least in part, to be driven by non-conscious factors. For this reason, the present research aimed to utilise measures involving automatic processing in order to more fully investigate risk. It has also been suggested that emotion (or affect) can notably influence risk perception (e.g. Lowenstein et al., 2001). Since emotion can be seen as a largely automatic process this further highlights the value of utilising measures that can investigate this type of processing. In order to provide a holistic approach, both implicit measures (the EPTs) and explicit measures (questionnaires and interviews) were incorporated to investigate risk perception.

3.4.1 Questionnaires

The main function of the questionnaires was to gather explicit ratings of words, terms, or images based on risk perception, affect, and familiarity. Of interest was whether participants rated a word such as “dangerous” as feeling good or bad (positive or negative), high risk or low risk, and if they were familiar with the word. This provided explicit data regarding participants’ risk and affect attitudes that could then be compared with the implicit data from the EPTs, or the data from the BART. Familiarity ratings clarified whether participants were sufficiently capable of accurate categorizations in the EPTs, and whether it was feasible for priming to influence them. In order to be primed participants would need to understand the meaning of the words or terms used as primes. For all but one study, this was done using an on screen slider with each end marking the most extreme of each choice (e.g. very high risk and very low risk). See Figure 3.1 for a screen shot of the risk options when using the slider. The ratings were made by moving a cursor, via the mouse, over the slider line and clicking. This produced a rating between zero and 100 although the participant did not see a number, only the cursor on the line.

When displaying these questionnaire ratings each slider was labelled for each extreme. For Risk ratings 0 = Very Low Risk and 100 = Very High Risk, for Affect ratings 0 = Felt Very Positively and 100 = Felt Very Negatively, and for Familiarity 0 = Not at all familiar and 100 = Very familiar.

Using the slider with a range of zero to 100 meant that finer grained ratings were possible for each participant than would be gathered via Likert scales. A more obvious advantage is that it is more reasonable to treat the subsequent data as continuous. This provides advantages for analysis and also has been claimed to lessen noise in questionnaire data (Treiblmaier & Filzmoser, 2009). It also leads participants to choose in an arguably more intuitive manner, lessening the likelihood of participants thinking of the rating in terms of numbers and making them less easily aware how each choice relates to their previous ratings.

The questionnaires also collected additional data to the risk, affect, and familiarity ratings. Depending on the specific questionnaire further details collected included personality test data (EPT study questionnaires), risk propensity test data

(BART study questionnaires), level of Information Communications Technology knowledge (cyber-security related studies), dietary restrictions (food health related studies), and familiarity with specific food nutrition labels (food health related studies). The rationale for collecting these details was that they could reasonably be expected to influence risk or affective responses. Knowledge of the specific contexts (e.g. cyber-security issues or food nutrition labelling approaches) could compromise the notion that the participants were laypeople in terms of perception. While some variation of knowledge was inevitable it would have been more problematic if some participants were close to expert level as risk perception can function differently for experts compared with laypeople. Personality and risk propensity data was also deemed worthwhile as this could clarify key differences among participants that could subsequently explain differing risk or affective tendencies. The eventual data collected was rather limited (due to the limited scope of the personality and risk propensity measures used) but this was not evident until after the data was collected.

The questionnaire included personality tests in the form of the Ten Item Personality Inventory (Gosling, Rentfrow, & Swann, 2003). See Appendix 1 for a copy of the test used. This measure was chosen as it is quick to administer so would not increase the length of the questionnaire to a prohibitive extent. This measure is based on the Five-factor model with two items for each factor. One weakness, however, of this test in comparison with longer personality measures is that it can only provide an indication of personality traits (Gosling et al., 2003). Due to the limited value of this test it was only included in the EPT studies and was not used for the BART studies.

The risk propensity measure was the Risk Taking Index (Nicholson, Soane, Fenton-O'Creevy & Willman, 2005). See Appendix 2 for a copy of the measure used. This measure considers self-perceptions of every-day risk-taking based on current behaviour and past behaviour. These are categorized according to differing types of risk, such as health risk or financial risks. As with the personality test this is a short-form measure and provides an indication of risk propensity rather than a comprehensive measure. It is also a self-report measure. This measure was only used during the BART studies.

Demographic details were collected via questionnaire for all studies. For gender this involved choosing one or other option. For age this involved the participant typing their exact age in a provided box. Data collected via questionnaire as part of studies that included EPT or BART measurement provided data that could also be contrasted with the EPT implicit data or the BART risk-taking behaviour data.

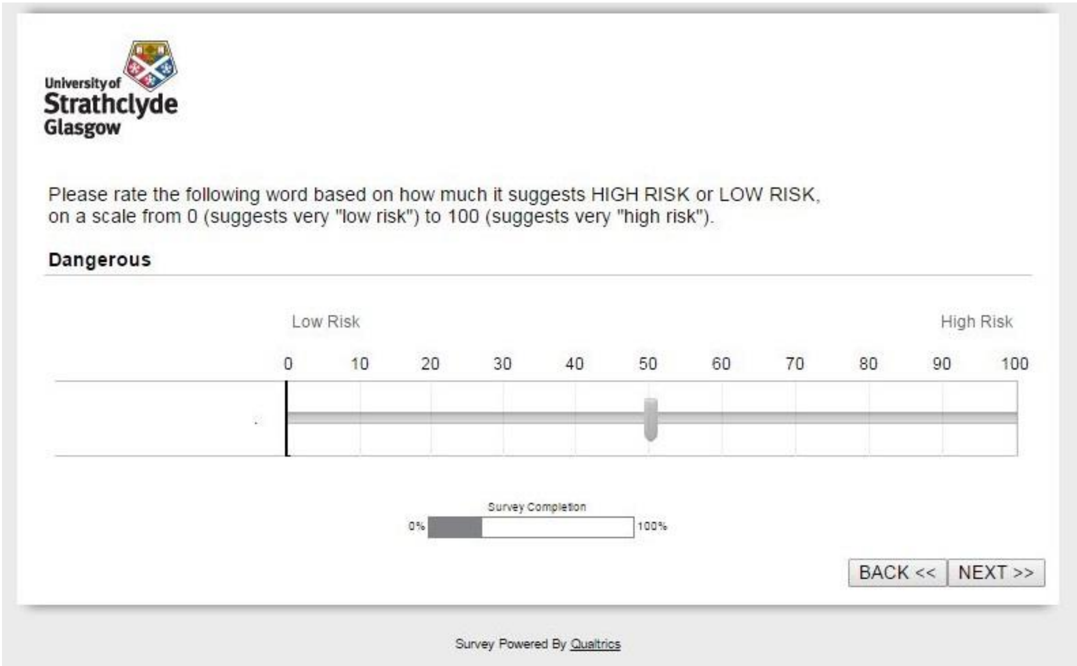
There were three initial questionnaire studies (Studies 1, 2, and 4) which served to provide base information about the nature of the explicit risk and affect associations. An additional role of these questionnaire studies was to systematically generate materials required for the subsequent EPT and BART tasks. The EPT tasks required sets of 'target' and 'prime' materials. The target materials were words that would be categorized, within the task, as either positive or negative, and as either high risk or low risk. As will be explained in Study 1, it was crucial that these words would be consistently categorized in one or other category. As such, the questionnaire studies provided a means of identifying words which would be expected to meet this demand.

Both the EPT and BART tasks also required sets of prime materials which could consist of words, terms, or images depending on the specific task. Within the tasks participants were shown the primes briefly on screen with their subsequent behaviour potentially influenced by this exposure. As with the target words it was important to have an expectation of likely influence. For the primes this would mean a potential change in behaviour (e.g. categorization speed in the EPT or risk-taking in the BART). Changes in behaviour that occurred could then be attributed to the characteristics of the prime (e.g. if the prime was expected to be associated with high risk based on previous ratings in the initial questionnaire study there would be expectations of how this would change behaviour, such as categorizing high risk target words more quickly in the risk version of the EPT). In some specific instances this included generating less typical examples, such as examples that tended to perceived as high risk but positive (or vice versa) as opposed to high risk and negative (Slovic, 2010b). The key point, regardless of specifics, was that there would be limited ambiguity as to how the materials would likely be perceived. It was also crucial that participants would be familiar with the materials used, so that their influence was consistent across participants. As such, the questionnaire studies allowed for a systematic generation of these materials that provided a solid base for the main tasks.

One concern with this approach was whether perceptions of the materials used were likely to be stable across different participants. It seemed reasonable, however, that by using this systematic approach and subsequently using words/terms/images that received consistently similar judgements in the questionnaire studies that consistent perceptions could be expected in the main tasks. This notion of perceptual consistency is ultimately in line with the overall methodological approach. It was also important to acknowledge that the materials generated were from explicit and conscious responses (i.e. from a questionnaire). Since the main tasks were primarily concerned with implicit cognition (including how these contrast with explicit responses) this limited the expectation of what would be found in the main tasks. One way this concern was alleviated was by considering that the questionnaire study results included a measurement of affect and automatic associations of risk are often related to emotional response (e.g. Lowenstein et al., 2001). Ultimately, any uncertainty about likely implicit responses was not of great concern, however, as by definition this uncertainty was a key point of the research. Ensuring that there was stability in explicit responses was all that was required in order to have appropriate materials.

The questionnaire studies (Studies 1, 2, and 4) were completed online by sending links via email. For all other studies the questionnaires were completed during the same sessions that the main tasks were completed. These were done in a private room with the experimenter present. This was necessary as the main tasks could not be done online since they were administered via the software package SuperLab. All questionnaire instructions were provided on screen rather than verbally to ensure consistency. Although completed in this way the questionnaires were technically still completed online since, like the questionnaire studies, they were conducted using the online website Qualtrics.

Figure 3.1: Screen shot of questionnaire risk rating page from the Risk Related Words BART study (Study 6). The word being rated in this example was Dangerous.



3.4.2 Interviews

Interviews were conducted as part of the EPT and BART studies (Studies 3, 5, 6, 7, and 8). The questionnaire studies (Studies 1, 2, and 4) used only questionnaires and were conducted online meaning that interviews were not possible. These studies were used to provide some initial explicit data on the affect heuristic which could not be directly investigated via interviews as this required correlation analyses. The other main purpose of these studies was to generate materials for the main tasks, e.g. target or prime words for use in the EPT. While the initial generation of possible target or prime words could have been done via interviews a different approach was used. This was a systematic approach involving the collection of a large amount of options (eventually reduced to 100) via several online thesauruses.
The websites used were Thesaurus.com (http://www.thesaurus.com),
Collinsdictionary.com (http://www.collinsdictionary.com/english-thesaurus),

Onlinethesaurus.co.uk (http://www.onlinethesaurus.co.uk), and Merriam-webster.com (http://www.merriam-webster.com/thesaurus). Given that only a small amount of target or prime words were actually needed (from 5 to 10 depending on the specific study) this approach provided enough words that were adequately familiar and rated sufficiently high or low for either risk or affect.

For the main studies, the procedure was to complete both the main task (either the EPT or BART) and questionnaire then complete the interview. This was done using a small set of consistent questions, such as asking if they had understood the instructions, whether they felt that the primes had influenced subsequent performance, or if they felt certain primes were particularly related to high/low risk and so on. The specific questions asked will be clarified within each study as these sometimes varied.

The interview was short (around 3 to 5 minutes) with no interview lasting more than 10 minutes. Nonetheless this did provide useful additional information and helped clarify general attitudes that could be combined with the questionnaire data. This could mean simply a reiteration of attitudes captured via the questionnaire but could also reveal that participants felt especially strongly about certain items despite the questionnaire data not revealing such clear distinctions.

For all interviews, participants were asked if they had any problems categorizing the target words (the EPT tasks), such as not knowing what any words meant, or if they had any specific issues while completing the tasks (both EPT and BART tasks), and had understood what they had to do. They were also asked if they had ever completed a similar task before (e.g. an EPT task or BART task).

For the food nutrition context studies, they were asked if considered any of the food products to be particularly indicative of high or low risk, and what they thought risk meant in this context. They were asked if there were any personal reasons (such as food allergies or dietary restrictions) that influenced their attitudes. Participants were then asked if they were familiar with the food traffic light system, how well they understood the system, and which aspects of the system tended to drive their attitudes.

For the cyber-security context studies, they were also asked if they had any issues with the cyber-security terms. After these questions they could add any further comments freely. Notes were taken of their responses and this information was used to identify key issues, trends, or common responses. After the main questions they could add any further comments freely (for all interviews). Notes were taken of their responses and this information was used to identify key issues, trends, or common responses.

Given the brevity and purpose of the interviews it was not necessary to conduct a full thematic analysis of the data. Thematic analysis of interview data aims to uncover consistent themes which then may suggest certain issues are of notable importance (Daly, Kellehear, & Gliksman, 1997). This process also often involves transcribing the interviews and then coding the information in order to reveal the dominant themes. For this research, this depth of analysis was not necessary as the additional data was only required to clarify that the tasks had been performed properly and to provide an opportunity for additional comments. It was not expected that these comments would tend to be particularly detailed as the questionnaire provided much of the likely relevant information and comment boxes were included. Instead, notes of key comments were taken and a summary of all answers. This information was then compiled and a basic thematic analysis conducted that produced confirmation of general attitudes, specific comments of interest, and clarification that the participant had no problematic issues with the tasks or instructions. This information could then be considered as supplemental information to support the questionnaire data.

3.4.3 Implicit Measures

Whereas explicit measures, such as questionnaires or interviews, are capable of measuring deliberative (explicit) processing, implicit measures can measure automatic (implicit) processing (Fazio & Olsen, 2003). Implicit measurement means capturing automatic thinking that is processed largely beyond personal control and therefore is less susceptible to dishonest responses. It is even possible for these measures to capture attitudes that the participant is not aware they (implicitly) hold (Fazio & Olsen, 2003). Capturing implicit (or automatic) attitudes is especially useful in certain contexts where it is suggested that automatic attitudes may dominant thinking (and behaviour). These contexts include when time is limited, information is limited, or information is complex and not easily processed (Kahneman, 2011).

There are different implicit measures that are available which vary in how they function albeit they often use reaction times (RTs) and association as key components (see Fazio & Olsen, 2003; De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009). The most commonly used and most widely validated is the Implicit Association Test (IAT) (Greenwald et al., 1998; Johnson & Steinman, 2009). This method involves displaying pairs of words simultaneously and measures RT during a category decision task, with RT differences presumed to be based on the apparent associations held between the pairs. Although widely used, the IAT is not without critics. It is not clear if participants' attitudes are being measured, or if instead the data may be driven by the similarity between concepts (De Houwer et al., 2005), or the differences between pairings of words (Rothermund & Wentura, 2004). The IAT involves switching between pairs of words (e.g. the words White and Good may be initially paired then later trials will display White with Bad). This has led to suggestions that the first pairing shown can produce faster responding due to the cognitive effort required for categorisation when switching between pairs (Messner & Vosgerau, 2010).

One way around the reliability issue (for such techniques) is to use ambiguous stimuli, such as with the Affect Misattribution Procedure (AMP) where priming words are followed by a Chinese writing symbol (Payne, Cheng, Govorun, & Stewart, 2005). Participants rate how pleasant the character appears after primes varying from pleasant to unpleasant valence. This technique is not well suited, however, to investigate risk perception as it would not be intuitive for participants to rate ambiguous symbols in terms of risk.

One issue with implicit attitude measures is that they are often found to not correlate (Fazio & Olson, 2003). As such, it is not clear that all implicit measures actually measure the same cognitive function. For this reason it has been suggested that research should aim to include more than one type of implicit measure. This could mean using multiple types in one study or ensuring that less common measures are used (Brand & Schweizer, 2015; Hyde et al., 2010; Seger, Smith, Percy, &

Conrey, 2014; Townsend et al., 2014). It was not practical in this thesis to use multiple implicit measures so it was deemed more beneficial to use a measure other than the IAT. There are also existing risk attitude measures based on the IAT (e.g. Siegrist et al., 2006) so developing an implicit risk method using a different technique fulfilled the need for alternative implicit methods that may lead to a fuller understanding of implicit measurement generally.

The approach favoured for this research was the EPT (Fazio et al., 1995). This method lends itself more readily to risk perception measurement than the AMP by using risk associated target words whereas the AMP uses ambiguous symbols as target items. It is also more readily appropriate for measuring separate non-relative exemplars rather than categories (as in the IAT). The Go/No-Go-Task (GNAT) (Nosek & Banaji, 2001) or Single Category IAT (SC-IAT) (Karpinski & Steinman, 2006) are not limited to categories but these are both based on the same theoretical principles and similar methodological characteristics as the IAT. Given that there are IAT based implicit risk attitude methods, developing a new method using either of these would not provide a sufficiently contrasting approach. They are also not so commonly used to measure multiple individual exemplars so there would be debate around how much of the validation these methods have gained can be attributed to somewhat unusual versions of them. That is, since they are not normally used to measure several non-relative exemplars, using them in this project would not necessarily be appropriate. Eventually it may be possible to clarify how the various implicit methods contrast in what they specifically measure. This cannot be achieved, however, by only developing or using the same methods (or variants of the same methods) continually. As such, developing a risk version of the EPT provides a genuinely novel method, based on fundamentally differing characteristics, which can broaden understanding and provide scope for comparisons among implicit risk attitude methods that is not possible at the moment.

3.4.3.1 Evaluative Priming Task (EPT)

The EPT is an implicit measurement technique that uses priming and reaction times (RT) to attempt to uncover automatic associations or activations in cognition (Fazio et al., 1995). The EPT uses words associated with the area of interest in order to elicit responses driven by automatic associations. This involves priming the participant to opposing types of association (e.g. good or bad) then asking for a response to separate target words (with a non-primed baseline measure also separately taken). If a participant responds to the target word in the baseline condition as good, then responds to this same target word in the "good" priming condition more quickly as good, it suggests that they hold a stronger underlying positive association to the target word than is evident from simply asking them (explicit measurement). It is also possible to find contrasting attitudes using this technique as implicit and explicit attitudes have been shown to often not correlate (e.g. Fazio et al., 1995; Hyde et al., 2010; Nosek, 2007; Spence & Townsend, 2007).

The procedure involves participants being briefly shown a prime (a word, phrase, or image) on a computer screen. This prime is displayed for a fraction of a second, although the exact amount of time it is shown can vary. More details regarding this will be given in the Method sections of the EPT studies (Sections 4.4.2.5 & 5.3.2.5) as this time varied among the studies within this research. After the prime has been displayed, and a blank screen is shown for a fraction of a second (which varies depending on the timing used for displaying the prime), the participants have to categorize a target word. These target words are specifically selected to be consistently categorized within one extreme of a specific category. In the original EPT these extremes were either good/positive or bad/negative (i.e. valence). So every target word should naturally be considered good or bad by ideally all the participants. The measurement is based on how long they take to make this categorization. They are instructed to make the categorization as quickly as possible.

The theoretical underpinning of the EPT lies in the Bona Fide Pipeline. The basis of the Bona Fide Pipeline is that activation of evaluation spreads from the prime to the evaluated target word (Fazio & Olson, 2003). This leads to changes in response speed when categorizing target words based on whether the participant perceives the prime and target items to be congruent or incongruent. For instance, if a participant holds an automatic association in memory of negativity towards e.g. sugar, they would be expected to categorize a subsequent "negative" target word more quickly (which is termed "facilitation") than they would categorize that same target word when no prime was shown. In contrast, after viewing the word sugar they would be expected to take longer to categorize a subsequent “positive” target word (which is termed “inhibition”).

3.4.3.2 Risk and Affect EPT Versions

While the original EPT measures implicit valence attitudes, two new variants were developed for this thesis that measured implicit risk attitudes, and implicit affective attitudes. The overall approach follows a study investigating implicit attitudes to a concept that is related to risk perception: trust (Burns, Mearns, & McGeorge, 2006). This study used a similar approach to generate priming/target words. The authors found that the priming words were reliable and effective (using the trust context), and they also found that implicit attitudes differed somewhat to explicit attitudes. The use of the EPT in this risk context, however, represents a novel use for the method.

Both new variants were based on the Bona Fide Pipeline approach as detailed by Fazio and colleagues (Fazio et al., 1995). For the affect variant, the target words were a selection from Fazio et al. (1995) that were readily associated with affect. The procedure also included asking participants to specifically categorize the words in terms of how they “felt” about the words. Although similar to the original valence EPT this change in instructions meant that the responses could reasonably be considered measures of affect (or affective perception). The target words were also chosen specifically due to their affective association.

In order to develop the risk EPT the data from one of the questionnaire studies was analyzed (Study 1). Specifically, this required identifying words that were consistently categorized as either “high risk” or “low risk”, and were sufficiently familiar to participants. Once this was done, five words within each category (10 in total) were selected for use as the target words in the risk EPT. The affect EPT also included five target words for each category meaning that 10 target words in total were used for both new EPTs (different words in each type of EPT). The total number of primes and targets used within each EPT was limited in order to avoid task fatigue.

The amount of time that the prime is presented, added to the amount of time that the screen is blank prior to presentation of the target word is called the stimulus onset asynchrony (SOA). The original study by Fazio et al. (1995) used an SOA of 450ms. While this SOA was used for one of the studies in this research, it was shortened for the other. The details and rationale will be explained within the Method sections for the EPT studies in order to avoid confusion. The sequence of blocks and amount of trials that were subsequently used also varied so again this will be explained within the Method sections for each study.

During the EPT, there is a baseline condition where no prime is shown but target words are still categorized. This is a crucial component of the analyses as will be explained in Section 3.4.3.3. A recognition phase was also included where participants would have to identify which words or images were displayed (at the end of the main task). This was included to ensure that participants had paid attention to the primes. In order to maintain consistency in the procedure as experienced by the participant, and in line with the typical EPT procedure, a row of asterisks were presented instead of the prime. This was the case for all EPTs.

The EPTs were administered via SuperLab version 4.5 using a Dell PC computer with a 21.5 inch screen. Words were shown on screen in Times New Roman 45-point font. When images were included these were displayed with dimensions ~300 pixels by ~500 pixels, at 300 dpi, with some slight variations based on differing basic shapes. Participants made their categorizations via a Model RB-530 response box. See Figure 3.2 for an image of the response box, although this image shows labels as used in the BART studies (Studies 6, 7, and 8). For the risk EPTs, one side button was labelled Low Risk, and the other button High Risk, with the top button labelled Yes, and the bottom button labelled No (Yes and No buttons were for the recognition test). For the affect version, the side buttons were labelled Good and Bad. The configuration was swapped randomly across participants (e.g. some participants had Low Risk as the left button while other participants had High Risk as the left button). This was done to ensure that there was no confounding effect due to differing dominance in handedness. No such effect was found but this approach should be encouraged as such effects are feasible.

3.4.3.3 EPT Analysis Approach

As previously mentioned, participants made their categorizations in two conditions: during a priming phase, and during a baseline phase. In both conditions they categorized all target words multiple times (which varied across the studies); whereas the priming phase included exposure to the primes, the baseline phase only showed a row of asterisks. Facilitation scores were calculated by subtracting the RTs in each priming condition from the baseline condition, for each participant (Fazio et al., 1995). These facilitation scores therefore provided a measure of the difference in RT for categorization that is caused by the prime. Each target word was presented multiple times in the baseline condition and the median used as the baseline RT for each target word. Similarly each target word was presented multiple times in each priming condition and the median used as the average for that prime/target combination. The use of the median was preferred to the mean because of the potentially disproportionate impact that an individual target word may have on a participant's average. This was particularly important when there were relatively few trials for a condition (e.g. some baseline measures), and it was deemed more consistent to maintain the same averaging for all other conditions.

Following the guidelines explained by Czyzewska and Graham (2008), the facilitation scores for each group of target words (e.g. the five high risk target words) were combined for each separate prime. This meant there were two averages (medians) for each prime. For the risk EPT this was a high risk average and a low risk average. For the affect EPT this was a positive average and a negative average. These two averages were then used to generate an implicit attitude index (Czyzewska & Graham, 2008). This was done by subtracting the high risk average from the low risk average, or subtracting the positive affect average from the negative affect average (depending on which EPT was being analyzed). This index provided an indication of the trend in the data. If the index was a positive number it suggested the participant holds an automatic association of high risk (or positive affect) for that particular prime. A negative index would therefore suggest they hold a low risk (or negative affect) association. The magnitude of the index also indicated the strength of the association. Following the investigations of risk perception, the next set of studies investigated risk-taking behaviour.

3.5 Measuring Risk-taking Behaviour

The use of implicit measures (and explicit measures) provides valuable and useful information regarding perception. While the potential link between perception and behaviour is often claimed there remains the question of whether behaviour is actually changed. This raises the challenge of how best to measure risk-taking behaviour, particularly in a laboratory setting. Several methods have been developed which aim to measure risk-taking behaviour in a systematic and quantified manner. The Iowa Gambling Task involves participants choosing cards from several separate decks with some cards providing gains and others causing losses (Bechara, Damasio, Damasio, & Anderson, 1994). The amount of loss cards varies among the decks so the tendency to focus on some decks more than others as the task progresses is of relevance for analysis. This method has been criticized due to potential confounds among the decks of cards (Chiu & Lin, 2007) but regardless is not appropriate for this project as it cannot easily be modified to measure changes in risk-taking behaviour.

Another card based risk-taking behaviour measure is the Columbia Card Task (Figner, Mackinlay, Wilkening, & Weber, 2009). This method includes versions that claim to measure affect related risk decision making and another that measures deliberative risk decision making. Initially this might seem of particular relevance due to these alternate versions that approximate similar distinctions to the dual process model. This task, however, is more readily used to investigate individual differences or developmental changes. As such, like the Iowa Gambling Task, it is more readily used to measure stable risk propensity, or related stable characteristics. The aim of the current research was to measure risk-taking behaviour changes across a single task, in a somewhat similar manner as the EPT. An increasingly popular risk-taking behaviour measure that showed more potential for this purpose was the Balloon Analogue Risk Task (BART) (Lejuez et al., 2002).

3.5.1 Balloon Analogue Risk Task (BART)

The BART is a computer game style task where participants pump an onscreen balloon and receive points or cash for every pump (Lejuez et al., 2002). At random points the balloon bursts and they receive nothing for that balloon. If they bank the balloon before it bursts they receive the points or cash based on how many times they pumped the balloon. The total points or cash accumulated for all banked balloons is combined to provide the participant's total score or cash reward at the end of the task. As such, the amount of balloon pumps a participant administers is a measure of risk-taking behaviour.

Although it can vary, the randomly generated burst point of each balloon normally averages 64 pumps, with a minimum of one and maximum of 128 (although in practice participants tend to pump each balloon on average around 30 times) (Lauriola, Panno, Levin, & Lejuez, 2014). There are several features that are commonly present when administering the task. These include a pumping noise for each balloon pump and popping noise when a balloon bursts which are included to make the task feel more natural. The screen displays a virtual balloon that gets larger with every pump and there are often counters on screen that show how many pumps have been administered for the current balloon, and a total for how many successful pumps have been collected overall. These counters may show points, cash, or pumps depending on the exact set-up of the task. See Figure 3.3(a) for an image of a typical BART display similar to that shown in Lejuez et al. (2002).

This measure has been shown to have good test-retest validity (White, Lejuez, & de Wit, 2008) and has also been shown to correlate with some real world risk tendencies such as gambling and drug taking (e.g. Fernie, Cole, Goudie, & Field, 2010). Normally the BART is used to measure stable trait-like characteristics of the participant (Lejuez et al., 2002). The BART is a way to rate or gauge someone's general risk propensity using a behavioural measure.

This is a laboratory test that arguably mimics real-world behaviour. Lejuez et al. (2002) successfully demonstrated that performance on the BART correlated with risk measures based on factors such as impulsivity. For this thesis it was necessary to use the BART to measure risk-taking changes in behaviour, as opposed to stable traits. In order to address this issue a new BART was developed that, as with the EPT studies, incorporated priming. To make the priming as equivalent as possible to the EPT studies, this involved a similar brief exposure to the priming object and measurements were taken as short term priming events. As this was a priming version, this new BART variant will henceforth be referred to as the BART-Priming, or BART-P.

3.5.2 Priming Version of the BART (BART-P)

The main purpose of the behavioural measure developed for this research was to capture changes in risk-taking behaviour. Specifically the aim was to measure changes when the participant was exposed to primes in a similar way to the EPT method. This meant creating a hybrid of the EPT and the BART. In the EPT the priming component is claimed to generate an automatic association in memory which subsequently impacts on speed of the target word categorization. For the BART-P the basis was to see if a similar association would cause the participant to take differing levels of risk decision making (based on how many times they pump the balloon).

For the BART-P the prime was shown briefly on screen immediately prior to the balloon. Specifically, the prime (word/term/image) was normally shown for 150ms followed by a blank screen for 50 ms then the balloon was shown. This meant (equivalent to the EPT) that there was an SOA of 200ms which is in line with the contention that shorter SOAs are optimal (Wentura & Degner, 2010). There were some variations in this BART-P SOA among the studies which will be clarified in the Method sections of the BART-P studies. When the balloon appeared the participant completed the process as per the regular BART.

There have been previous variants of the BART that have been developed. For instance, a version designed specifically for adolescents (Lejuez et al., 2007), or a version that used losses rather than gains as the basis (Benjamin & Robbins, 2007). Along with incorporating the priming component there were some other modifications that were made in the BART-P. A minimum burst point (i.e. the amount of pumps before a balloon will burst) of nine was selected, and a maximum of 121. This kept the average at 64 but ensured that no balloon would burst so quickly that it might cause undue caution in the participant. This set-up has been used in other studies previously (e.g. Essex, Lejuez, Qian, Bernstein, & Zald, 2011). The balloon was also displayed with no counters (see Figure 3.3(b)). This was done to ensure that participants approached each balloon as individually as possible which was important as small differences among separate balloons were likely. It was also felt that the counters may encourage participants to simply choose a set number of pumps for each balloon, or allow them to easily increase the pumps, by a small amount, on successive banked balloons. Since the balloon image only increased in size by a small amount for each balloon this made it less likely that participants would know how many pumps they had made each time, and thus their behaviour would be more instinctive.

Many versions of the BART award cash for each balloon pump on successfully banked balloons. These cash awards are then summed and given to the participant at the end of the task. There are some studies, however, that use a points system where the best performers may receive a cash prize but their total is based on the points (Fischer & Hills, 2012). This points system was used in the studies for this research mainly so that participants did not focus too much on what they were 'earning' as they completed the task. This avoided them deciding they had earned enough and therefore banking early, and it meant that they would not know how well they were doing in comparison to others.

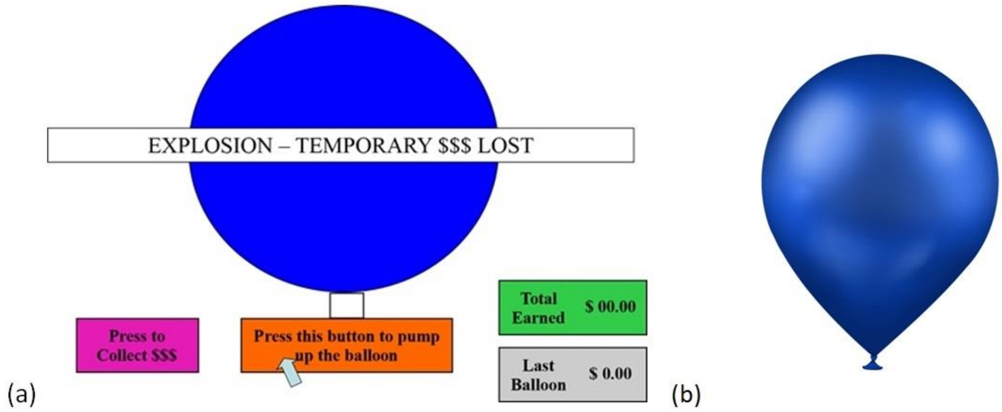
Participants were asked to complete the task as they wished but they knew that the best performers (i.e. most overall pumps for banked balloons and least balloons burst) would receive a cash prize. This encouraged participants to be more risk-taking in general and avoided them simply basing their choices on whether the money they had accumulated was sufficient for them. It is important to clarify that a participant's score was based on all balloons (in both baseline and priming phases). The aim was to encourage a general approach across the entire task which might make participants less likely to modify their approach when primes were included compared to the baseline balloons. This made it more likely that any changes that were detected (i.e. comparing behaviour in the priming phases with the baseline phases) would therefore be due to automatic processing. This also relates to the EPT procedure where participants are asked to categorize as quickly as possible in order to make it more likely that small differences will be measurable. It is also worth noting that the mean amount of balloon pumps across the studies in this research, when combining all phases of administration, was similar to levels reported in previous studies (~30 pumps per balloon) (Lauriola et al., 2014).

The priming component was incorporated in a similar way to how priming is used in the EPT. The primes were briefly flashed on screen before each balloon. After the prime had been shown the participant then completed one trial of the BART-P (i.e. one balloon) in the same way that the BART is normally completed. After the balloon had been either banked or had burst, a new prime was shown and then another balloon. This process continued until all balloons were completed. As with the EPTs, there were also baseline conditions where no prime was shown.

The procedure was administered via SuperLab 5.0 using a Dell PC computer with a 21.5 inch screen, with a Model RB-530 response box. See Figure 3.2 for an image of the response box, including the labels used. Words were shown on screen in Times New Roman 45-point font. When images were included these were displayed with the dimensions were ~300 pixels by ~500 pixels, at 300 dpi, with some light variations based on differing basic shapes.

Figure 3.2: Image of the Model RB-530 response box with labels set-up for the BART-P tasks (Studies 6, 7, and 8). The same box with different labels was used for the EPT tasks.

Figure 3.3: (a) A version of the regular BART display (similar to that provided in the paper by Lejuez et al. (2002)) and (b) the display used in the current thesis.



3.5.3 BART-P Analysis Approach

The original version of the BART normally uses two main measurements. The main one of these is the "adjusted mean pumps" (Lejuez et al., 2002). This is the average of pumps that the participant administered for successfully banked balloons. The overall mean pumps (pumps on all balloons) are rarely used for analyses. One reason for this is that it does not account for times when the balloon bursts which could subsequently influence behaviour. For instance, a participant who only had a few balloons burst compared with someone who had half of the balloons burst cannot be compared without adjustment. The adjustment is that all the data from balloons that burst are ignored. Only the mean of pumps for balloons which were banked were used.

For the BART-P, a similar strategy was used for the main measure of analysis. Rather than the mean, however, the median was used since there were relatively few balloons in some conditions (the lowest being eight). With that amount of balloons there is more chance of vulnerability to outliers or even just one or two extreme trials. Reliability has been shown to be sufficient in the BART with just 10 balloons (Lejuez et al., 2002) so having lower amounts in some conditions was not deemed problematic. In line with the EPT analyses, an average was calculated for the baseline conditions (no prime shown), and then for each prime condition, with baseline average subtracted from each prime average. This produced a “facilitated” version of the “adjusted pumps”, analogous to facilitation in the EPT. This was termed the “facilitated average pumps”, with higher totals meaning the participant took more risks following exposure to the prime compared with baseline.

Another measure that is normally included in reporting of results is the amount of times a balloon bursts. This is normally treated as a secondary measure and of less interest (especially since occasional participants will have very few bursts). Also, the average burst point may vary meaning that some participants have more balloons burst at earlier points than others. It is still worth noting, however, as it provides some indication of times when “too much” risk was taken. For the BART-P, the amount of balloons that burst during the baseline condition trials was subtracted from those that burst during each priming condition. The totals were converted to percentages initially for equivalence as there were differing total balloons in some conditions. As with the pumps, this meant that higher totals meant more risk was taken after exposure to the prime. This measure was termed the “facilitated bursts”.

Comparisons could then be made to find any difference between e.g. the baseline adjusted pumps and the pumps for one of the primes. If the prime pumps were higher, this would suggest that the prime is associated with high risk. If appropriate the results for the primes could be compared to each other but this is not always relevant and comparison to baseline provided a more clearly relevant comparison.

With the methodological approach clarified there is one aspect of the research to clarify in completing this chapter. The final section of this chapter considers the type of sample that was used in the research.

3.6 Sampling Approach

It was decided to use a sample of students for the research. This decision was based on several factors. Firstly it was a convenience sampling approach based on pragmatic reasoning due to the relatively large amount of participants that would be needed to complete the various studies. While no individual study needed a particularly large sample it was necessary to avoid using the same participants for multiple studies. As the studies included priming items and used measures capturing automatic cognitions there would be a potential issue of participants already recognizing the priming items or type of task from a previous study. This recognition, especially given that each study included a debrief that explained the purpose of the tasks, could compromise the interpretations as it would not be clear if participants may be ‘second guessing’ the task aim. For instance, if a participant was aware that their response speed in the EPT was considered a measure of their implicit attitudes to the priming items they might deliberately alter their response due to explicit attitudes. This could leave the findings vulnerable to misleading results or high error rates (i.e. they could delay their responses and subsequently make their categorizations outside of the time thresholds).

The characteristics of the sample also seemed appropriate as young people will continue to face the risks associated with the research contexts (food nutrition and cyber-security) in the future. Providing some perspective on these issues that may remain relevant beyond the short-term makes the research of more value. As mentioned in Section 1.3 there were also other reasons why this type of sample fitted well with investigation of these research contexts (e.g. the potential for biases that could drive notable implicit attitudes). Regardless, by focusing research on one societal group, it meant that any conclusions could be more specific and arguably valid than would be the case if a widely varying set of samples were used. This approach limits the generalisability of the findings but alternatively makes the interpretations of the findings (within the limitations of the population of younger people) more valid.

With the background and methodological approach in place, the following chapter provides the first set of studies.

Chapter 4:
Evaluative Priming Tasks
– Food Nutrition

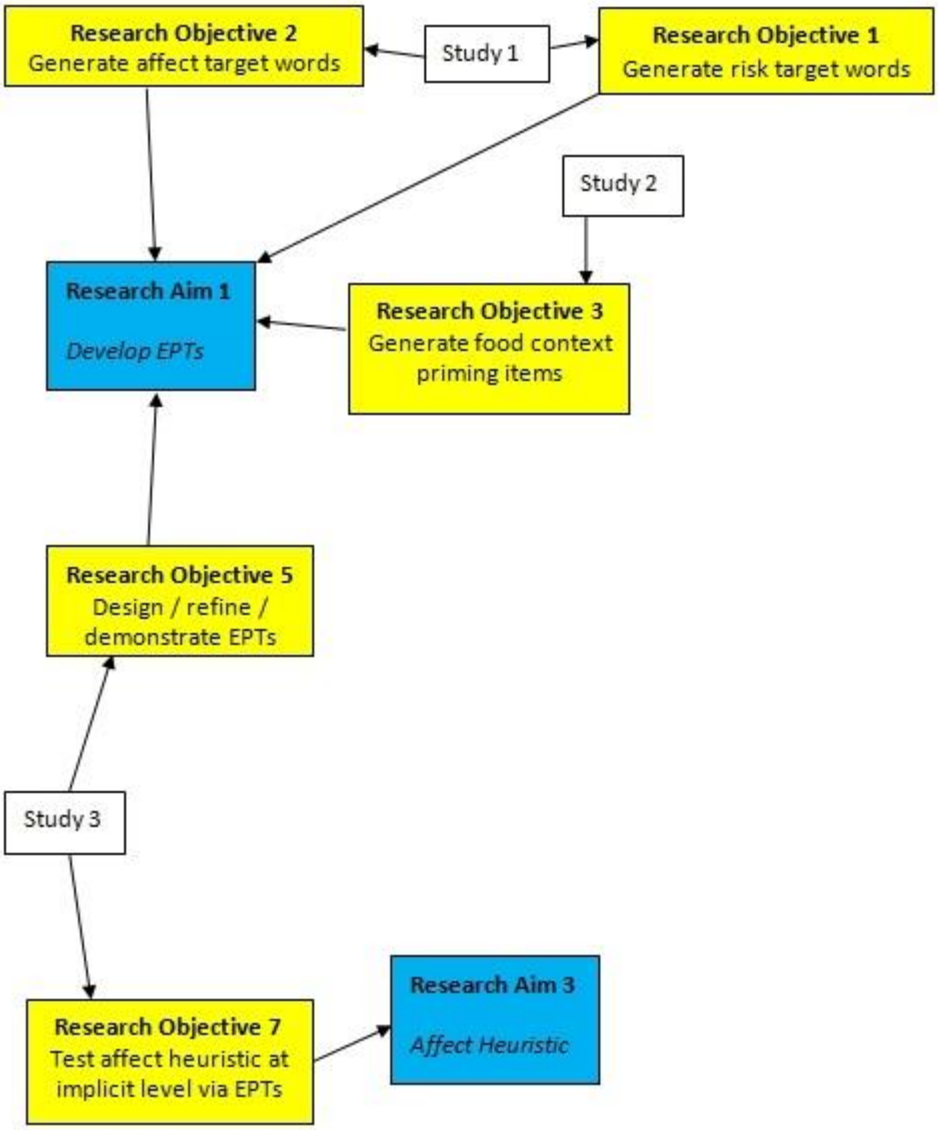
4.1 Introduction

Research Aim 1 of the thesis was the development and demonstration of a novel implicit measure of risk attitudes, along with an implicit measure of affect. The approach chosen was to modify the already established Evaluative Priming Task (EPT) (Fazio et al., 1995). This method has been previously used to measure valence attitudes, and has already been modified in order to measure implicit trust attitudes (Burns et al., 2006). The novel versions that were developed for this thesis constitute the first versions of the EPT that measure risk attitudes and affective attitudes specifically.

In order to meet the demands of Research Aim 1, several research objectives were identified. These objectives were achieved via three studies that are presented in this chapter. See Figure 4.1 for a schematic showing the flow from each study to each research objective, and finally how these objectives combine to meet the demands of Research Aim 1.

Research Objective 1 was that data sets would be generated containing words associated with either high risk or low risk for use as 'target words' in the new versions of the Evaluative Priming Task (EPT). Research Objective 2 was that equivalent data sets would be generated for target words associated with affect. Study 1 achieved both of these objectives and is presented following this section (in Section 4.2). Research Objective 3 was that data sets would be generated containing food products and nutrition labels for use as 'priming items' in the new versions of the EPT. Study 2 achieved this objective and is presented in Section 4.3. Research Objective 5 was that the EPT methods would be designed and demonstrated in the food nutrition context. Study 3 achieved this objective and is presented in Section 4.4.

Figure 4.1: Schematic showing the relationship between the studies conducted (in white), research objectives (in yellow), and research aims (in blue), for Chapter 4.



In order to develop the new EPTs it was first necessary to generate materials that would form components of the EPTs. The EPT requires priming words, terms, or images, along with target words. The procedure involves exposing the participant to a prime before they categorize a set of target words. These target words must be naturally and consistently categorized into one of two categories by most (or ideally all) participants. The original version of the EPT included a set of words that were consistently categorized as either "positive" or "negative" (Fazio et al., 1995). This meant that there were several different target words but each one would be expected to be categorized as meaning either good or bad. For this thesis the main issue in terms of target words was to generate a set of risk-related words that would be consistently categorized as being synonymous with either “high risk” or “low risk”. While the approach for developing an affect version was partly driven by target word generation and also by how the task was administered.

To generate risk-related words that could then be used as the target words for a risk version of the EPT, a questionnaire study was constructed. This questionnaire included 100 words that were associated with risk, with 50 associated with high risk and 50 associated with low risk. The purpose was to find which words from these 100 produced the strongest ratings from participants when they rated each based on risk association. While this only produced explicit attitudes to the words it was nonetheless suitable as all that was required was to generate a set of words that would consistently be categorized in terms of risk. The actual categorization is still an explicit process with the ‘implicitness’ of the measurement based on very small reaction time differences that may occur during the categorization process.

This development was undertaken to contribute new measures that can be used in a variety of contexts where implicit risk attitudes would be relevant. Siegrist et al. (2006) developed an Implicit Association Test (IAT) to measure automatically activated risky and safe associations for cell phone base stations vs. power lines. Siegrist and colleagues pointed out that the IAT is limited because it is a relative measure (i.e. they could only compare implicit risk perceptions of cell phone base stations relative to power lines, and not to any other attitude-objects). Traczyk and Zaleskiewicz (2015) developed an implicit risk measure based on the IAT. This measure, however, is vulnerable to the same criticisms as the original IAT, i.e. the specific context and nature of the items used can produce biased responses with the IAT. When the items used in the IAT are similar (but beyond semantic similarity as the test is supposed to operate), this can bias responses (e.g. De Houwer et al., 2005). The cognitive effort required to switch between pairing types has led to suggestions that the first pairing type will often produce faster responses (Messner & Vosgerau, 2010). While there have been contrasting findings (e.g. Banse et al., 2001; Egloff & Schmukle, 2002), there have also been suggestions that the IAT can be susceptible to faking by participants (e.g. Fielder & Bluemke, 2005; Kim, 2003; Steffens, 2004; Wallaert et al., 2010). The EPT may not be immune to this issue but there have suggestions that it is less susceptible to faking strategies (Degner, 2009).

There are several reasons why the EPT was chosen as the basis for the automatic attitude measure in this research. The various implicit measures available, such as the IAT, AMP, or EPT, often produce weak correlations when directly compared (Bosson et al., 2000; Fazio & Olson, 2003; Hyde et al., 2010) and it has been suggested that researchers should avoid simply using the same measure every time. This could mean using multiple types in one study or ensuring that less common measures are used (Brand & Schweizer, 2015; Townsend et al., 2014). The IAT is the most widely used but this could lead to the problem that there is a lack of contrasting data using other methods (e.g. the EPT or other priming tasks). The EPT has been used extensively so it is not a method that is lacking in representation. It is also definitively based on different procedures than the IAT. A key difference between the IAT (and related measures based on similar principles) and the EPT is that the mechanism in the EPT is more akin to spontaneous evaluative reaction (Brand & Schweizer, 2015; Gawronski & De Houwer, 2014). Given that the aims of the thesis are based on finding just such a reaction in a new domain the EPT also seemed more readily flexible.

While developing and demonstrating the new methods formed the basis of Research Aim1, this also presented an opportunity. Given that there would be two related measures of implicit risk attitudes and implicit affect attitudes, it was then possible to directly investigate the affect heuristic at an implicit level. This is relevant for risk perception research but also for implicit cognition research as emotion or affect often drives implicit or automatic thinking.

Research Aim 3 of the thesis was to investigate the affect heuristic at an implicit level. This aim was met via Research Objective 7 which stated that the new versions of the EPT would be tested for relationships to discern if an affect heuristic effect is evident at an implicit level. Study 3 includes analyses and discussion relating to this objective which is presented within Section 4.4. The approach that was taken was to use an implicit risk attitude measure, and a complimentary implicit affect measure. The results from these two measures could then be compared to discern whether the affect heuristic is evident at an implicit level. Townsend et al. (2014) found that the affect heuristic was more associated with, and predicted by, deliberative (explicit) attitudes and measures. They did concede, however, that the implicit methods they employed could not fully clarify if the affect heuristic may still operate, to some extent, at an implicit level, or that implicit measures may be predictive. To directly investigate the affect heuristic at an implicit level it is necessary to have implicit measures of risk and affect that can then be directly compared. The affect heuristic is also considered a spontaneous process (Slovic et al., 2007), so using the EPT (risk and affect versions) constitutes a suitable approach to take (Brand & Schweizer, 2015; Gawronski & De Houwer, 2014).

The following section (Section 4.1.1) provides some background on the research context for this chapter: food nutrition. Following Section 4.1.1 is the first questionnaire study of this chapter (Study 1 in Section 4.2), the second questionnaire study (Study 2 in Section 4.3), then the first demonstration of the new versions of the EPT are presented (Study 3 in Section 4.4).

4.1.1 Food Nutrition Context

The first context that was used for investigation using the EPTs was food nutritional labelling. This is a topical issue of universal concern and one that is likely to become even more relevant in the future (Apovian, 2010). People will often be exposed to nutrition labels while shopping but this can be a time-constrained activity. The information may also appear complex to some shoppers, while also lacking potentially relevant details (e.g. some labels list nutrients such as salt or sugar on the front of the pack while nutrients such as vitamins are only presented on the back). Kahneman (2011) suggested that limited time, complex information, and information that is lacking detail, can all lead to a reliance on implicit processing. This suggests that investigating nutrition labels using implicit methods would be appropriate and potentially revealing. Nutrition labels could also be described as a form of risk communication so measuring implicit risk attitudes specifically may be informative.

In food health research, the EPT has been successful in measuring recently induced food attitudes using images as both primes and targets (Verhulst, Hermans, Baeyens, Spruyt, & Eelen, 2006). Food likes and dislikes have also been successfully measured using the EPT (Roefs, Herman, MacLeod, Smulders, & Jansen, 2005). Attitudes for participants varying in body mass index (BMI) have been investigated, and restrained eaters compared with unrestrained eaters (Czyzewska & Graham, 2008; Papies, Stroebe, & Aarts, 2009).

An increasingly common approach to nutritional labelling in the UK is the food traffic light system. With the exception of some eye-tracking studies (e.g. Ares et al., 2013), research on the food traffic light system has generally been limited to explicit measures such as questionnaires (e.g. Balcombe, Fraser, & Di Falco, 2010).

The food traffic light system is a format for the labelling of nutritional information on food products but it can also be considered a form of food risk communication. It was developed by the Food Standards Agency (FSA) in the UK in the early 2000s largely as a response to the difficulty many consumers had with previous nutritional information formats (Drichtoutis, Lazaridis, & Nayga, 2006). This system has focused on five main areas of concern for food health: energy/calories, fat, saturated fats, sugars, and salt. Along with numerical details such as the amounts of each nutrient in grams, each of these categories is colour coded (other than energy) with green indicating low levels, amber indicating medium levels, and red indicating high levels of each nutrient (Department of Health, 2013). The FSA calculated these levels based on the recommended daily intake of each nutrient while considering that they would form only part of the overall daily diet. As such, high levels can sometimes constitute less than a third of the recommended daily intake, although in some cases may be much higher.

Research has shown positive results regarding the effectiveness of the food traffic lights system, especially in comparison with other nutrition labelling formats. For example, Jones and Richardson (2007) used eye tracking measures and found that standard nutrition formats are often difficult to understand and result in a lack of focus on the relevant details. These issues were greatly reduced for the traffic light system, and it also enabled more accurate healthiness judgements. Borgmeier and Westenhoefer (2009) suggested that the traffic light system enables better healthiness judgements of foods compared with other formats but argued that it is unlikely to lead to actual changes in food choices. Thorndike, Riis, Sonnenberg, and Levy (2014) in contrast found that foods labelled with colours denoting healthiness (e.g. red as unhealthy, green as healthy) resulted in healthier food choices in a hospital cafeteria. Although this system used colour coding it was a different system to the UK version of food traffic lights.

Dual Process Theories of Thinking (Kahneman, 2011) can be used to explain how people make risk decisions in food choices. System 1 processing consists of quick, intuitive responses that can often be associated with emotion. In contrast, System 2 processing is slower and results in deliberative, consciously controlled responses. Food choices have been considered to be normally governed by System 2 (deliberative) processing (Dieckmann, Dippold, & Dietrich, 2009) but there is some disagreement as nutritional information can be difficult to process (Milosavljevic & Cerf, 2008). This complexity coupled with potential time constraints when making food choices suggests that System 1 (automatic/intuitive) processing may occur more frequently than previously thought as this type of processing is known to be favoured in situations of complexity or time limitations (Kahneman, 2011).

The procedure for generating items for use as primes in the EPT (food packaging and nutrition labels) was to collect potential items from which a smaller set of exemplars could be selected. In order to maintain ecological validity it was necessary to collect real world examples of food products. It was also necessary to collect the relevant food nutritional information for these products so that the relative levels were based on actual levels. Constructing manufactured nutritional information was deemed unsuitable as (along with lacking ecological validity) this could result in labels that might not seem convincing to participants. The labelling that was used was the traffic light system.

4.2 Study 1: Questionnaire Study – Generating Target Words

4.2.1 Introduction

The first task for this questionnaire was to generate the initial set of potential target words. This was done by collecting words via several online thesauruses. The websites used were Thesaurus.com (http://www.thesaurus.com), Collinsdictionary.com (http://www.collinsdictionary.com/english-thesaurus), Onlinethesaurus.co.uk (http://www.onlinethesaurus.co.uk), and Merriam-webster.com (http://www.merriam-webster.com/thesaurus). The key words used were "safe" and "risky" with all synonyms of these collected. From this set a selection was made based on which could reasonably be considered as likely to be familiar to most participants and where the risk association was logical. Some words were considered too obscure and therefore likely to be unfamiliar to many participants, such as "inviolable" (synonym for "safe"). Some were considered as being only loosely related to risk or potentially ambiguous, such as "touchy" (synonym for "risky"). Also some synonyms were phrases, such as "on thin ice" (synonym for "risky"). These could not be used as EPT target words must be individual words.

A limit of 50 was decided for each categorization type (high risk or low risk, "risky" or "safe"). This limit was motivated by a desire to avoid the questionnaire becoming prohibitively lengthy. The questionnaire length was restricted to ensure cooperation from participants (i.e. to avoid participants giving up before completion) but was also based on wishing to avoid task fatigue. If the questionnaire became notably taxing some participants could stop rating the words accurately and instead simply rate randomly for some words. The limit of 50 for each category (100 in total) was also close to the totals collected once inappropriate words had been removed so if a larger set had been sought it would not have been particularly larger than the eventual set anyway.

This set of 100 words was then presented in random order within the questionnaire. Participants were asked to rate their familiarity with the words in order to discount words that were likely to cause confusion when used in the EPT. Participants were also asked to rate the words based on how much they associated each word with either high or low risk, along with how positively or negatively they felt about the words. While the risk ratings were a more obvious requirement it was also useful to collect affective ratings. This meant it was possible to conduct an initial test of the affect heuristic at an explicit level. Although investigating the affect heuristic at an implicit level was the ultimate aim, clarification that such an effect was present based on explicit attitudes was still needed. This also provided an initial baseline of expectation for the subsequent explicit attitudes (including explicit demonstration of the affect heuristic). The EPT studies included a questionnaire so that comparison of explicit and implicit attitudes could be made, and to measure the risk/affect relationship at an explicit level (with the EPT providing the possibility to do this at an implicit level).

Study Aims

1) To generate target words for use within the EPT studies based on associations with high risk or low risk.

2) To investigate the affect heuristic based on explicit risk and affect ratings from questionnaire items.

4.2.2 Method

4.2.2.1 Participants

There were 78 participants in total consisting of fourteen males and 64 females. The mean age was 20 (*SD* = 3.4), ranging from 18 to 44. This was a convenience sample and all participants were undergraduate students, studying Human Resource Management, and received course credits for taking part.

4.2.2.2 Materials

A set of 100 words was generated with 50 consisting of synonyms for “safe” and 50 being synonyms for “risky”. The full list of these words can be seen in Figure 4.2. Appendix 3 also provides the full list along with the mean ratings for risk, affect, and familiarity.

4.2.2.3 Procedure

A link was made available to the online website Qualtrics for the student cohort participants. Demographic information (e.g. age and gender) were also collected. The questionnaire used the 0-100 slider technique as described in Chapter 3. High scores (nearer 100) meant high risk or positive affect. Low scores (nearer zero) were more indicative of low risk or negative affect. For familiarity ratings, scores nearer 100 meant high familiarity. All 100 words were rated for all three rating types. Participants were able to add comments at the end of the questionnaire.

4.2.3 Results / Discussion

4.2.3.1 Target Word Generation

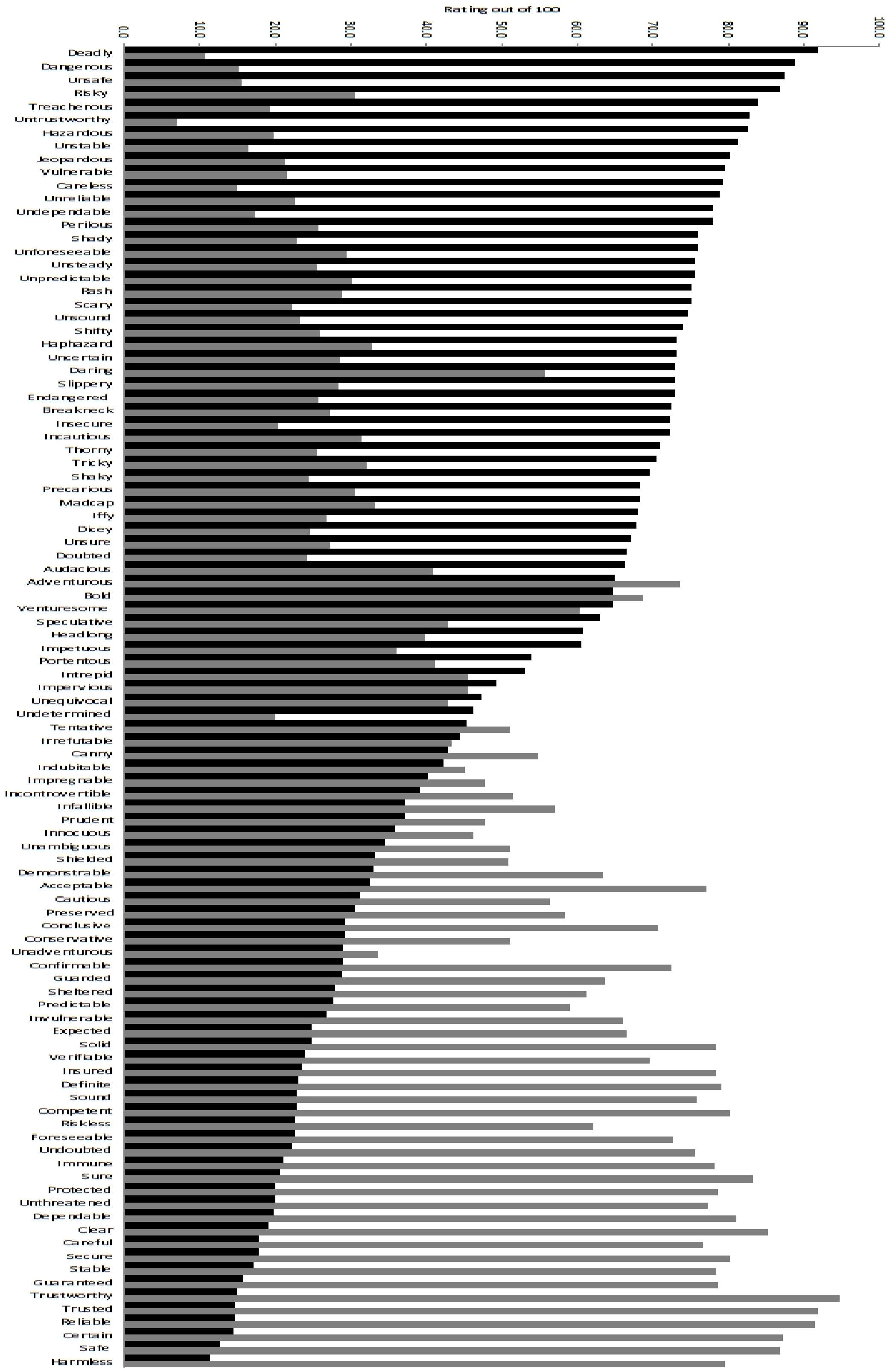
In order to check for age or gender effects, by-subjects analyses were conducted. No such effects were found for age (all $p > .21$), nor gender (all $p > .55$).
The mean risk and affect ratings for all words are presented in Appendix 3 and Figure 4.2. These are presented in order from the highest risk rating to the lowest. As expected, most of the ‘high risk’ words (i.e. synonyms for “risky”) were in the top half of the table meaning they were rated higher for risk. From item 49 (Impervious) to item 52 (Tentative) there is some deviation from this but it should be noted that familiarity ratings are generally lower in the middle of the table. This suggests that participants were unsure how to rate many of these words and tended towards a neutral rating.

Items in Appendix 3 (and Figure 4.2) from item 85 to 100 (denoting strong low risk ratings) were rated above 90 (out of 100) for familiarity. As such, none of these items were considered problematic in terms of potential confusion or ambiguity. For the EPT, five target words were needed within each category (i.e. five high risk and five low risk). The five words with the lowest risk ratings were Harmless, Safe, Certain, Reliable, and Trusted. All of these had high familiarity (95.8 to 97.8) meaning they were very familiar. The affect ratings for these words were between 79.5 and 91.9, meaning they were also rated as positive. One-sample t-tests were conducted and all five words were significantly rated as low risk and familiar (all $p < .001$). There were no other issues that were identified with using these words so they were selected as the 'low risk' target words for use in the EPTs.

The selection of the 'high risk' words was not as straightforward. The word rated highest for risk was *Deadly* but this was considered problematic as one of the contexts that would be used was food health. The next highest word for risk rating was *Dangerous* which was also rated highly for familiarity (97.5). This was considered a viable option. The third word was *Unsafe* and while also rated highly for risk and familiarity this was discounted as it contained the word "safe" within it. As *Safe* was one of the low risk words, this was considered to potentially cause confusion given the speediness of categorization in the EPT. The fourth word was also discounted (*Risky*) because it contained the word "risk" within it. As participants would be asked to categorize based on either "High Risk" or "Low Risk" this presence of the word "risk" was considered potentially problematic. The fifth word (*Treacherous*) had a relatively lower rating for familiarity (77.3) which was considered not ideal given that there were still other options with similar risk ratings that had familiarity ratings above 90. A similar issue was present for the ninth word (*Jeopardous*) so both of these were discounted. The sixth word (*Untrustworthy*) was rated highly for both risk and familiarity. This was discounted, however, as one of the 'low risk' words was *Trusted* and the repeated presence of the word "trust" within both words was considered potentially confusing for participants when categorizing at speed. The words that were next highest in risk ratings (79.2 to 82.5), and that all had high familiarity ratings (91.2 to 96.6) were *Hazardous, Unstable, Vulnerable,* and *Careless*. One-sample t-tests were conducted and all five selected words were significantly rated as high risk and familiar (all $p < .001$). Therefore the five words selected as the ‘high risk’ target words were: *Dangerous*, *Hazardous*, *Unstable*, *Vulnerable*, and *Careless*.

The process for generating target words for the affect version of the EPT was not the same as that for the risk EPT. Dr Russell Fazio, who developed the EPT, provided the lists of target words that they used in their EPT studies. They sent a selection of target word lists generated for the Fazio et al. (1995) paper. These words were based on valence with some personality trait terms included. Words from these that were specifically related to affect were selected. The affect EPT only required words of this sort and the main difference from the original EPT was that participants were asked to categorize based on how the words made them “feel” rather than as simply positive or negative. Some of the words sent were not appropriate for the purposes of the research as they were not specifically related to affect (e.g. honest or intelligent). The words chosen for positive affect were *Delightful*, *Fabulous*, *Great*, *Appealing*, and *Wonderful*. The words chosen for negative affect were *Annoying*, *Awful*, *Disturbing*, *Irritating*, and *Horrible*.

Figure 4.2: Bar graph of all risk-related words based on risk and affect presented in order from highest risk rating to lowest. (Black bars = Risk ratings, Grey bars = Affect ratings).



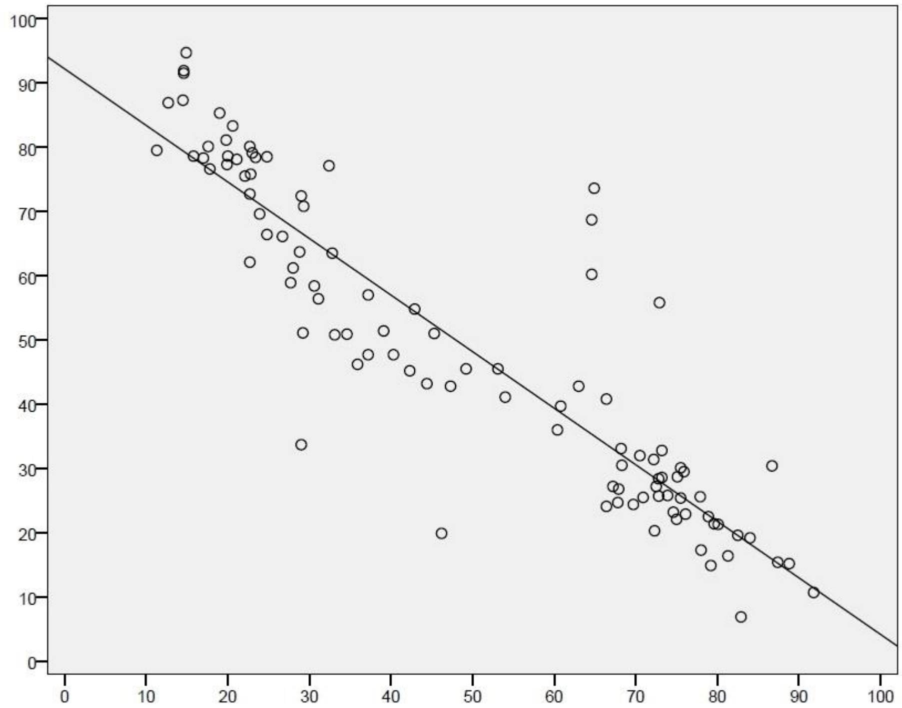
4.2.3.2 Affect Heuristic

The second aim of this study was to conduct an initial investigation of the affect heuristic based on the explicit risk and affect ratings. Figure 4.3 displays a scatterplot of all words, including the line of best fit. This shows that as the risk ratings gradually increase (from low to high risk), the affect ratings gradually decrease (from positive to negative affect). While there are some exceptions to this trend the overall pattern is consistent which suggests that there is a negative linear correlation between the two variables.

In order to clarify this relationship between the two variables correlation analyses were conducted. When combining all 100 items, there was a significant correlation between risk and affect, $r(98) = -.906$, $p < .001$. Since high affect scores meant positive ratings, this correlation showed a relationship between high risk with negative affect, and between low risk with positive affect (in line with the affect heuristic).

Figure 4.3: Scatterplot of all risk-related words based on risk and affect, including line of best fit.

Affect ratings (from zero = very negative, to 100 = very positive)



Risk ratings (from zero = low risk, to 100 = high risk)

4.2.3.3 Summary

The questionnaire provided a systematic process for generating target words that could then be used in the new versions of the EPT. In line with the first aim the risk target words were selected. The high risk target words were Dangerous, Hazardous, Unstable, Vulnerable, and Careless. The low risk target words were Harmless, Safe, Certain, Reliable, and Trusted. The positive affect words were Delightful, Fabulous, Great, Appealing, and Wonderful. The negative affect words were Annoying, Awful, Disturbing, Irritating, and Horrible. These words could reasonably be expected to produce consistent categorizations in the EPTs based on the consistency of ratings from this questionnaire.

The second aim of this study was to provide an initial investigation of the affect heuristic at an explicit level. The results showed a very strong correlation between the risk and affect ratings for the words. This suggests that it is reasonable to expect to find a similar affect heuristic effect based on explicit measurement in the following studies.

This study provided the target words that form part of the EPT studies to follow but those tasks also require priming materials (i.e. priming words, terms, or images). The next study conducted provided priming materials for one of the thesis contexts: food health (specifically food nutritional labelling).

4.3 Study 2: Questionnaire Study - Food Nutrition Labels

4.3.1 Introduction

While the previous study (Study 1) provided target words for use in the EPTs, it was still necessary to generate items for use as primes. These were the items that were flashed on screen prior to the categorization.

Two versions of the questionnaire were designed with one collecting risk ratings for the items and the other collecting affect ratings. This was done because the questionnaire included several additional components that made the overall questionnaire longer than would have been the case if only collecting ratings for the items. These included information regarding shopping habits, attitudes to food health related organizations (such as the Food Standards Authority), dietary restrictions, a personality questionnaire, and trust attitudes to food related organizations (the latter was collected for an unrelated study).

The aim of this study was to generate items for use as primes. It was not possible to investigate the affect heuristic as the risk and affect ratings were collected from different samples.

4.3.2 Method

4.2.2.1 Participants

The initial convenience sample was sourced via postgraduate Business Skills students and resulted in 22 participants for the risk ratings questionnaire, and 18 participants for the affect ratings questionnaire. These samples were deemed of insufficient size so more participants were sourced elsewhere. This was done by posting a link on forums known for including questionnaire link sections. The sites used were Mumsnet (http://mumsnet.com), Netmums (http://netmums.com), and AVForums (http://avforums.com). Additional participants were sourced by sending links via the University of Strathclyde internal email system. The results from the student cohort were compared with the externally sourced participants and no significant differences were found (all $p > .43$).

Once pooled this provided, for the risk ratings questionnaire, a total of 75 participants (15 male and 60 female), with a mean age of 34 ($SD = 8.8$), ranging from 21 to 53. The affect ratings questionnaire had a total of 40 participants (19 male and 21 female), with a mean age of 27 ($SD = 7.7$), ranging from 19 to 57. The postgraduate student cohort received course credits for participation, while all other participants were entered into a cash prize draw for taking part.

4.2.2.2 Materials

A set of 16 food items were collected via the Waitrose supermarket website (Waitrose.com). This site included nutritional details for many items making it possible to find a range of options which could be paired with accurate nutritional labels. Given that ideally some of the eventual primes would potentially produce higher risk associations with others producing lower risk associations, a selection was made that included a mix of items with differing levels of labelling. This meant including items that had multiple red traffic lights, all green lights, or variations therein. There were also some items included due to their labelling differing somewhat from likely expectation. Examples of this were pastry/cake items with no red lights and mostly green lights, or fresh fish fillets that had red lights.

The full list of food products can be seen in Table 4.1 with the relevant traffic light colours included for each component. All products were packaged. The products selected were all ‘own brand’ products from Waitrose (Waitrose, 2014). The reasons behind this were that nutrient details were available and the packaging was consistent across products. Waitrose is also considered a ‘high end’ or more expensive supermarket (“Food and grocery prices”, 2013) so given that the sample included young students it seemed likely that few of the participants would recognize the packaging (none of them did).

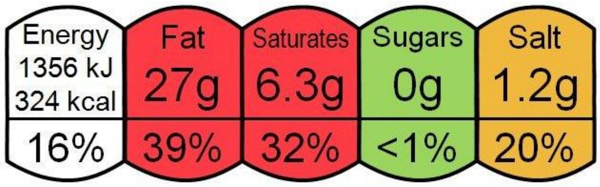
Any details on the packaging, such as the Waitrose logo and already present traffic lights were removed. This allowed for the addition of standardized traffic lights to the products. This made it possible to use accurate nutritional information while keeping the appearance of the labels the same. The UK Department of Health, in conjunction with the FSA, the UK devolved governments, and the British Retail Consortium published guidelines on the standard procedure for creating the traffic lights (Department of Health, 2013). The food product traffic lights were created for this study based on these guidelines to ensure that all images (images that included labels) were in the same format and resolution. The traffic lights were then added to the images of the food products, ensuring that they were all equal in size. See Figure 4.4 for examples of images with and without labels added. Figure 4.5 displays an example label on its own. All three configurations (product with label, product without label, and label only) were rated by participants. Appendix 4 displays all of the products used in this study (with and without labels).

Table 4.1: All food products that were rated with the colours for each food traffic light included.

	Fat	Saturates	Sugars	Salt
Carrots	Green	Green	Amber	Green
Back Bacon	Amber	Amber	Green	Red
Spaghetti Carbonara	Red	Red	Green	Red
Ice Cream Cones	Amber	Red	Red	Green
Tomato Side Salad	Amber	Green	Green	Amber
Apples	Green	Green	Amber	Green
Muffins	Red	Amber	Red	Amber
Mackerel Fillets	Red	Red	Green	Amber
Crumpets	Green	Green	Green	Amber
Spaghetti Bolognese	Amber	Red	Green	Amber
Continental Salad	Green	Green	Green	Green
Mushrooms	Green	Green	Green	Green
Cod Fillets	Green	Green	Green	Green
Beef Burgers	Red	Red	Green	Amber
Ice Lolly	Green	Green	Red	Green
Green Grapes	Green	Green	Red	Green

Figure 4.4: Examples of images displayed in the study for one of the food products: Mackerel Fillets. This includes the image 'without label' (a) and 'with label' (b).

Figure 4.5: Example of the traffic label in isolation for Mackerel Fillets.



4.2.2.3 Procedure

Participants accessed the online website Qualtrics and completed the questionnaire online. Demographic information (e.g. age and gender) were collected. The questionnaire used the 0-100 slider technique with high scores (nearer 100) meaning high risk or positive affect. Low scores (nearer zero) were more indicative of low risk or negative affect. For familiarity ratings, scores nearer 100 meant high familiarity. All 100 words were rated for all three rating types. Participants were able to add comments at the end of the questionnaire.

4.3.3 Results / Discussion

4.3.3.1 Risk Rating Questionnaire Results

Table 4.2 shows the mean risk ratings for all products with separate results for when the product packaging was shown without any food traffic lights (Pack without label), the product packaging was shown with traffic lights on the front (Pack with label), and when the traffic light labels were shown in isolation without the food product packaging (Label only). These figures were initially ranged from zero to 100 but were transformed so that they ranged from -50 to +50. This was done in order to make the results more intuitive since this produced a neutral level of zero with positive numbers meaning 'high risk' and negative numbers meaning 'low risk'. Table 4.2 also includes the results of the difference between packaging shown with and without labelling (column 5). Higher numbers in this column meant that the addition of the label raised the risk rating, and lower (negative) numbers meant that the addition of labels lowered the risk rating. The size of the number (in either direction) was an indication of how much difference there was between explicit risk attitudes to the products and those same products when the relevant nutritional information was present.

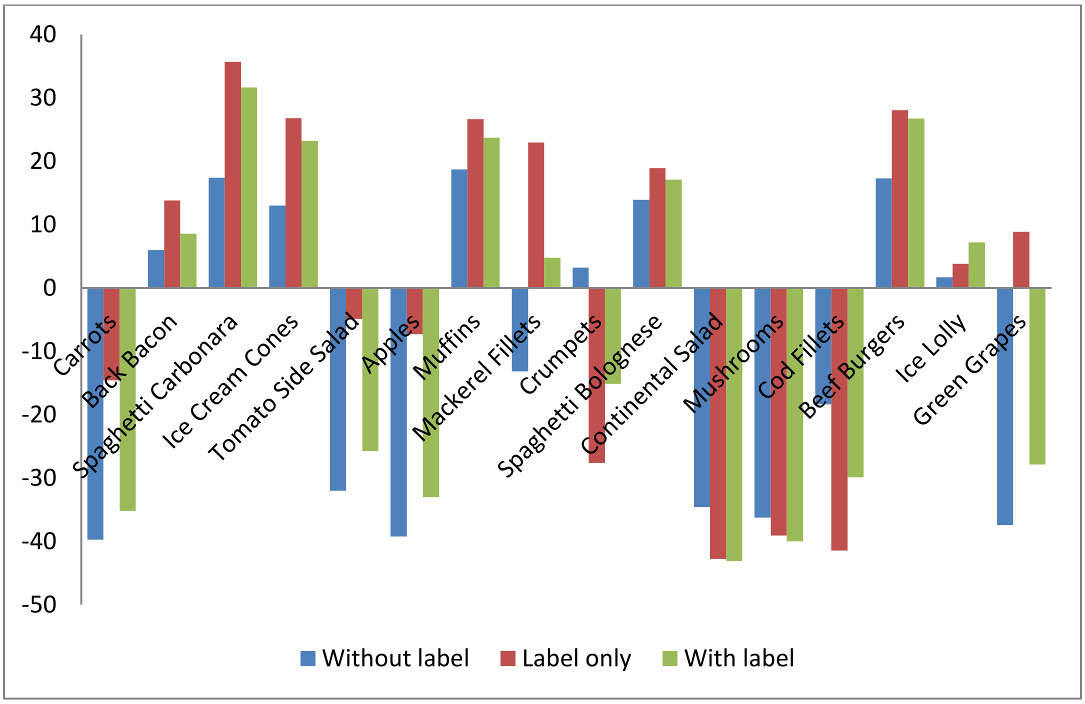
Table 4.2: Mean risk ratings of all food products for product pack without nutritional labelling, labelling alone, and product pack with labelling. (Range from -50/Low Risk to +50/High Risk).

	Pack without label	Label only	Pack with label	Pack with label minus Pack without label (Difference)
Carrots	-39.7	-14.6	-35.2	4.5
Back Bacon	6	13.8	8.6	2.6
Spaghetti Carbonara	17.4	35.7	31.6	14.2
Ice Cream Cones	13	26.8	23.2	10.2
Tomato Side Salad	-32	-4.9	-25.7	6.3
Apples	-39.2	-7.3	-33	6.2
Muffins	18.7	26.6	23.7	5.0
Mackerel Fillets	-13.2	23	4.7	17.9
Crumpets	3.2	-27.6	-15.1	-18.3
Spaghetti Bolognese	13.9	18.9	17.1	3.2
Continental Salad	-34.6	-42.7	-43.1	-8.6
Mushrooms	-36.3	-39.1	-40	-3.7
Cod Fillets	-18.4	-41.4	-29.9	-11.5
Beef Burgers	17.3	28.1	26.7	9.4
Ice Lolly	1.7	3.8	7.2	5.5
Green Grapes	-37.4	8.8	-27.8	9.5

In order to visualize this information the data from Table 4.2 is presented in a bar graph (Figure 4.6). If the bar is above the zero point this means the item rated above neutral for risk (i.e. high risk), and if it was below the zero point it was below neutral (i.e. low risk). Each version (pack without label, label only, and pack with label) is displayed together for each product.

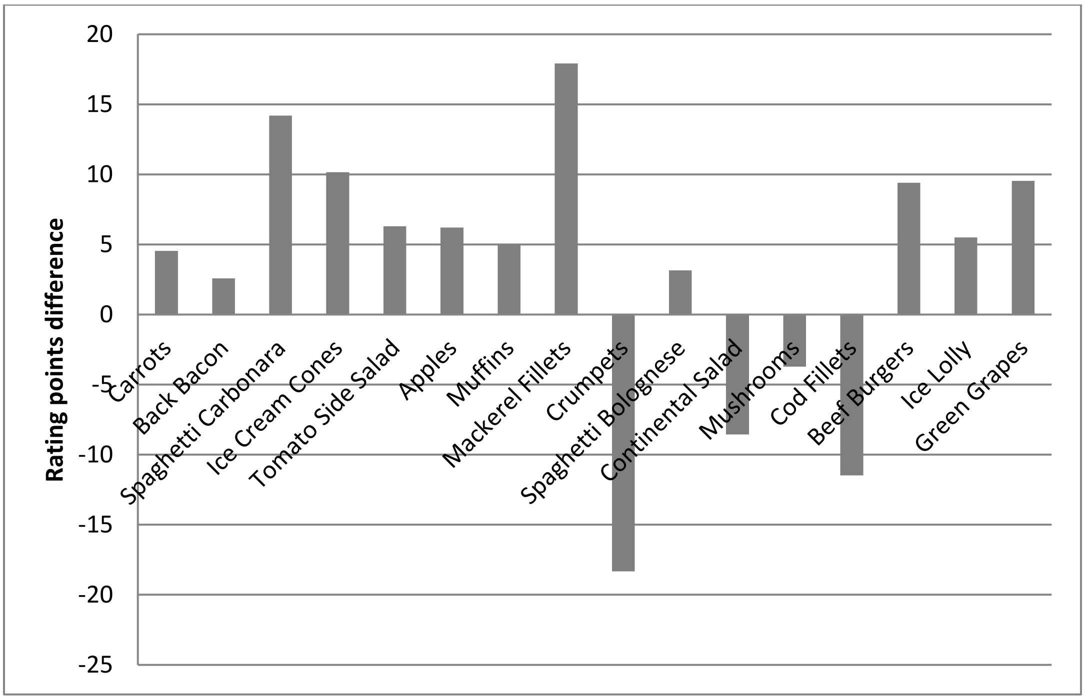
Figure 4.6 shows that Spaghetti Carbonara, Ice Cream Cones, Muffins, Spaghetti Bolognese, and Beef Burgers all seemed reasonably high for risk ratings across all configurations. Carrots, Tomato Side Salad, Apples, Continental Salad, Mushrooms, and Cod Fillets all appeared to have produced relatively low risk ratings. Ice Lolly was relatively neutral for all configurations with the other items showing some variation depending on the configuration (e.g. Mackerel Fillets is below neutral for the product without labelling but above neutral when the labelling is present, with the rating for label only much higher than either).

Figure 4.6: Mean risk ratings for all food products with a neutral level of zero. (Higher levels indicate higher risk ratings).



Of key interest for the aims of the EPT was the difference caused by the presence of food traffic lights on the packaging, given that this is a form of risk communication. In order to visualize this information Figure 4.7 displays the differences between the risk ratings when the packaging included labelling and when no labelling was present on the packaging. Higher numbers indicate that the addition of labelling led to an increase in the risk ratings, while lower (negative) numbers indicated a decrease in risk ratings after labelling was included. The two products showing the biggest difference in terms of a rise in risk rating were Mackerel Fillets and Spaghetti Carbonara. The two products showing the biggest difference in terms of a reduction in risk rating were Crumpets and Cod Fillets.

Figure 4.7: Risk rating differences when products were shown with labels compared with products without labels. (Higher levels indicate addition of label increased the risk rating).



When the information from Figures 4.6 and 4.7 were combined there were certain options that seemed of more interest in terms of generating EPT items with a variety of characteristics. Figure 4.7 particularly highlighted that certain products produced larger risk rating differences (in either direction) after the addition of the labels. One of these (Spaghetti Carbonara) produced the second highest rise in risk rating and also from Figure 4.6 this can be seen as one of the highest overall. Mackerel Fillets produced a large increase in risk rating after labelling was added but this was more mixed overall with only the image with labels version producing an overall risk rating above neutral (without the label this was below neutral). As such, these were selected as the two 'high risk' options for use as primes given that one appeared to be considered high risk with or without labelling whereas the other was only considered high risk when the labelling was added. This latter item (Mackerel Fillets) could be seen as having nutritional information that may go against expectation.

Figure 4.7 also highlighted two products that resulted in greater decreases in risk rating after labelling was added: Crumpets and Cod Fillets. Figure 4.6 shows that Cod Fillets was overall rated as low risk in all configurations. This made Cod Fillets similar to Spaghetti Carbonara in terms of consistency of risk rating but in the opposite direction. Crumpets, in contrast, while producing a decrease in risk rating after labelling was added showed more mixed risk rating overall in Figure 4.6. When no label was present the image of the product produced a slightly above neutral risk rating but this changed to below neutral after labelling was added. This then was analogous to Mackerel Fillets but in the opposite direction. It was decided that a more neutral option would be included and the product that showed the most neutral results across all configurations in Figure 4.6 was Ice Lolly.

4.3.3.2 Affect Rating Questionnaire Results

Table 4.3 shows the mean affect ratings for all products with separate results for when the product packaging was shown without any food traffic lights (Pack without label), the product packaging was shown with traffic lights on the front (Pack with label), and when the traffic light labels were shown in isolation without the food product packaging (Label only). These figures were initially ranged from zero to 100 but were transformed so that they ranged from -50 to +50. This was done in order to make the results more intuitive since this produced a neutral level of zero with positive numbers meaning ‘positive’ affect and negative numbers meaning ‘negative’ affect. Table 4.3 also includes the results of the difference between packaging shown with and without labelling (column 5). Higher numbers in this column meant that the addition of the label produced a more positive affect rating, and lower (negative) numbers produced a more negative affect rating.

Table 4.3: Mean affect ratings of all food products for product pack without nutritional labelling, labelling alone, and product pack with labelling. (Range from -50/Negative to +50/Positive).

	Pack without label	Label only	Pack with label	Pack with label minus Pack without label (Difference)
Carrots	14.6	7.3	19.8	5.2
Back Bacon	6.6	-7.2	0.2	-6.5
Spaghetti Carbonara	-11.1	-24.9	-25.7	-14.7
Ice Cream Cones	0	-21.5	-10.6	-10.6
Tomato Side Salad	6.1	2.1	0.4	-5.7
Apples	15.3	6.6	18.3	3.1
Muffins	-1	-23.4	-10.7	-9.7
Mackerel Fillets	-12	-19.5	-18.6	-6.6
Crumpets	2.7	15	6.7	4.1
Spaghetti Bolognese	-10	-17.8	-18.2	-8.2
Continental Salad	6.9	22.1	16.4	9.6
Mushrooms	5	22.8	13.7	8.7
Cod Fillets	-6.3	25.3	4.2	10.5
Beef Burgers	-0.6	-20	-10.7	-10.1
Ice Lolly	6.6	1.6	0.4	-6.2
Green Grapes	22	-5.5	14	-8.1

Bar graphs were constructed following a similar process and rationale as the risk ratings results. These are shown in Figures 4.8 and 4.9. Figure 4.8 shows that Carrots, Apples, Crumpets, Continental Salad, and Mushrooms produced above neutral (positive) affect ratings across all configurations. Spaghetti Carbonara, Muffins, Mackerel Fillets, Spaghetti Bolognese, and Beef Burgers produced below neutral (negative) affect ratings across all configurations. The other products produced a mixed result. Figure 4.9 shows that three products produced notably high increases in positivity of affect ratings after labels were added: Continental Salad, Mushrooms, and Cod Fillets. Most products produced a more negative affect rating after labels were added. This latter result could potentially be seen as a result of the labelling itself producing a negative response even if the information is relatively benign (e.g. Table 4.1 shows that Tomato Side Salad did not contain any red lights yet the rating was more negative when the label was shown). Figure 4.7 also shows that most risk ratings increased after labels were added albeit these increases were mostly relatively small.

Figure 4.8: Mean affect ratings for all food products with a neutral level of zero. (Higher numbers indicate more positive affect ratings).

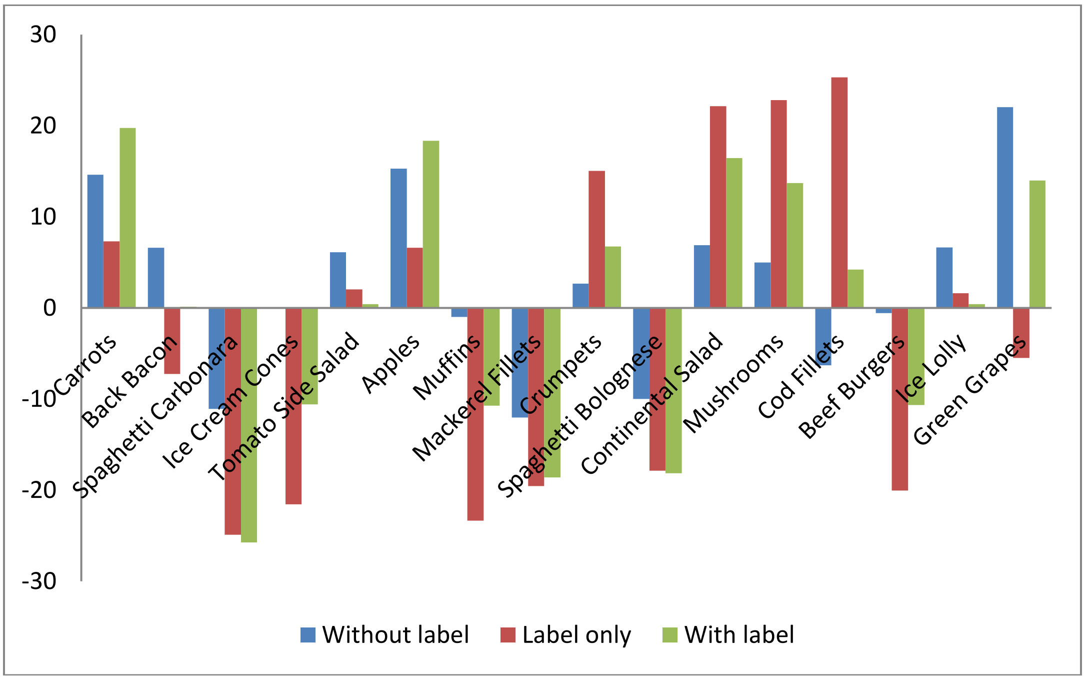
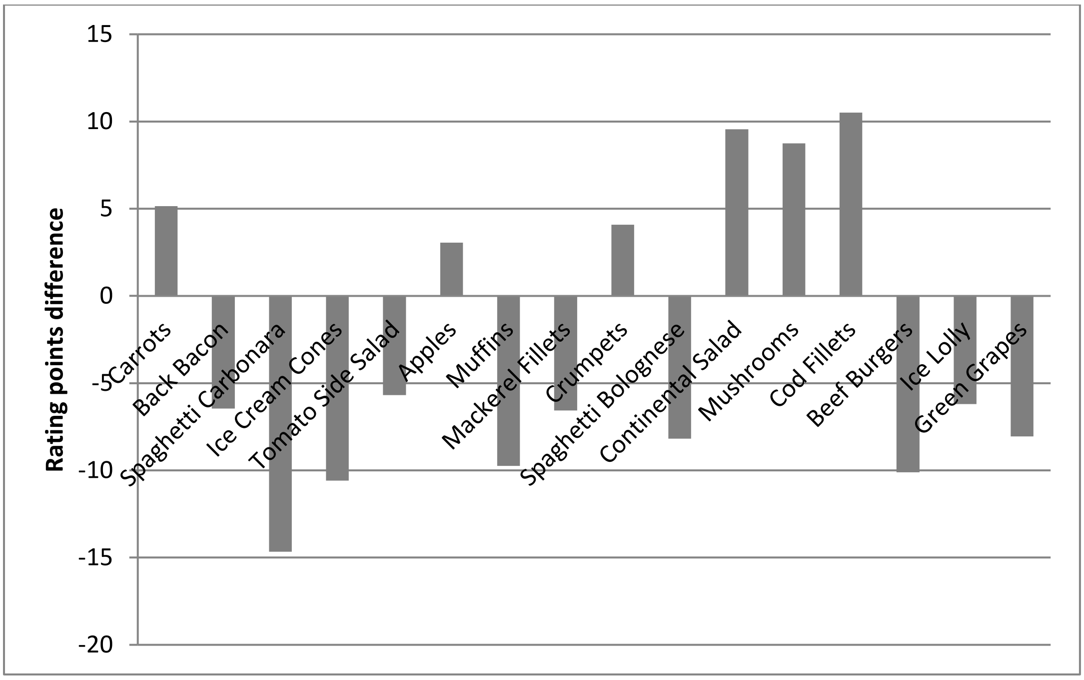


Figure 4.9: Affect rating differences when products were shown with labels compared with products without labels. (Higher levels indicate addition of label resulted in more positive ratings).



4.3.3.3 Conclusions

Given that the more important method development and area of interest was in risk perception specifically, it seemed logical to focus mainly on the risk rating results in order to choose priming items for the EPT. Based on the risk ratings the logical choices were Spaghetti Carbonara, Mackerel Fillets, Cod Fillets, Crumpets, and Ice Lolly. This gave two high risk items, two low risk items, and a neutral item. This also gave one item within each category (high or low risk) that was rated as such regardless of the label being present, with the other item in each category showing a change when the label was added. This change arguably could be seen as an indication that the nutritional information may be somewhat different to expectation. This selection also provided a mix of traffic light colour configurations, including three red lights, two red lights, one red light, and all green lights, with no label that was exactly the same across the products.

Consideration of the affect ratings did not indicate any specific issues with this selection. The two high risk items were also rated as negative overall, and the addition of labels increased how negatively they were rated. One of the low risk items (Crumpets) had overall positive ratings. Also both low risk items were rated more positively when labels were added. The neutral option was also relatively neutral overall in terms of affect rating. As such, these items would be suitable for investigating the affect heuristic (at explicit or implicit levels) despite not being able to test this within this study.

Subsequently, the five items selected for use as primes within the first EPT study were Spaghetti Carbonara, Mackerel Fillets, Cod Fillets, Crumpets, and Ice Lolly. With the target words generated from Study 1 and the priming items generated from this study it was now possible to design and construct the first EPT, investigating food nutritional labelling.

4.4 Study 3: Food Nutrition Labels EPT

4.4.1 Introduction

This study met the initial demands of Research Objective 5. It provides the first demonstration of the developed versions of the EPT that measure implicit risk and affect attitudes. The context used for this first demonstration was food nutrition (specifically nutrition labels in the form of food traffic lights). Using the materials generated from Studies 1 and 2, these new measures can provide a valuable new resource in the field of risk research and broaden the scope of implicit risk research approaches.

Study Aims

1) To develop EPT measures of risk and affective attitudes toward food products and use these along with explicit measures to investigate the role of food traffic lights on risk attitudes to food.

2) To use explicit and implicit measures to investigate the affect heuristic, with and without food traffic light risk information.

4.4.2 Method

This study consisted of three parts: priming tasks, a questionnaire, and an interview. The priming tasks measured participants' implicit risk and affective attitudes towards the same food products. The questionnaire measured participants' explicit risk and affect towards a set of food products. A short informal interview was used to clarify participants' explicit attitudes, to discern any additional relevant information, and to ensure instructions had been understood.

Participants were randomly allocated to one of two conditions, which involved viewing the images with or without traffic lights. In the 'without traffic lights' group, the order of rating types was counterbalanced so that an equal number of participants completed the risk priming task first as those who completed the affect priming task first. This group was also counterbalanced so that half of the participants completed the priming tasks first, and half completed the questionnaire first. The ‘with traffic lights’ group was similarly counterbalanced although all completed the priming task first. This was because completing the questionnaire first would have provided key information on the traffic lights which could then have resulted in confounds. No order effects were found based on these variations. Following the completion of all sections, participants were fully debriefed.

4.4.2.1 Participants

The participants were 64 undergraduate students (studying Human Resource Management) who received course credits for their participation. They were randomly allocated to one of two conditions: ‘images with traffic lights’ and ‘images without traffic lights’, with 32 participants in each condition. In the ‘with traffic lights’ condition, there were five males and 27 females, with mean age of 19.8 years ranging from 18 to 22 years (*SD* = 1.3). The ‘without traffic lights’ condition included 11 males and 21 females, with mean age 19.8 years ranging from 18 to 24 years (*SD* = 1.4). This was a convenience sample but 18 to 24 year olds were also considered an appropriate sample as they were likely used to seeing traffic lights and given their youth, were a relevant population when considering what future attitudes may be to the traffic light system.

4.4.2.2 Materials

Based on the results from Study 2, the five food products that were selected for use in this study were Mackerel Fillets, Crumpets, Ice Lolly, Cod, and Spaghetti Carbonara.

4.4.2.3 Questionnaire

The questionnaire measured risk attitudes and affective attitudes based on explicit ratings of the food product images. The risk items required participants to rate the images based on how they would most accurately categorize them on a 6-point scale (1 = Very Low Risk, 2 = Moderately Low Risk, 3 = Somewhat Low Risk, 4 = Somewhat High Risk, 5 = Moderately High Risk, 6 = Very High Risk). The affect items were identical but with different rating choices (1 = Very Negative, 2 = Moderately Negative, 3 = Somewhat Negative, 4 = Somewhat Positive, 5 = Moderately Positive, 6 = Very Positive). Other details, such as any foods participants do not eat were also collected.

The questionnaire was completed in a private room during the same session as the priming tasks. Participants were given as much time as required to complete the questionnaire but no participant took longer 15 minutes. The questionnaire was completed using the online website Qualtrics. All instructions were given on screen but the experimenter reminded participants that they could take as long as they needed to complete the questionnaire.

4.4.2.4 Interview

Short interviews were conducted after the EPTs and questionnaire had been completed. Initially participants were asked if they had any specific issues while completing the earlier tasks and had understood what they had to do. Participants were asked if they had any problems categorizing the target words, such as not knowing what any words meant. Participants were also asked if they had ever participated in an implicit task before, and if they could work out what the EPT tasks were measuring. They were asked if considered any of the food products to be particularly indicative of high or low risk, and what they thought risk meant in this context. They were asked if there were any personal reasons (such as food allergies or dietary restrictions) that influenced their attitudes. Participants were then asked if they were familiar with the traffic light system, how well they understood the system, and which aspects of the system tended to drive their attitudes. After these questions they could add any further comments freely. Notes were taken of their responses and this information was used to identify key issues, trends, or common responses.

4.4.2.5 Priming Task

Two different priming tasks were developed for this study so that implicit attitudes towards both risk and affect could be measured. They were both variants of Fazio et al.'s (1995) Bona Fide Pipeline. One task measured implicit affect toward the food products, largely as per Fazio et al.'s (1995) method. Unlike Fazio et al. (1995) this version specifically measured affect attitudes rather than general valence attitudes. The other task measured implicit risk attitudes toward the food products.

In each version of the task, participants were briefly shown a prime (food product image) and then had to categorize a subsequently displayed target word. The target words were selected based on the findings from Study 1. Participants were instructed (via on screen instructions) to base their categorizations either on "how the terms made them feel" (affect version), or "how much they associated the terms with high or low risk" (risk version). This meant both versions diverged from the original Fazio et al. (1995) study format. The number of primes and target words were limited in order to avoid participants becoming fatigued during the tasks.

Each priming task involved three phases: a baseline phase, a priming phase, and a recognition memory test. The purpose of the first phase was to obtain baseline data for the target words. Here, participants classified a target word as either high / low risk or good / bad (depending on which version of the task they were completing). The second phase was the priming task. In each trial, a food product image flashed on screen followed by a target word. The participants had to pay attention to the image but judge the meaning of the target word. The last phase consisted of a recognition memory test and was included to ensure participants had followed instructions to pay attention to the primes in the priming phase.

Following the procedure used by Fazio et al. (1995), each food product image was displayed in the centre of the screen for 315 ms then the screen was blank for 135 ms, followed by the target word which the participant had to categorize. This meant the stimulus onset asynchrony (SOA) was 450 ms. There have been suggestions that SOAs are optimal at lower intervals (e.g. 200ms or lower) (Wentura & Degner, 2010) but given the amount of information in the images (picture of food, name of food in text, and traffic lights) it was deemed appropriate to maintain this longer SOA. The priming phase consisted of five blocks with each target word categorized once within each block. Also within each block all primes were shown twice, with them being followed by one target word from each category. All pairings of prime and target word were included over the entire task. The order of presentation within each block was generated randomly.

The baseline condition was identical to the priming condition but with a row of asterisks instead of the image prime. Each baseline reaction time was calculated based on two blocks of 10 trials which were administered before the priming trials (i.e. each target word shown twice). The baseline phase was conducted after some practice trials. The recognition memory test required participants to indicate whether they had been shown an image from a set of 10 (the five images that were shown and five filler images). The purpose of this was to ensure that participants had paid attention to the prime images during the task. Analyses of the memory tests showed that participants paid sufficient attention to the primes.

4.4.2.6 Equipment

The priming task and questionnaire were conducted on a Dell PC computer with a 21.5 inch screen. The priming task was designed and administered via Super Lab version 4.5. The images were shown on the centre of the screen and the dimensions were ~300 pixels by ~500 pixels, at 300 dpi, varying based on differing basic shapes. The target words were also shown on the centre of the screen in Times New Roman 45-point font. Participants used a Model RB-530 response box which included buttons labelled Yes and No, along with either High Risk and Low Risk, or Good and Bad, depending on the task version.

4.4.3 Results

4.4.3.1 Detection Data

Participants were instructed to always pay attention to the prime items during the priming phase. They were told that there would be a recognition memory test at the end which would ask them to identify which items they had seen. This test included filler items, along with the actual prime items, and participants had to state whether each item had been shown to them or not. The results were checked in order to ensure that participants had paid sufficient attention during the task. Following Fazio et al. (1995) this was done by subtracting the proportion of times the participant had incorrectly identified a filler as having appeared from the proportion of times they correctly identified items that were shown. Chance level performance would result in a score of zero with perfect performance resulting in a score of one. A one-sample t-test revealed participants' mean score to be .86 (SD = .18) which was significantly above chance, $t(63) = 37.41$, $p < .001$, 95%CI [.82-.91].

4.4.3.2 Preliminary Analyses

No significant or problematic differences were found between the questionnaire ratings or scores from the priming tasks based on gender, nor with task order. The same was true for associations with native language (i.e. native language was English or not), and food preferences (e.g. vegetarians and non-vegetarians). No associations were found between the ratings / scores and age.

The questionnaire included personality tests in the form of the Ten Item Personality Inventory (Gosling et al., 2003). This measure was chosen as it is quick to administer so would not increase the length of the questionnaire to a prohibitive extent. This measure is based on the Five-factor model with two items for each factor. One weakness, however, of this test in comparison with longer personality measures is that it can only provide an indication of personality traits (Gosling et al., 2003). Analysis of the results in relation to the main results (e.g. risk ratings) produced no significant relationships.

4.4.3.3 Relationship between Explicit and Implicit Measures

In order to investigate the relationships of the explicit measures (questionnaire) and implicit measures (priming task), correlation analyses were conducted for each category (risk and affect) separately. Table 4.4 contains the results of these analyses. As expected, no associations were found for any of the combinations. This suggests that the implicit risk and affect priming tasks measure separate processing constructs from the corresponding explicit measures. Based on previous studies (e.g. Fazio & Olson, 2003), this lack of correlation provides a preliminary validation of the implicit measure.

Table 4.4: Pearson correlation results when comparing explicit results (questionnaire) and implicit results (priming task) for combinations of risk or affect when images were shown with traffic light nutrition information or without.

	Rating type	*r*	p-value	N
Images with Traffic Lights	Risk	.147	.068	156
	Affect	-.084	.292	160
Images without Traffic Lights	Risk	.141	.077	158
	Affect	.137	.088	157

4.4.3.4 Questionnaire Data (Traffic Lights)

Initial analyses were carried out by gathering descriptive statistics of the data. See Table 4.5 for the means and standard deviations for the risk questionnaire results with and without traffic lights condition, and Table 4.6 for the affect questionnaire results.

Table 4.5: Means and standard deviations (*SD*) for the risk questionnaire ratings when participants viewed food product images with or without traffic light nutrition information.

		Mean	*SD*	N
With Traffic Lights	Mackerel	3.7	1.49	32
	Crumpets	2.88	1.45	32
	Ice Lolly	3.66	1.64	32
	Cod	1.38	0.83	32
	Spaghetti Carbonara	5.34	1.1	32
Without Traffic Lights	Mackerel	2.47	1.11	32
	Crumpets	2.81	1.91	32
	Ice Lolly	3.03	1.64	32
	Cod	2.28	1.46	32
	Spaghetti Carbonara	3.19	1.53	32

(Range 1-6)

Table 4.6: Means and standard deviations (*SD*) for the affect questionnaire ratings when participants viewed food product images with or without traffic light nutrition information.

		Mean	*SD*	N
With Traffic Lights	Mackerel	3.38	1.36	32
	Crumpets	4.47	1.44	32
	Ice Lolly	4.03	1.71	32
	Cod	5.22	1.1	32
	Spaghetti Carbonara	2.38	1.86	32
Without Traffic Lights	Mackerel	3.44	1.66	32
	Crumpets	4.19	1.47	32
	Ice Lolly	4.87	1.54	32
	Cod	3.41	1.56	32
	Spaghetti Carbonara	4.22	1.48	32

(Range 1-6)

From Table 4.5, Mackerel, Spaghetti Carbonara, and to a lesser extent Ice Lolly reveal higher risk scores when the nutritional information (traffic light labels) is added. Conversely, the risk score for Cod reduces when the nutritional information is added. This is in line with what was anticipated based on prevalence of red or green lights. From Table 4.6, Spaghetti Carbonara and again to a lesser extent Ice Lolly reveal more negative affect judgements when the information is present. Cod also shows a slight increase in positive affect judgements when the information is present. As with the risk judgements, these trends are in line with expectations.

In order to test the differences based on presence of traffic lights, independent-samples t-tests were conducted (see Table 4.7). Mackerel and Spaghetti Carbonara showed significantly higher risk scores when the traffic lights were present, while Cod showed lower risk scores. For affect judgements, only Cod and Spaghetti Carbonara showed a significant difference (with Ice Lolly marginally non-significant and more negative with traffic lights included). In line with expectations, Cod was judged as more positive when traffic lights were present, and Spaghetti Carbonara as more negative.

Table 4.7: Questionnaire Independent samples t-test results for all food products (both Risk and Affect judgements) based on differences between 'with traffic lights presented' and 'without traffic lights' conditions.

	t-stat	p-value	df	Mean Diff	95% CI of diff	
RISK						
Mackerel	3.82	**<.001**	62	1.25	0.595	1.91
Crumpets	0.15	.883	62	0.06	-0.79	0.91
Ice Lolly	1.53	.132	62	0.63	-0.19	1.44
Cod	-3.04	**.003**	62	-0.91	-1.502	-0.31
Spaghetti Carbonara	6.48	**<.001**	62	2.16	1.49	2.82
AFFECT						
Mackerel	-0.16	.87	62	-0.06	-0.82	0.697
Crumpets	0.77	.442	62	0.28	-0.45	1.01
Ice Lolly	-1.84	.07	62	-0.75	-1.56	0.06
Cod	5.37	**<.001**	62	1.81	1.14	2.49
Spaghetti Carbonara	-4.39	**<.001**	62	-1.84	-2.68	-1.004

(Range 1-6)

4.4.3.5 Interview Data

Participants were asked to state if they had any issues or confusion while performing the tasks. Three participants stated they were initially confused but this was alleviated after the practice trials. No other participant specified having any issues or confusion. No participant stated that they had problems understanding the meaning of any of the words or how to categorize them. Two participants asked for clarification due to lacking confidence on this point but their understanding of the word meanings was correct. No participant had ever taken part in an implicit task before and none of them guessed the true aim of the priming tasks. While some participants found performing all the tasks in one session a long process, no one specifically stated that they found any individual priming task long.

Only six participants specifically said they would tend to think of any of the food products as high or low risk. All of these participants said they were thinking in terms of food poisoning or illness due to food not being kept fresh. No one provided details regarding dietary issues that they did not also include in the questionnaire (no effects were found based on dietary restrictions from the questionnaire data). Most participants (46) said they were familiar with the food traffic light system. Only 20 of these said they had a good understanding of how the system specifically worked beyond colour coding as high/medium/low. All participants (including those who said they were not previously familiar with the system) said they now understood how they worked after the tasks. Several participants (23) suggested that they were largely influenced by the presence of red lights. Some comments included, “I only really noticed red lights”, and “I would avoid a product with a red light. It would make me think I was going to overeat”. No other common themes emerged from the interviews although six participants did say that they already knew that Crumpets were not “unhealthy” with one saying it was a known “treat for people on a diet”.

4.4.3.6 Priming Task Data (Traffic Lights)

Facilitation scores were calculated following the procedure described by Fazio et al. (1995) (see Section 3.4.3.3 for a description of this calculation). The response time for each trial in the priming task (i.e. when a specific image was displayed) was subtracted from the baseline condition (no prime shown) for the corresponding target word resulting in a facilitation score. The latencies for trials on which participants did not respond or made an error were not included in the calculation (mean of 4.4% trials per participant).

Following the procedure of Czyzewska and Graham (2008), the median facilitation score for each prime was calculated for each group of target word (i.e. high risk / low risk targets for the risk priming task) for each participant. Accordingly, this resulted in two median facilitation scores (i.e. high risk and low risk for the risk priming task) for each prime for each participant. The high risk facilitation score was then subtracted from the low risk facilitation score to produce an implicit attitude index (Czyzewska & Graham, 2008). This implicit attitude index indicates the general trend in the responses. For example, in the risk priming task, a positive index indicates an automatic association of the prime with high risk, and a negative index indicates an automatic association of the prime with low risk. The magnitude of the index indicates the strength of that association. A similar process was carried out for the affect data, with a positive index indicating an automatic association of the prime with positive affect, and a negative index indicating an automatic association of the prime with negative affect. The average index score for each prime was then calculated.

Table 4.8 reports the means and standard deviations (SDs) for the risk index scores from the priming task in the with and without traffic lights conditions, and Table 4.9 reports the priming task affect index scores. From these averages, Mackerel appeared to score higher for risk when the traffic lights were present. To a lesser extent, a similar trend was shown for Spaghetti Carbonara and Ice Lolly. The affect scores appear to show more positive judgements for both Cod and Spaghetti Carbonara.

Table 4.8: Means and standard deviations (*SD*) for the risk attitude index scores (in the priming tasks) when subjects viewed food product images with or without traffic light nutrition information.

		Mean (ms)	***SD***	**N**
With Traffic Lights	Mackerel	86.3	143.4	32
	Crumpets	73.5	203.2	31
	Ice Lolly	117.6	222.1	31
	Cod	64.6	198.3	32
	Spaghetti Carbonara	128.4	201.2	30
Without Traffic Lights	Mackerel	-28.3	195.2	32
	Crumpets	88.2	173.2	31
	Ice Lolly	55.1	217.3	32
	Cod	72.6	198.1	31
	Spaghetti Carbonara	32.7	211.9	32

Higher risk averages denote higher (more) risk attitude scores.

Table 4.9: Means and standard deviations (*SD*) for the affect attitude index scores (in the priming tasks) when subjects viewed food product images with or without traffic light nutrition information.

		Mean (ms)	***SD***	**N**
With Traffic Lights	Mackerel	-14.7	157.4	32
	Crumpets	21.7	142.9	32
	Ice Lolly	-3.3	131.3	32
	Cod	-18.2	114.2	32
	Spaghetti Carbonara	23	134.9	32
Without Traffic Lights	Mackerel	-42.7	179.9	32
	Crumpets	-42.1	73.5	31
	Ice Lolly	-14.9	102.4	31
	Cod	-36.1	132	32
	Spaghetti Carbonara	-51.3	122.4	31

Higher affect averages denote more positive attitude index scores.

In order to investigate any differences between the conditions (with or without traffic lights) in the priming task data, independent-samples t-tests were conducted. See Table 4.10 for all results across both risk and affect conditions.

Table 4.10: EPT Independent samples t-test results for all food products (both Risk and Affect judgements) based on differences between 'with traffic lights presented' and 'without traffic lights' conditions.

	t-stat	p-value	df	Mean Diff	95% CI of diff	
RISK						
Mackerel	2.68	**.009**	62	114.6	29.1	200.2
Crumpets	-0.31	.76	60	-14.7	-110.6	81.2
Ice Lolly	1.13	.263	61	62.5	-48.2	173.2
Cod	-0.16	.873	61	-8.01	-107.9	91.9
Spaghetti Carbonara	1.82	.074	60	95.7	-9.4	200.8
AFFECT						
Mackerel	0.66	.509	62	28.1	-56.4	112.5
Crumpets	2.22	**.03**	61	63.7	6.2	121.3
Ice Lolly	0.39	.697	61	11.6	-47.8	71.04
Cod	0.58	.565	62	17.9	-43.8	79.5
Spaghetti Carbonara	2.29	**.026**	61	74.3	9.3	139.3

The only significant difference within risk comparisons was Mackerel, with the product categorized as higher risk in the 'with traffic lights'. Spaghetti Carbonara also showed higher risk results but was marginally non-significant. In the affect condition, only Cod and Spaghetti Carbonara showed significant differences with both categorized as more positive when traffic lights were present. All the above results are in line with expectations other than the affect result for Spaghetti Carbonara.

4.4.3.7 Questionnaire Data (Risk and Affect)

In response to the second aim, the expected associations of high risk with negative affect, and low risk with positive affect were found for explicit measures. The strength of this was higher when traffic lights were present, and was evident for implicit measures in this 'with traffic lights' condition only.

Correlation analyses were conducted on the questionnaire data to investigate the relationship between risk and affect in each traffic light condition. The data from all food products were combined in order to calculate an overall correlation coefficient for each condition. The results are shown in Table 4.11, and indicate a moderate to strong relationship for the 'with traffic lights' condition, and a weaker but also significant relationship for the 'with traffic lights' condition.

Table 4.11: Pearson correlation results when comparing risk and affect ratings in questionnaire.

	r	**p-value**	**N**
Images with Traffic Lights	-.592	<.001	160
Images without Traffic Lights	-.305	<.001	160

4.4.3.8 Priming Task Data (Risk and Affect)

Correlation analyses were conducted on the priming task data to investigate the relationship between risk and affect in each condition. The results are shown in Table 4.12, and indicate a significant relationship for the 'with traffic lights' condition but no relationship for the 'with traffic lights' condition.

Table 4.12: Pearson correlation results when comparing risk and affect attitude index scores in the priming tasks.

	r	**p-value**	**N**
Images with Traffic Lights	-.246	.002	156
Images without Traffic Lights	.042	.603	155

The expected associations of high risk with negative affect, and low risk with positive affect were found for explicit measures. The strength of this was higher when traffic lights were present, and was evident for implicit measures in this 'with traffic lights' condition only. This provided a demonstration of the affect heuristic at an implicit level.

4.4.4 Discussion

The first main aim of the thesis was to develop and demonstrate two novel implicit risk methods. The first of these methods was an implicit risk attitude measure, and this study provides the first demonstration of that method (as developed from the EPT). The second main aim of the thesis was to investigate the affect heuristic at an automatic (implicit) level, and this study provides the first such investigation. This section will discuss both of these aims but initially will discuss the context which was used for this demonstration. This context was food health (specifically nutritional labelling).

4.4.4.1 The Food Traffic Light System

In this study, differences were found based on the presence or absence of the food traffic lights for explicit measures (questionnaire data) of risk and affect. Both Mackerel and Spaghetti Carbonara showed higher ratings of risk perception when the traffic lights were included compared with when they were absent. In the design of the study the food products were selected based on various characteristics. Among these was whether the traffic lights were likely to meet expectations. Both Mackerel and Spaghetti Carbonara contained multiple red lights (denoting high levels) but this was contrary to expectations for Mackerel only. The fact that both showed an effect may suggest that the presence of red lights (at least multiple red lights) may be sufficient to influence explicit risk perception. Previous studies have suggested that people do tend to focus mainly on red lights when considering traffic light information (e.g. Balcombe et al., 2010; Hieke & Wilczynski, 2012). The interview data also showed that for many participants it was the presence of red lights that was the main driver of their risk attitudes.

The questionnaire results also revealed that Cod tended toward lower risk perceptions when the traffic lights were present. This can be explained based on similar characteristics as above since Cod contained all green lights (low levels). This was not deemed contrary to participants' likely expectations but possibly the presence of all green lights was nonetheless sufficient to produce the effect. Crumpets also had all green lights yet did not show an effect. Based on comments in the interviews, this is possibly due to some participants being more aware of the likely nutrient levels in Crumpets than was expected. This cannot be clarified, however, as only a small minority of participants mentioned this knowledge of Crumpets. Ice Lolly also showed no effect but this was expected as it was included as a neutral option.

For explicit affect, when traffic lights were present, more positive perceptions for Cod were found, and more negative perceptions for Spaghetti Carbonara only. This perhaps demonstrates that affect can also be impacted by traffic lights but in a less consistent manner and requires further investigation.

For the implicit risk measures (EPT tasks), the only difference found was for Mackerel. Specifically, when traffic lights were present, Mackerel yielded a higher implicit risk attitude index than when they were absent. As with the questionnaire data results, part of the reason may be the presence of multiple red lights. Since, however, the priming task results did not show the same effect for Spaghetti Carbonara, it may be that the potentially unexpected presence of the red lights (as perceived by the participants) may have added to the effect. It is not clear if this is possibly due to the implicit effect simply being smaller, or if this is due to the sensitivity of the implicit measure. Certainly, further research is needed but it does seem that food traffic lights can automatically activate perceptions of risk. It is also worth noting that while most participants stated they were familiar with the traffic light system in the interviews, a minority said they had a good understanding.

The implicit affect measures showed a more positive response for both Crumpets and Spaghetti Carbonara. Given that Crumpets contained mostly green lights this is in line with expectations, albeit no other effect was evident for this product across the results. Spaghetti Carbonara is a surprising result given that it contains several red lights. It is not clear why this result emerged and further research into the affect component is needed (as already mentioned regarding the questionnaire data).

It is important to clarify at this point that these results can only be seen as an indication of where future research might focus. In themselves they cannot be said to prove anything. It is clear, however, that any influence of the traffic lights on risk perception is greater when judgements are made explicitly. This suggests that in a situation where someone is consciously thinking about the concept of risk, the risk information contained in the traffic lights may be more salient. A study in a Boston hospital claimed that a variant of the traffic light system did influence shoppers to make healthier choices but only when they were consciously made aware of the health issues (Sonnenberg et al., 2013).

While these results present intriguing findings that may increase understanding of how food traffic lights operate, and how they impact attitudes, it must be acknowledged that these results were captured using new methods. The following section discusses the demonstrations of the EPTs in broader terms with focus given to the method development (the first main aim of the research).

4.4.4.2 Method Development

This study makes a contribution to the literature in that it is the first study to have developed and used an Evaluative Priming Task (EPT) to measure implicit attitudes to risk. Siegrist et al. (2006) and Visschers et al. (2007) called for more use of implicit measures of risk. The various implicit measures have often produced weak correlations when directly compared (Fazio & Olson, 2003). This has led to suggestions that avoiding using the same (or similar) measure every time may enhance understanding of what is specifically being measured (Hyde et al., 2010). This could mean using multiple types of implicit measure in one study or ensuring that less common measures are used (Brand & Schweizer, 2015; Townsend et al., 2014). The IAT is the most widely used but this could lead to the problem that there is a lack of contrasting data using other methods. A key difference between the IAT (or related measures based on similar principles) and the EPT is that the mechanism in the EPT is more akin to spontaneous evaluative reaction (Brand & Schweizer, 2015; Gawronski & De Houwer, 2014). This attribute and the EPT's differing theoretical basis to other implicit risk measures means that this provides a valuable new method that enhances the field of implicit risk research. The interview data (Section 4.4.3.5) also showed participants did not tend to find the task difficult or confusing. This suggests it could be used with a variety of people without issue.

The lack of relationship that was found between explicit and implicit measures (for both risk and affect) was consistent with the findings from Siegrist et al. (2006) and the wider implicit attitude literature (e.g. Fazio et al., 1995; Greenwald et al., 1998). This is consistent with the idea of dual systems for information processing. The relationship of implicit and explicit attitudes can vary, however. For instance, one study found that these correlations were high for some factors but almost zero for others (Nosek & Smyth, 2007). The results from this study provide support for the notion that such a relationship should not be expected. This highlights the need for implicit measures to be specifically measured.

The risk EPT results from this study produced one significant result with Mackerel receiving higher risk scores when the traffic lights were present in the packaging compared with the packaging with no traffic lights. A similar but marginally non-significant result was also found for Spaghetti Carbonara. Both of these items included multiple red lights so this increase in risk association seems logical. Given that there were only five priming items (with one chosen as a neutral option) this suggests that the risk EPT was effective in capturing risk attitudes. Since the method was based on the same principles as the original EPT (i.e. small reaction time differences) it is reasonable to suggest that these attitudes were implicit (or automatic). While one study can only give an indication of the efficacy of the method the results nonetheless suggest that further use would be warranted.

The affect EPT results produced two significant results. Cod produced more positive affect scores when the traffic lights were included, while Spaghetti Carbonara also produced more positive affect scores when traffic lights were included (compared with the packaging with no traffic lights). The result for Cod met expectation as this included all green lights. Initially (like the risk EPT) this suggests that the method was effective, at least to some degree. The result for Spaghetti Carbonara, however, was contrary to expectation as this included multiple red lights. This result suggests that more research using the affect version of the EPT is needed before being confident of the method's efficacy. Another possibility, however, is that this latter result was understandable because, while showing red lights, the overall configuration of traffic lights may have still been "better" than expected (i.e. participants may have felt positively because they expected the traffic lights to have even more red lights). This is a speculative notion, however, and is not supported by the risk EPT results and no such suggestions were explicitly made in the questionnaires or interviews.

The lack of significant results for several primes may suggest a lack of efficacy but alternatively this could suggest that only certain primes produced sufficiently strong implicit attitudes. Regardless it was necessary to further demonstrate the methods using a different context. This way it would be possible to see if there were consistent or contrasting characteristics in the results. The following chapter (Chapter 5) provides this demonstration using the context of cyber-security. Further discussion of the methods that includes comparison of the results from both contexts is provided in the General Discussion section of Chapter 5 (Section 5.4).

The third main aim of the thesis was to investigate the affect heuristic at an implicit level. The following section discusses this aspect of the research.

4.4.4.3 Affect Heuristic

The correlation analyses of the questionnaire data produced the expected associations of risk and affect (e.g. higher risk associated with negative affect) for both the ‘with traffic lights’ and ‘without traffic lights’ conditions. The effect size was larger, however, in the ‘with traffic lights’ condition. This suggests that the food products by themselves may not be as readily subject to the effects of the affect heuristic. Indeed, it may be that any risk judgements of typical supermarket food products may be based on other factors or even largely ignored. Alternatively, explicit affect may be driven by other factors rather than risk, such as taste preferences (Grunert & Wills, 2007), or pricing (Waterlander, Steenhuis, de Boer, Schuit, & Seidell, 2012).

An association was found between implicit measures (EPT) of risk and affect only when traffic lights were present. This finding is somewhat consistent with the interpretations of the results from the questionnaire. It would seem that the effects of the affect heuristic do not operate at an implicit level for food products by themselves (or this effect is sufficiently small to avoid detection using the implicit measures). The traffic light information, especially involving the warning signal of red, seems to be more salient for this type of processing. It is not clear how these potentially differing processes may combine when the food products are shown with traffic lights but the fact that the effect size was notably smaller than the equivalent explicit measure (i.e. questionnaire correlations for the ‘with traffic lights’ group) may suggest that there is some competition between the two types of processing.

4.4.4.4 Limitations / Future Research

The sample was restricted to 18-24 year olds. This group were familiar with traffic lights and given their youth, are a relevant population for longitudinal study. There is also evidence that adolescents can be influenced by the traffic light system in comparison to other nutritional formats, including making healthier food judgements (Babio et al., 2013). While this study has been useful in providing data about 18-24 year olds, future research should include older people, like parents, in order to provide a more complete understanding of how traffic lights are perceived.

The risk priming task was a newly developed measure for this study and inevitably there are potential refinements that could be made in the future. For example, the SOA times could be varied, and the number of trials could be increased. It would also be useful to use this measure to collect data about attitude-objects other than food products since they may not be as readily associated with risk as some other products or concepts. The type of food products studied could also be varied in future research. As the selection in this study was rather limited, a larger selection may produce more informative data. It is also worth considering how perception might vary based on whether the food product is a full meal, component of a meal, snack, a treat, or other variations. Participants’ knowledge of nutrition may also be an important variable to consider but doing so would require some form of test as self-report measures may be subject to biases.

Arguably the most important question is whether perception effects will lead to behavioural change. As mentioned previously, there are doubts over how likely it is that shoppers will change their food choices based on the traffic lights. If it were possible to fully combine the implicit measures with a behavioural correlate, this would provide a more convincing argument regarding the likely influence of the traffic lights on food choices. The work that has been done in this area is valuable but since many (possibly most) shoppers will not be paying much attention to the traffic lights, a link between implicit, automatic processing and behaviour is needed to know how useful the traffic light system really is.

4.4.4.5 Conclusions

This study provides the first demonstrations of novel implicit risk and affect measures (EPTs), and a demonstration of the affect heuristic at an implicit level. In order to further develop the measures, the following chapter provides another demonstration in a new context that is arguably more readily associated with risk: cyber-security. This also provides an opportunity to make some refinements to the design in an effort to improve the method.

Chapter 5:

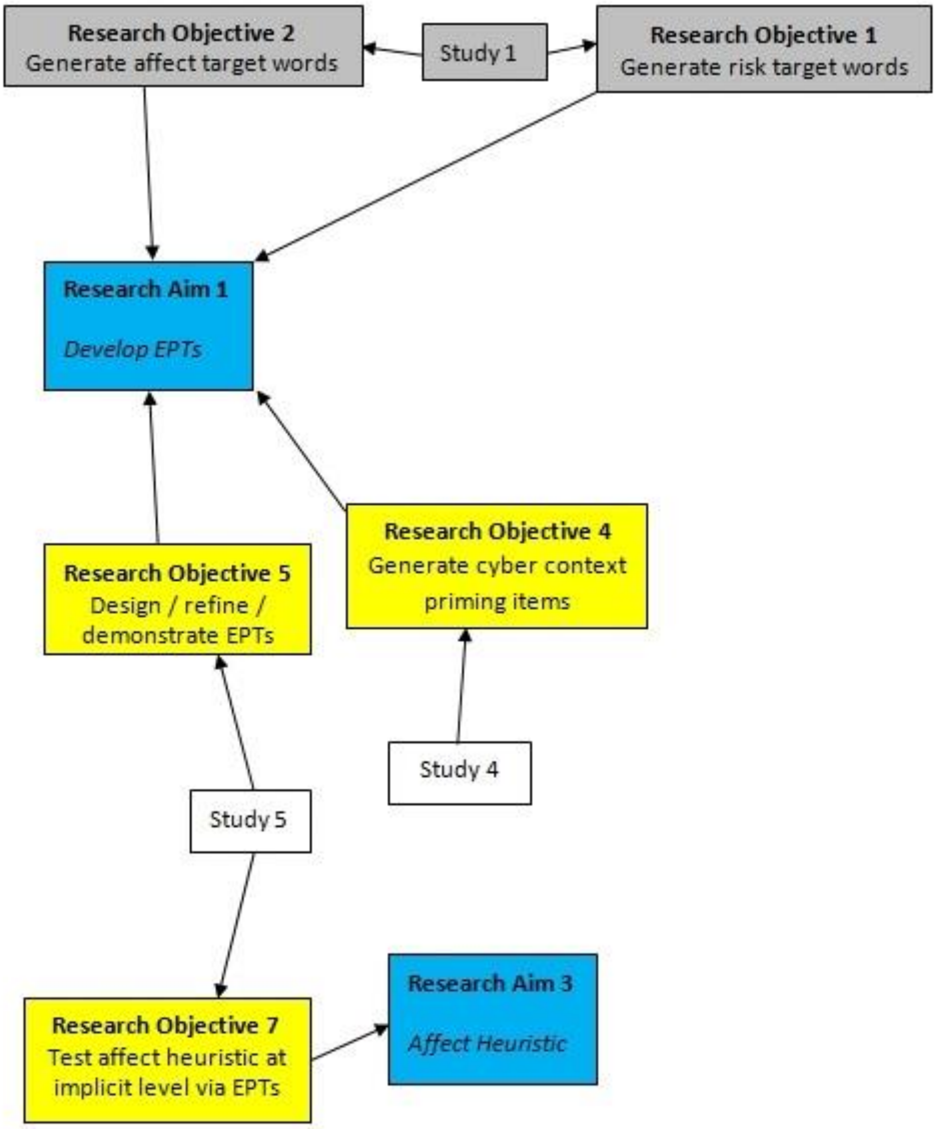
Evaluative Priming Tasks – Cyber-security

5.1 Introduction

Research Aim 1 of the thesis was the development and demonstration of a novel implicit measure of risk attitudes, along with an implicit measure of affect. The final study of Chapter 4 provided the first demonstration of the newly developed versions of the EPT in the context of food nutrition. This chapter reports another EPT study that used a new context: cyber-security. This context contrasts with food nutrition in that it is arguably more readily associated with risk. It also contrasted in terms of the EPT design in that it involved using words in text form whereas the first EPT study used images (of food products). It has been suggested that the performance of the EPT can vary depending on how the priming items are presented (e.g. as text or images) (Wentura & Degner, 2010).

In order to meet the remaining demands of Research Aim 1 (beyond what was presented in Chapter 4), several research objectives were identified. See Figure 5.1 for a schematic showing the flow from each study to each research objective, and finally how these objectives combine to meet the demands of Research Aim 1. As shown in Figure 5.1 (within the grey boxes) there were research objectives that were relevant to this chapter but which were already presented in Chapter 4 (Research Objectives 1 and 2). These were both achieved via Study 1 in Chapter 4 and relate to the target words that were generated for the EPTs. The same target words are used in this chapter as the findings of Study 1.

Figure 5.1: Schematic showing the relationship between the studies conducted (in white), research objectives (in yellow), and research aims (in blue), for Chapter 5.



Note: Grey boxes show studies and objectives that were presented in a previous chapter but are still relevant for this chapter.

The remaining research objectives (coloured yellow in Figure 5.1) were achieved via two studies presented in this chapter. Research Objective 4 was that data sets would be generated containing cyber-security terms for use as 'priming items' in the new versions of the Evaluative Priming Task. In the same way as this task was approached for generating priming to use in the food nutrition EPT, this was done by conducting a questionnaire study (Study 4 in Section 5.2).

Research Objective 5 was that the EPT methods would be designed, refined, and demonstrated in the cyber-security context. This objective was actually broader than described and met via both the food nutrition EPT study and the cyber-security EPT study (Study 5 in Section 5.3). This objective was overall that the EPT would be developed and demonstrated in both contexts. This objective was initially met by Study 3 (food nutrition EPT study) and this process completed via Study 5 (cyber-security EPT study) that is presented in this chapter. Study 5 involved refinements to the EPT design (beyond using a different context) and these will be explained in Section 5.3.

Research Aim 3 of the thesis was to investigate the affect heuristic at an implicit level. This aim was met via Research Objective 7 which stated that the new versions of the EPT would be tested for relationships to discern if an affect heuristic effect is evident at an implicit level. Study 3 (in Chapter 4) provided the first investigation and Study 5 in this chapter completes this process in order to meet this objective.

The following section (Section 5.1.1) provides some background on the research context for this chapter: cyber-security. Following Section 5.1.1 is the first study of this chapter (Study 4 in Section 5.2), then the second demonstration of the new versions of the EPT are presented (Study 5 in Section 5.3). Finally this chapter includes a general discussion section that discusses the empirical and methodological implications of the findings from both EPT studies presented in Chapter 4 and this chapter.

5.1.1 Cyber-security Context

Despite the ever increasing use of information technology and the internet, polling of public perceptions regarding cyber-security has been very limited (Allouche & Lind, 2010). This lack of information creates a challenge for effective risk communication (e.g. IT managers encouraging safer online behaviour for employees, etc.) as these perceptions are likely to influence decisions and behaviour online. It has also been suggested that tackling the complex issue of cyber-security requires a greater understanding of human perception (and other psychological factors) than is currently the case (Wiederhold, 2014).

The limited available evidence suggests that risks relating to cyber-security are often poorly understood. Largely due to media exaggeration, some people may perceive relatively rare risks (such as cyber-terrorism) as common threats (Hansen & Nissenbaum, 2009). There is in fact much debate over what actually constitutes cyber-terrorism, with conflicting views over its prevalence, or even existence (Jarvis, MacDonald, & Nouri, 2014). Often, alleged incidents of cyber-terrorism are in fact cases of ‘hacktivism’ (hacking as political activism) with the aim simply to cause inconvenience or mischief (Jarvis et al., 2014; Stohl, 2007).

While the level of media attention (or public perception of prevalence) regarding particular cyber threats is debatable, some threats appear to be quite common. Identity Theft, for instance, has been dubbed the “crime of the century”. (Hoar, 2001). Fears around this issue seem somewhat justified when considering recent statistics of how prevalent this issue has become. A recent survey found that 9% of respondents across 20 countries reported having been victims of identity theft (Rusch, 2014). It was also claimed that there have been over 13 million identity theft victims in the United States in 2013 (Rusch, 2014). The reasons why an issue like cyber-terrorism receives more media attention than other cyber-security issues may be because it plays on the public’s fears.

This leads to questions regarding how attitudes to cyber-security may compare in terms of differing thought processes. It is reasonable to suspect that deliberative or explicit attitudes on this topic may differ from automatic or implicit attitudes. This is especially relevant if many people are indeed emotionally influenced by reports in the media or elsewhere.

5.2 Study 4: Questionnaire Study – Cyber-security

5.2.1 Introduction

The cyber-security questionnaire study served two main purposes. The first was to generate materials for use in the subsequent cyber-security EPTs. The second purpose was to further investigate the affect heuristic (at an explicit level) using this new context. A selection of various cyber related words or terms were collected via online lists (www.scottschober.com/glossary-of-cybersecurity-terms/; www.honeywellprocess.com), a glossary of cyber-security terms (Kissel, 2013), and also a selection of prominent cyber related organizations. In total there were a set of 26 cyber related terms, and 11 cyber organizations. The full list of these can be seen in Figure 5.2 and Appendix 5. The inclusion of the organizations was in order to broaden the scope of options before selecting exemplars for the EPTs. This study provided a similar function to the questionnaire study for food health (Study 2) in that it generated appropriate prime items for use in the subsequent EPTs. The context, however, for this study was cyber-security. As fewer exemplars were used in this study compared with Study 2, it was possible to collect both risk and affect attitudes in a single task (unlike in Study 2 which required separate questionnaires for risk and affect). This made it possible to use the data to investigate the affect heuristic in this new context as the same participants made both ratings.

Study Aims

1) To generate terms for use as primes within the cyber-security EPT studies based on associations with high risk or low risk.

2) To investigate the affect heuristic based on explicit risk and affect ratings from questionnaire items.

5.2.2 Method

5.2.2.1 Participants

Twenty males and 23 females were included, meaning 43 participants in total. The mean age was 27 (SD = 7.3), ranging from 21 to 60. All participants were postgraduate students, studying Human Resource Management, and received course credits for taking part.

5.2.2.2 Materials

A set of 37 words or terms relating to information communication technology were sourced, with a particular focus on cyber-security. These were sourced via the resources described in Section 5.2.1. Several terms were selected based on how appropriate they were in terms of cyber-security, including terms that could be described as relatively benign in this context. For instance, the term “Hacking” was included as this is a clear cyber-security threat, the term “Firewall” was included as this is a form of cyber-security protection, and the term “Download” was included as this is relatively benign but could potentially be perceived as either high risk (e.g. downloading malicious software) or low risk (downloading protective software).

Initially there were two options for what type of terms to use. The options were general cyber related terms with the other option being cyber related organizations. In order to maintain the possibility of either option, a selection of cyber related organizations were included based on these either being very well known (e.g. Apple) or specifically related to cyber-security (e.g. McAfee). Only terms or organizations that were considered likely to be recognized by participants were included.

5.2.2.3 Procedure

As with the other questionnaire studies a link was made available to the online website Qualtrics. This questionnaire used the 0-100 slider technique with high scores (nearer 100) meaning high risk or positive affect. Low scores (nearer zero) were more indicative of low risk or negative affect. For familiarity ratings, scores nearer 100 meant high familiarity. All 37 words/terms were rated for all three rating types. Participants were able to add comments at the end of the questionnaire. Participants were also asked state their self-reported knowledge of information communication technology. This was also done using the slider with higher levels (nearer 100) suggesting strong knowledge, and lower levels (nearer zero) suggesting weak knowledge.

5.2.3 Results / Discussion

In order to check for age or gender effects, by-subjects analyses were conducted. No such effects were found for age (all p > .11), nor gender (all p >.39). The mean self-reported level of information communication technology knowledge was 66.6 based on a range of zero (weak knowledge) to 100 (strong knowledge) (*SD* = 13.5). This was significantly high (i.e. significantly strong self-reported knowledge), $t(42) = 8.28$, $p < .001$, 95% CI of diff [12.86, 21.14]. No significant differences or relationships were found when comparing knowledge levels with either risk or affect ratings (all p > .32). Only three items produced a significant correlation when comparing knowledge with the familiarity rating, which were Electronic Footprint, Upload, and Norton (all r = .31 to .36, all p = .017 to .04). No other individual item produced a significant correlation (all r = -.04 to .3, all p = .054 to .78). However, when all items were pooled to provide an overall familiarity rating for all items combined, this produced a significant correlation with knowledge, $r(41) = .33$, $p = .033$.

5.2.3.1 Priming Terms Generation

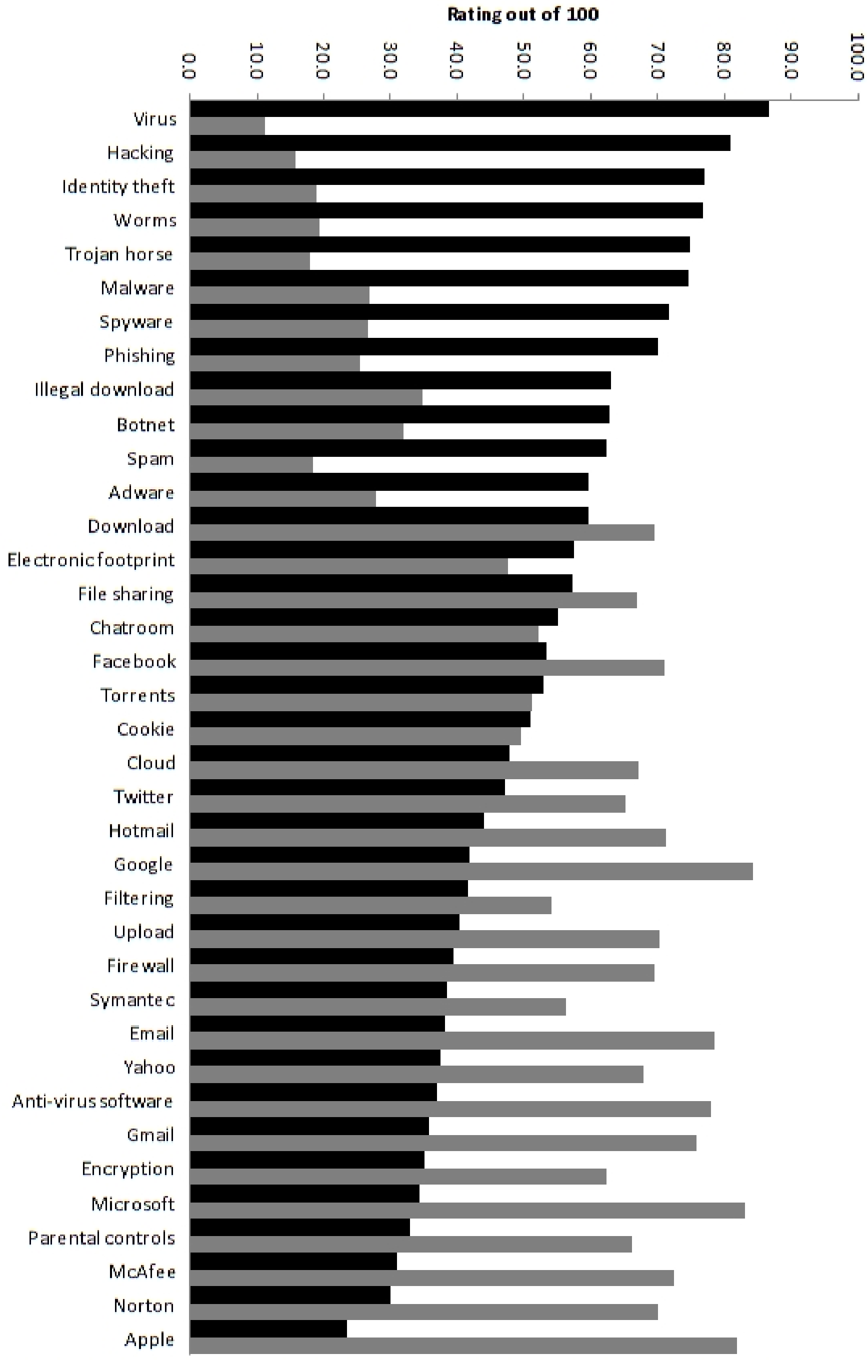
Figure 5.2 displays the risk and affect ratings in bar graph form. Appendix 5 shows the mean risk ratings, affect ratings, and familiarity ratings for all items. Both Figure 5.2 and Appendix 5 display the items in order from the item with the highest risk rating to lowest risk rating. As can be seen in Figure 5.2 and Appendix 5, the three items that received the highest mean ratings for risk were Virus, Hacking, and Identity Theft. All of these also received significantly high levels of familiarity among participants, based on one-sample t-tests (all p < .001). They also all received significantly high risk ratings (all $p < .001$), and significantly negative affect ratings (all $p < .001$). Most of the lowest risk ratings were for organizations with the lowest risk ratings for general cyber terms being Parental controls, Encryption, Anti-virus software, and Firewall. The level of familiarity for all of these was significantly high (all $p < .001$). They also all received significantly low risk ratings (all $p < .002$), and significantly negative affect ratings (all $p < .001$).

It was decided that the organizations should be dismissed from consideration as they could be prone to brand association, and a mix of terms and organizations could present difficulty in interpreting the future results. Given that all the main candidates for high risk / negative exemplars were terms, this issue would be even more problematic. Since the three highest risk terms all had significantly strong levels of risk, affect, and familiarity they were selected as the exemplars for that category. The term Identity Theft was not ideal as it is somewhat longer than may normally be used for brief exposure priming, and includes two separate words. The level of familiarity for the next five highest risk items (from Worms to Phishing) were among the lowest, however, so ensuring that the exemplars were strongly rated as high risk limited the options. Also the fact that Identity Theft has been prominently identified as a prevalent and high profile cyber-security issue (e.g. Rusch, 2014) suggested that this was a good option.

For the low risk / positive terms there were four candidates, although the design constraints (for the EPT in particular) meant that five exemplars in total were favoured which meant two low risk exemplars were needed. It was considered that the inclusion of the word “virus” within Anti-virus software could be problematic given the brief exposure priming involved for the EPTs. This term additionally was longer than would normally be used. As the prospective participants for later studies were likely to be students, it was also considered that the term Parental controls may induce alternate feelings to safety (such as external control) that may confound the results. This term was also longer than would be ideal.

Following these analyses of the relative levels of risk, affect, and familiarity ratings, and with consideration of potential confounds, a selection of exemplars was made. These were Virus, Hacking, and Identity Theft (high risk and negative), along with Encryption and Firewall (low risk and positive). It was considered reasonable to expect that participants in the cyber-security EPT studies would consider these exemplars in a similar way to participants in this study (for explicit attitudes at least), and be sufficiently familiar with them.

Figure 5.2: Bar graph of all cyber related words/terms based on risk and affect presented in order from highest risk rating to lowest. (Black bars = Risk ratings, Grey bars = Affect ratings).

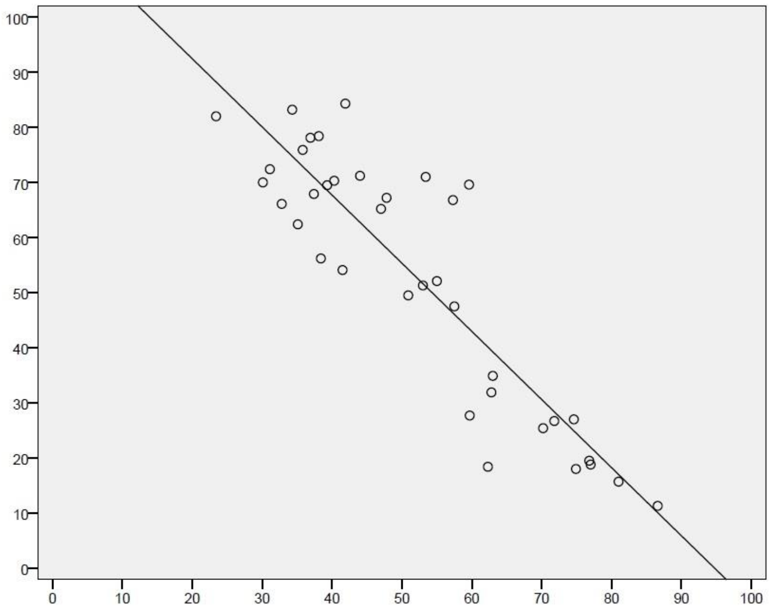


5.2.3.2 Affect Heuristic

The second aim of this study was to investigate the correlations of risk and affect (i.e. to investigate the affect heuristic). Figure 5.3 displays a scatterplot of all words, including the line of best fit. This shows that as the risk ratings gradually increase (from low to high risk), the affect ratings gradually decrease (from positive to negative affect). While there are some exceptions to this trend the overall pattern is consistent which suggests that there is a negative linear correlation between the two variables.

In order to clarify this relationship between the two variables correlation analyses were conducted. When combining all 37 items, there was a significant correlation between risk and affect, $r(35) = -.897$, $p < .001$. Since high affect ratings meant positive ratings, this correlation shows a relationship between high risk and negative affect, and between low risk and positive affect. When analyzing the cyber terms only (not including the organizations), this correlation remained significant, $r(24) = -.894$, $p < .001$. When analyzing the organizations only, there was no significant correlation for Risk and Affect, $r(9) = .35$, $p = .291$, albeit this only included 11 items.

Figure 5.3: Scatterplot of all cyber-security terms based on risk and affect, including line of best fit.



5.2.3.3 Conclusions

The first aim of this study was to generate terms for use as primes within the cyber-security EPT studies based on associations with high risk or low risk. Although the option of using organisations as primes was initially included it was decided that only the cyber related terms should be used for prime term selection. Given the design specifics of the new EPT versions (as described in Study 3) there was a need for five priming items. For the cyber-security EPTs it was decided to dispense with a neutral option as this had provided limited benefit in clarifying the findings in the food health EPTs (Study 3). Given that there were three clear options for high risk items and more issues regarding selection of low risk items it was decided to include three high risk items and two low risk items.

The second aim of this study was to investigate the affect heuristic based on explicit risk and affect ratings from questionnaire items. As with Study 1 (Questionnaire Study – Generating Target Words) and the questionnaire component of Study 3 (EPT – Food Nutritional Labels), a significant correlation was found between explicit risk and affect ratings, so an affect heuristic effect was evident. This demonstrates that in three contexts (risk related words, food health / nutritional labelling, and cyber-security) an explicit affect heuristic effect was found. This suggests this is a robust effect and that it would be reasonable to expect a similar effect in the subsequent cyber-security EPT results (for the explicit questionnaire data at least).

The items selected as high risk items for use in the cyber-security EPTs were Virus, Hacking, and Identity Theft. While the low risk terms were Encryption and Firewall. Using these as the primes and the target words generated from Study 1, this laid the foundations for the subsequent cyber-security EPTs that aimed to investigate implicit risk and affect in this context.

5.3 Study 5: Cyber-security EPT

5.3.1 Introduction

This study met the final demands of Research Objective 5 (following the initial demands being met via Study 3). It provides the second demonstration of the developed versions of the EPT that measure implicit risk and affect attitudes. The context used for this second demonstration was cyber-security. The materials generated in Study 1 (from Chapter 4) and Study 4 aided in the development of the versions of the EPT that were used. There were also some refinements that were made to the EPT based on the performance of the methods in Study 3. These will be explained in Section 5.3.2.5.

Study Aims

1) To further develop the EPT measures of risk and affective attitudes and to use these, along with explicit measures, to investigate attitudes to cyber-security.

2) To use explicit and implicit measures to investigate the affect heuristic in the context of cyber-security.

5.3.2 Method

This study consisted of three parts: priming tasks, a questionnaire, and an interview. The priming tasks measured participants' implicit risk and affect attitudes towards cyber-security terms. The questionnaire measured participants' explicit risk and affect attitudes towards these terms. A short interview was included after the questionnaire which was used to clarify their explicit attitudes, to discern any additional relevant information, and to ensure instructions had been understood. The administration of the questionnaire and EPT were counter-balanced and no task order effects were found.

5.3.2.1 Participants

Forty undergraduate Human Resource Management students participated, and received course credit. The mean age was 20 years, with a range of 19 to 23 years (*SD* = 1.19). The sample included 33 females (mean age 20), and seven males (mean age 20.3). This was a convenience sample but 19 to 23 year olds were also considered an appropriate sample as they were likely used to considering cyber-security issues and given their youth, were a relevant population when considering what future attitudes may be to cyber-security.

5.3.2.2 Materials

Based on the results from Study 4 a selection of cyber-security terms were selected for use as primes in the current study. The selection included three terms that were rated as high risk (i.e. Virus, Hacking, and Identity Theft), and two terms rated as low risk (i.e. Encryption and Firewall).

5.3.2.3 Questionnaire

The questionnaire was completed online via Qualtrics but this was done in the experiment room after the main tasks. All of the terms were rated for risk and affect. Ratings were made using the on-screen slider that produced a value between zero and 100. Each extreme of this scale (zero and 100) was labelled. For the risk ratings, the two extremes were ‘very low risk’ and ‘very high risk’. For affect, these were ‘very positive/good’ and ‘very negative/bad’. Various demographic details along with familiarity with the terms were also collected. Participants were also asked to state their self-reported knowledge of information communication technology. This was also done using the slider with higher levels (nearer 100) suggesting strong knowledge, and lower levels (nearer zero) suggesting weak knowledge.

5.3.2.4 Interview

Short interviews (around five minutes) were conducted after the EPTs and questionnaire had been completed. Initially participants were asked if they had any specific issues while completing the earlier tasks and had understood what they had to do. They were asked if they had any problems categorizing the target words, such as not knowing what any words meant. Participants were also asked if they had ever participated in an implicit task before, and if they could work out what the EPT tasks were measuring. They were also asked if they had any issues with the cyber-security terms. After these questions they could add any further comments freely. Notes were taken of their responses and this information was used to identify key issues, trends, or common responses.

5.3.2.5 Priming Task

The two new versions of the EPT that were used for Study 3 (Food Nutrition Labels EPT) were used again for this study with some modifications. During the interviews for Study 3 no participant suggested that they had found the EPT tasks unduly long. This had been a concern when designing the EPT for that study. This made it reasonable to make some modifications even though these would lengthen the tasks. In Study 3 the target words were categorized twice in the baseline phase (where no primes were shown) with these two blocks administered before the priming phase (where primes are shown before each categorization). In order to increase the data collected this was increased to four blocks with each target word categorized four times in the baseline phases.

Two blocks were administered before the priming phase with two blocks administered after the priming phase. The fact that the baseline phase was at the start of the task had caused some concern due to possible practice effects that could cause earlier categorizations (and thus the baseline categorizations) to be artificially slower than later categorizations. This was the approach of Fazio et al. (1995) but given the option of adding more baseline trials it was decided to include baseline blocks at both the beginning and end of the task. Initially this had the potential of off-setting any practice effects and also provided an opportunity to measure if such an effect existed. When the results from the first two blocks were compared with the last two blocks there was in fact no significant difference (p = .54). Nonetheless this modification seemed logical and suggests this approach should be adopted in future administration of EPTs as the results from this study cannot rule out the possibility of practice effects in future studies.

Having four trials for every target word in the baseline condition also held other advantages. It provided a more robust average given the additional data but also it provided some insurance for instances where participants made mistakes (e.g. pressing the wrong button accidentally). These advantages also suggested the number of trials that were administered in the priming phase should be increased.

In Study 3, the priming phase consisted of five blocks of trials with each target word categorized once within each block. Each block was separated so that participants could take a break if needed. Also within each block all primes were shown twice, with each prime followed by one target word from each category. All pairings of prime and target word were included over the entire task. For this study this was increased to 10 blocks with every target word and prime term paired twice rather than once. This was designed to operate like the priming phase of Study 3 (i.e. five blocks) administered twice in a row. This was done to ensure that the same target/prime pairing did not repeat soon after first appearance. The actual order was randomized, however, so the second set of five blocks was not ordered in the same way as the first five blocks. This meant an average could be calculated for each target/prime pairing that had not been possible in Study 3. It also meant that if a mistake was made in categorization there was another similar trial that could be used which reduced the chances of blank cells in the data.

Another modification was that the stimulus onset asynchrony (SOA) was reduced. The SOA is the time taken to flash the prime on screen and the time that the screen is blank before the target word appears. In Study 3 the SOA had been 450ms which was the SOA for Fazio et al. (1995). Wentura and Degner (2010), however, have suggested that SOAs are optimal at lower intervals. For Study 3 the longer SOA was used as the priming stimuli were information rich. Since the priming stimuli in this study were just words on screen this was not an issue. As such, each prime was displayed in the centre of the screen for 150 ms (milliseconds). The screen was then blank for 50 ms, before the target word was presented. This gave an SOA of 200ms in line with recommendations (Wentura & Degner, 2010). Given that this was only the second demonstration of the new EPTs and the modifications mentioned above, it was decided to use the same target words as Study 3. Such changes may be of value in future refinements of the measures but it seemed logical to avoid altering the tasks too much across the studies as this could compromise any subsequent comparison of the results from the two demonstrations of the new EPTs. The tasks were otherwise equivalent to the EPTs in Study 3, and analyses of the memory tests showed that participants paid sufficient attention to the primes. The equipment used was the same with the priming words shown in the centre of the screen in Times New Roman 45-point font.

5.3.3 Results

5.3.3.1 Detection Data

Participants were instructed to always pay attention to the prime items during the priming phase. They were told that there would be a recognition memory test at the end which would ask them to identify which items they had seen. This test included filler items, along with the actual prime items, and participants had to state whether each item had been shown to them or not. The results were checked in order to ensure that participants had paid sufficient attention during the task. This was calculated using the same technique as the food health EPT study (Study 3). A one-sample t-test revealed participants' mean score to be .89 (SD = .14) which was significantly above chance, $t(39) = 41.47$, $p < .001$, 95% CI [.85,.93].

5.3.3.2 Preliminary Analyses

No significant or problematic differences were found between the questionnaire ratings or scores from the priming tasks based on gender, nor with task order. The same was true for associations with native language (i.e. native language was English or not). The same personality questionnaire that was used in the food health EPT study (Study 3) was used for this study. Analysis of the results in relation to the main results (e.g. risk ratings) produced no significant relationships. There were also no associations found based on age, nor ICT knowledge with the main task results (risk or affect). The ICT knowledge scores involved a self reported rating between one and 100. The mean was 48.8 (SD = 24.2), and based on one-sample t-test analysis, was not significantly different from the neutral value of 50, $t(39)$ = -

0.32, *p* = .75, 95% CI of diff [-8.95, 6.5]. The self-reported ICT knowledge for Study 4 (the study for generating cyber-security priming items) was significantly high, i.e. significantly strong knowledge. This shows a difference in knowledge across the samples, or possibly a difference in confidence relating to knowledge.

5.3.3.3 Relationship between Explicit and Implicit Measures

In order to investigate the relationships of the explicit measures (questionnaire) and implicit measures (priming task), correlation analyses were conducted for each category (risk and affect) separately. The results from this study showed a lack of correlation (Pearson) for both the risk comparison, $r(198) = .003$, $p = .96$, and the affect comparison, $r(198) = -.05$, $p = .47$. This provided an initial validation that the explicit and implicit measures are measuring different processing. This suggests that the implicit risk and affect priming tasks measure separate processing constructs from the corresponding explicit measures. Based on previous studies (e.g. Fazio & Olson, 2003), this lack of correlation provides a preliminary validation of the implicit measure.

5.3.3.4 Questionnaire Data

One-sample t-tests were conducted on each of the cyber-security terms for both the risk ratings and affect ratings. This clarified the explicit attitudes that were held by participants towards the priming items. Table 5.1 contains the data from these tests and shows that all results were significantly different from the neutral value of 50, other than those for Encryption (risk only) (significant results shown in bold). The means show that these differences were in the expected direction for all the significant results (i.e. Virus, Identity Theft, and Hacking were rated as high risk and negative affect, while Firewall was rated as low risk and positive affect).

Table 5.1: One-sample t-test questionnaire results of all cyber-security terms for both risk and affect ratings (range zero to 100). Higher risk means denote higher risk ratings, and higher affect means denote more positive affect ratings.

		Mean	*SD*	N	t-stat	p-value	CI lower	CI higher
Risk	**Virus**	91.6	10.8	40	24.4	**<.001**	38.2	45.1
	Firewall	26.3	24.4	40	-6.2	**<.001**	-31.6	-15.9
	Identity Theft	95.7	6.2	40	46.5	**<.001**	43.7	47.7
	Encryption	47.6	29.6	40	-0.51	.651	-11.8	7.1
	Hacking	90.1	10.2	40	25	**<.001**	36.9	43.4
Affect	**Virus**	11.1	22	40	-11.2	**<.001**	-45.99	-31.9
	Firewall	73.02	26.8	40	5.4	**<.001**	14.4	31.6
	Identity Theft	6.95	16.8	40	-16.2	**<.001**	-48.4	-37.7
	Encryption	58.4	24.6	40	2.2	**.038**	0.51	16.2
	Hacking	7.3	10.9	40	-24.7	**<.001**	-46.2	-39.2

*CI diff means from neutral value of 50

5.3.3.5 Interview Data

Participants were asked to state if they had any issues or confusion while performing the tasks. One participant said they were not sure what Hazardous meant but had guessed it was a high risk associated term. One participant said they incorrectly categorized Safe as high risk a few times. They did not know why they were doing it as they knew that was wrong. They did stop making this mistake quickly, however. No other participant specified having any specific issues or confusion in terms of how to categorize the target words. Some participants (9) said they found the priming tasks quite long and subsequently found it harder to concentrate towards the end of each task. They did not suggest this was a major problem, however.

The participants stated no issues regarding the cyber-security terms other than some comments regarding one term. Six participants specifically said they were unsure of what Encryption meant. The questionnaire data on familiarity suggests more were unsure of this term but only six actually mentioned being unsure. Two participants also said that they had thought of it (the term Encryption) in terms of having their computer hacked and all their files encrypted with a ransom then demanded. They mentioned that they had seen reports relating to such a scenario in recent media. No other common themes emerged.

5.3.3.6 Priming Task Data

Following the procedure described by Fazio et al. (1995), the facilitation scores were calculated for each term. Each priming condition response time was subtracted from the baseline condition time. Average response times for each participant within each group of target words (e.g. the low risk target words) were then calculated. This meant there were two average values for each participant based on each cyber-security term (low risk average and high risk average). Following the guidelines described by Czyzewska and Graham (2008), an implicit attitude index was then calculated by subtracting the high risk average from the low risk average. Greater automatic risk activation (i.e. higher risk association) was evident as the index score increased. Higher index scores also demonstrated more positive affect association. The latencies for trials on which participants did not respond or made an error were not included in the calculation (mean of 3.2% trials per participant).

One-sample t-tests were then conducted on each of the cyber-security terms for both the risk ratings and the affect ratings. This was done in order to see if the presence of priming items caused any significant changes in subsequent risk-taking behaviour (as measured by 'facilitated average pumps'). Table 5.2 contains the data from these tests and shows when the results were significantly different from the neutral value of zero (significant results shown in bold). For the risk scores, only Identity Theft showed a significant result, with this being an association to high risk. For the affect scores, both Identity Theft and Hacking showed significantly negative affect associations. Encryption also showed a significantly negative affect association despite this being chosen as one of the terms that was expected to be considered as positive affect (and low risk). These results showed that the presence of primes before completing the balloon task did produce some significant changes in implicit risk and affect attitudes.

Table 5.2: One-sample t-test EPT results of all cyber-security terms for both risk and affect ratings. Positive/Higher medians denote High Risk/Positive Affect, while Negative/Lower medians denote Low Risk/Negative Affect. (ms = milliseconds)

		Mean(ms)	SD	N	t-stat	p-value	CI lower	CI higher
Risk	**Virus**	0.99	113.4	40	0.06	.956	-35.3	37.3
	Firewall	4.95	93	40	0.34	.738	-24.8	34.7
	Identity Theft	36.3	87.5	40	2.6	**.012**	8.3	64.3
	Encryption	-6.5	99.7	40	-0.41	.682	-38.4	25.4
	Hacking	0.47	131.7	40	0.02	.982	-41.6	42.6
Affect	**Virus**	9.3	74.1	40	0.79	.433	-14.4	32.99
	Firewall	-14.2	63.9	40	-1.4	.168	-34.6	6.2
	Identity Theft	-32.6	68.4	40	-3.01	**.005**	-54.5	-10.7
	Encryption	-23.1	68.02	40	-2.2	**.038**	-44.9	-1.4
	Hacking	-32.8	57.3	40	-3.6	**.001**	-51.1	-14.4

*CI diff means from neutral value of 50

5.3.3.7 Relationship between Risk and Affect

In order to test whether the affect heuristic was evident with the cyber-security terms, and to investigate whether it can be demonstrated through implicit measures, correlation analyses were conducted between the risk and affect measures for both questionnaire findings and EPT results. For the explicit measure (questionnaire), there was a significant negative correlation between the risk ratings and the affect ratings, $r(198) = -.85$, $p < .001$. Although a smaller effect, a similar association was found for the implicit measure (EPT), $r(198) = -.16$, $p = .02$. Both these results show that high risk was associated with negative affect, and low risk was associated with positive affect, in line with the affect heuristic. This provided a demonstration of the affect heuristic at an implicit level.

5.3.3.8 Familiarity Results

Questionnaire ratings were collected of each participant's level of familiarity with the cyber-security terms on a scale from one to 100. For four of the terms (Virus, Firewall, Identity Theft, Hacking), the mean level was between 71.3 and 88.2

with all significantly above the neutral value of 50 based on one-sample t-test results (all p <.001). The mean familiarity rating for Encryption was 42.9 which was not significantly different from the neutral value of 50, $t(39) = -1.32$, $p = .19$, 95% CI of diff [-17.91, 3.76]. These analyses are reported as all terms were expected to produce significantly high scores for familiarity as was found in Study 4. The lack of familiarity for Encryption therefore compromises any conclusions made regarding that term.

5.3.4 Discussion

The first main aim of the thesis was to develop and demonstrate two novel implicit risk methods. The first of these methods was an implicit risk attitude measure, and this study provides the second demonstration of that method (as developed from the EPT). The second main aim of the thesis was to investigate the affect heuristic at an automatic (implicit) level, and this study provides the second such investigation. This section will discuss both of these aims but initially will discuss the context which was used for this demonstration. This context was cyber-security.

5.3.4.1 Cyber-security

The first aim of this study was to further develop the EPT measures of risk and affective attitudes and to use these, along with explicit measures, to investigate attitudes to cyber-security. In the results for the explicit measures (questionnaire), the cyber-security terms Virus, Identity Theft, and Hacking were all rated as significantly high risk and negative affect, as expected based on the Study 4 results. The term Firewall was rated as significantly low risk and positive affect, again as expected. Encryption was not rated significantly different from neutral for risk and was rated as significantly negative for affect (despite being chosen as a low risk / positive exemplar). It should be noted, however, that the term Encryption was the only term that was not rated as significantly familiar by participants.

The implicit measures (EPT) results showed that for affect, both Virus and Firewall did not produce significant results, i.e. they did not reveal positive or negative affect associations. Both of the terms, Identity Theft and Hacking, however, revealed significant affect results in the expected direction (i.e. both terms had negative affect associations). Encryption also showed a negative affect association despite being chosen as one of the terms likely to be considered positive (and low risk). From the interview data, some participants indicated that they were unfamiliar with the term Encryption. Also some explained they had presumed it was a negative and high risk term. This may help explain this otherwise anomalous result.

The risk EPT results did not yield strong implicit attitudes (i.e. facilitation index scores significantly greater than baseline) to four of the five terms (Virus, Firewall, Encryption, and Hacking). This may have been due to lack of sensitivity of the measure given that it is a new variant of the EPT (i.e. measuring risk). It may also suggest that these terms do not automatically activate risk associations in the same way that they sometimes activate automatic affect associations, or explicit associations.

There are also other potential explanations for the results that are applicable to each individual prime. For example, the term Virus may have caused some conflicting reactions due to not being solely associated with information technology. The EPT relies on quick responses so if participants had to consciously remember to think of it in information technology terms, this could have impacted on the eventual results. Firewall may also have been subject to similar conflicting reactions as it could initially bring to mind the idea of threat, given that its purpose is to protect against online threats. This may have then required some conscious focus which again would potentially impact reaction times. For the term, Hacking, the potential explanations given do not so readily apply but one possibility is that many participants would not consider this a personally risky issue. Hacking is normally thought of in terms of organizations rather than individuals

The term, Identity Theft did produce a significant effect with the risk EPT, showing an association with high risk. As mentioned earlier, some cyber-security issues are often thought to be more common than they actually are in reality (Jarvis et al., 2014). Identity Theft, however, is not only thought of as common and receives much media attention, but also does appear to be a common problem (Rusch, 2014). Possibly a perception of high prevalence contributes to the automatic activation but it may be that due to being a personal issue (i.e. a risk to the individual), and the fears having some basis in fact, this concept elicits a stronger automatic reaction than the other terms.

5.3.4.2 Method Development

This study makes a contribution to the literature in that it is the second study to have developed and used an Evaluative Priming Task (EPT) to measure implicit attitudes to risk. As mentioned in Chapter 4, the need for more use of implicit risk measures but also a varied approach to types of implicit measure that are used have both been suggested (Hyde et al., 2010; Siegrist et al., 2006). The EPT has been described as more akin to spontaneous evaluative reaction (Brand & Schweizer, 2015; Gawronski & De Houwer, 2014) so was deemed a suitable method to develop for measuring implicit risk attitudes. As with Study 3, the interview data (Section 5.3.3.5) also showed participants did not tend to find the task difficult or confusing (albeit there were signs that increasing the length of task more may present issues with concentration). This study increased the length of the task compared with Study 3. Nonetheless, as no specifically problematic issues were highlighted by participants, this suggests it could be used with a variety of people without issue.

The relationship of explicit and implicit measures has produced varied results with these measures sometimes showing associations and sometimes dissociations (e.g. Nosek & Smyth, 2007). The results from this study provide support for the notion that such a relationship should not be expected. This highlights the need for implicit measures to be specifically measured.

Both the risk and affect EPT tasks produced significant results for certain primes. Since the method was based on the same principles as the original EPT (i.e. small reaction time differences) it is reasonable to suggest that these attitudes were implicit (or automatic). While this study can only give an indication of the efficacy of the method the results nonetheless suggest that further use would be warranted. Section 5.4.1 will discuss the method development in more detail for both this Study 5 (cyber-security EPT study) and Study 3 (food nutrition EPT study).

The third main aim of the thesis was to investigate the affect heuristic at an implicit level. The following section discusses this aspect of the research.

5.3.4.3 Affect Heuristic

The second aim of this study was to use explicit and implicit measures to investigate the affect heuristic in the context of cyber-security. The correlation analyses showed significant correlations of risk and affect for both types of measure. These results suggest that high risk is associated with negative affect, and low risk is associated with positive affect. This is in line with the affect heuristic which makes similar suggestions regarding risk perception (Slovic et al., 2007). The implicit measure results showed a weaker effect but it is not clear if this is due to a fundamental difference in processing or a sign that the measure is less sensitive than the explicit measure. Despite this, an affect heuristic type effect was still found for both types of measure.

5.3.4.4 Limitations / Future Research

Given the problems of familiarity with one of the terms (Encryption), it is crucial that future research includes more consistently recognized terms. Study 4 (while generating the priming items) found a significantly high level of familiarity for the term, and the samples from both that study and this study were similar (i.e. students), so the low familiarity levels in this study were surprising. It is worth noting that the self-reported knowledge levels of information communications technology also differed across the studies. The participants from Study 4 had significantly high levels but the participants from this study did not significantly differ from neutral. Given the similarity in sample types this is also somewhat surprising. What can be learned from this, however, is that no assumptions should be made on what may be expected from a sample, even if they appear similar to previously measured samples. The problems with the term (Encryption) did compromise the analyses, however, and suggest that this term was not ideal. As such, future studies would benefit from taking measures to ensure priming items are likely to be sufficiently familiar.

The number of priming items used was also limited. This was largely due to practicality as more items would necessarily increase the length of the tasks. Both EPT studies were limited in the same way for this same reason but if possible including more items would be beneficial. This is especially the case when considering that some items may not be sufficiently familiar despite efforts to avoid this. The fact that the item that was not well recognized in this study (Encryption) was a low risk/positive term also highlights another issue. From Study 4 it seemed that it was relatively easier to find high risk terms than low risk terms. It could also be argued that even low risk terms may often elicit high risk associations as they can be associated with protection from threat. Along with a wider range of terms in general, it would also be beneficial if more effective low risk/positive terms could be found.

Although only a minority of participants specifically stated that they found the EPT tasks long to perform (from the interview data), this does highlight an issue with the tasks. If participants get bored or find it difficult to concentrate it is likely to influence the small reaction time differences that underpin the EPT analyses. This also presents a problem for adding more priming items. While the length of the tasks did not appear to have a problematic impact in this study it is still important to ensure that the task length is limited. It would be natural to want to collect more data but if this is at the expense of the quality of that data this would be counter-productive.

As with the food health EPT study (and other studies in the thesis) the sample was restricted to younger adults. This was seen as beneficial as it provided information on a section of society that will continue to be affected by the issues investigated in future years. Nonetheless, future research collecting data from other groups would both enhance the value of the data in terms of cyber-security attitudes, and in terms of refining the methods. Future research would also benefit from investigation of technology experts as this could be used to discern what factors tend to drive laypeople attitudes even if these are not reasoned attitudes. Given that a benefit of using implicit measures is to investigate such non-reasoned (or automatic) attitudes this comparison across samples would be useful.

5.3.4.5 Conclusions

Cyber-security is a growing and pervasive issue. In order to more effectively communicate the risks to the general public it is necessary to understand how these risks are perceived. This study recognized that many people will find the relevant technical information difficult to process, and thus find it difficult to make safer choices. As such, it is important to recognize the need to consider implicit (or automatic) thought processes, as well as explicit (or deliberative) processing. This study used explicit (questionnaire and interview) and implicit (EPT) measures in order to investigate the varying processing. It is also important to consider the role of emotion (or affect) on these processes. This study found that risk and affect were associated for both explicit and implicit measures (i.e. high risk with negative affect, and low risk with positive affect). It was also found that some (but not all) of the cyber-security terms used produced significant explicit ratings and implicit scores. These were generally in line with expectations (i.e. Identity Theft considered high risk). It was also clear that familiarity played a part when particularly low. It also appears that implicit (automatic) risk attitudes to the terms were more evident when the term receives notable media attention, or is a genuine and personally relevant threat.

5.4 General Discussion – EPT Study Chapters

Both EPT chapters (Chapters 4 and 5) provided demonstrations of the newly developed EPT measures. These new EPTs measured implicit risk attitudes and implicit affect attitudes. The initial purpose for these new EPTs was to provide new methods that can be used in risk research, as well as in the area of implicit cognition more generally. There are other implicit risk attitude measures that already exist (e.g. Siegrist et al., 2006; Traczyk & Zaleskiewicz, 2015) but there are reasons for developing new methods. Firstly, the currently available implicit risk attitude measures are based on the IAT which has been criticized for being limited to relative comparison of categories rather than individual exemplars (Siegrist et al., 2006). While variants of the IAT are not so prone to this limitation, other criticisms have included dispute over the theoretical basis of the IAT (Fazio & Olson, 2003), or the impact of practice effects (Bluemke & Friese, 2006). It is not actually necessary to dismiss the value of the IAT measures, however, to justify developing new implicit risk attitude measures.

Fazio and Olson (2003) pointed out that the various implicit attitude measures often fail to produce strong correlations. This leads to speculation about what is actually being measured by the various methods since strong correlations would be expected if they were simply measuring the same "implicit cognition". In order to provide more clarity on this issue it has been suggested that different implicit methods should be used in research, and that it is counter-productive for the same methods to become too dominant (Hyde et al., 2010; Seger et al., 2014). The IAT is the most widely used implicit measure (and the one that has already been modified to measure implicit risk attitudes) so arguably the development of a qualitatively different implicit measure is needed. The EPT is also a popular implicit measure and it has been suggested that the mechanism in the EPT is more akin to spontaneous evaluative reaction than the IAT (Brand & Schweizer, 2015; Gawronski & De Houwer, 2014). It is also founded on a different theoretical basis unlike variants of the IAT. As such, a risk version of the EPT was developed with the aim of providing an alternative implicit risk measure that could therefore contribute to the understanding of implicit measurement.

The EPT involves priming items which are flashed on screen before the participant categorizes various target words. In order to develop the new EPTs it was first necessary to generate appropriate target words and priming items. Studies 1, 2, and 4 used questionnaires to generate familiar words/terms/images that were consistently rated as either high risk or low risk (and positive or negative for affect) so that they would be appropriate for use in the new versions of the EPT. This systematic approach meant that it was reasonable to presume that future participants in the EPT studies would correctly categorize target words, potentially be influenced by the priming items, and would be unlikely to find words or terms confusing. Overall this aim was met albeit there was a notable exception with one of the priming terms in the second EPT study that investigated cyber-security (Encryption). This term was significantly familiar to participants in the initial material generation questionnaire study but was not significantly familiar to participants in the EPT study. The samples in both studies were students so this difference was surprising and highlights how the characteristics of samples can vary despite attempts to limit such issues. Overall, however, the material generation questionnaire studies seemed to adequately provide appropriate materials for use in the EPT studies and provided a solid basis for the new EPT designs.

The two EPT studies provided demonstrations of the new methods in two contexts that were considered topical and of near universal relevance; food health (specifically food nutritional labelling) and cyber-security. Both these contexts are of current concern to society and are likely to remain so in the future. This meant that any findings could be claimed to have value beyond simply providing demonstrations of the new methods. Both of these EPT studies also included explicit measures (questionnaires and interviews) in order to compare the implicit and explicit responses.

The food health EPT study produced similar questionnaire results to the material generation questionnaire (for the food products that were used in the EPTs). This demonstrated that the explicit attitudes were relatively consistent across the samples and thus were suitable items for using in the EPTs. The focus of the food health EPTs was on the impact of including food nutritional labelling in the form of traffic lights. Given that every-day food products are unlikely to elicit strong risk associations, and the traffic lights represent a form of risk communication, this was a logical approach. The risk EPT produced one significant result with Mackerel Fillets producing a high risk association when traffic lights were added compared with no traffic lights being included. The affect EPT produced two significant results with both Crumpets and Spaghetti Carbonara producing more positive associations when the traffic lights were added.

A key aspect of the traffic light system is that it includes red lights which may be perceived as a warning sign and this may have a notable influence (e.g. Balcombe et al., 2010). The interview data also backed up this notion that red lights would be especially influential. The results for Mackerel Fillets in the risk EPT can be explained based on this red light impact as this product contained two red lights. So while being generally considered a low risk product this addition of red lights in the nutritional information caused the automatic perception to shift to higher risk. The affect EPT results for Crumpets could be understood due to the absence of red lights, and in fact dominance of green lights. As Crumpets are a similar product to cake the affective response may be variable as it may be seen as less healthy but also an enjoyable snack. The addition of information suggesting low risk may then cause any negative feelings to be alleviated resulting in a more positive feeling towards the product. The affect EPT result for Spaghetti Carbonara was more surprising as this did include red lights yet produced a more positive response when these red lights were present. It is possible that this is due to the traffic light information including fewer red lights than expected and thus the change in affective response was relative. Alternatively it could suggest that either there is a more complex process underpinning the implicit attitude formation or that the measures may not always produce consistency in measurement performance. This could be considered in future research from the perspectives of both investigating implicit attitude formation in relation to food nutritional labels, and in terms of refining the EPT measures.

The cyber-security EPT study also produced similar questionnaire results to the material generation questionnaire (for the items that were used in the EPTs). As mentioned previously, there was one notable exception but the other items were largely similar in results. This demonstrated that the explicit attitudes were relatively consistent across the samples and thus were suitable items for using in the EPTs. The risk EPT produced one significant result with Identity Theft revealing a high risk association result. The affect EPT produced three significant results with Identity Theft, Hacking, and Encryption all producing more negative association results. Identity Theft was identified as a high risk term from the material generation questionnaire so the risk EPT result was in the expected direction. The fact that this was the only significant result could be understood due to the fact that Identity Theft is arguably a more personally relevant issue than some of the other terms, less prone to ambiguity, and a genuinely prevalent issue.

5.4.1 Method Development

While the methods were used to investigate the two stated contexts, the main aim for the thesis was in the development of these new versions of the EPT. Taking the EPT results across both studies into consideration it is notable that both studies produced some significant results with both types of EPT. The risk EPT produced one significant result in each study. Certain factors were identified which may explain why these images or terms produced significant results when other images or terms did not. These are results that contradict expectation (Mackerel having red lights), personal relevance (Identity Theft), clear warning signals (red lights for Mackerel), clarity or lack of ambiguity (Identity Theft), and genuine prevalence of threat (Identity Theft). These factors can only be speculated upon based on the results but they do point to how future research could focus to either investigate these topics more or refine the EPT.

The affect EPTs produced five significant results across the studies albeit with one result seemingly anomalous, and one of little value due to familiarity issues. The other three results largely follow a similar line of explanation to the risk EPT results. The results are clearly not the same, however, so one issue that would be relevant for future research would be that the two types of EPT may be more sensitive to certain characteristics or that implicit risk attitudes and implicit affective attitude may operate in qualitatively different ways. If the latter were to be demonstrated in future research, incorporating refined versions of the methods, this would be a notable finding and would clarify the benefits of the new methods.

One thing that must be acknowledged is that the EPTs failed to produce significant effects with most of the primes. This may suggest that the methods are lacking sensitivity and even that there are key flaws in either design or analyses techniques. As with most implicit measures, the EPT relies on reaction times which are often inconsistent and prone to distortions. It is easy for a participant to intermittently lose concentration which can lead to changes in response speed that are not driven by attitude activation. This reliance on reaction time data may present an inherent weakness in the methods but this is an issue that is similar to most implicit measures. An alternative explanation for the results may be that these were the only priming items that produced sufficiently strong implicit attitudes. It is reasonable to expect that implicit results may often not correlate with explicit results (e.g. Nosek & Smyth, 2007), so finding significant effects from explicit measures for certain primes does not mean similar effects should be presumed from the implicit measures. It is also reasonable to expect that certain attitude-objects will not activate particularly strong attitudes automatically, even if they do produce strong explicit attitudes. As such, rather than the results suggesting a weakness in the efficacy of the methods, they may instead provide support for the value of the methods in that such differences between implicit and explicit attitude activation would otherwise go unnoticed without such methods.

Further research using these new methods could clarify these issues, including research in diverse risk domains. It has been suggested that risk attitudes and risk-taking behaviours can vary in different domains (e.g. Weber, Blais, & Betz, 2002). The EPT studies did include two different domains but if these methods were further used in a greater variety of domains this may go some way to more clearly understand their efficacy and function. It should also be acknowledged that the development conducted within this thesis provides a starting point for these new methods. The designs were based on systematic development and established EPT characteristics, with some refinements carried out between studies, but the methods will likely require further refinements. They will also require a greater body of work using the methods in order to more fully understand their strengths and weaknesses.

One issue that was revealed as potentially impactful from the two studies within the thesis was the time taken to complete the tasks. It is not clear that the results were adversely affected by the task lengths but there were suggestions from the interview data that the versions of the EPT used in the cyber-security study were perceived as long causing difficulties with concentration, albeit only for a minority. When reliant on small reaction time differences the issue of difficulty in concentration is clearly important. The food health EPT was shorter than the cyber-security EPT and was not reported to be prohibitively long. There is a clear tension that emerges between seeking more data and avoiding task fatigue. This is an issue that could be tackled by conducting a series of EPTs with systematically varying lengths in order to find the point when task length tends to become a problem. This issue of task length is also relevant to other variations or refinements that could be made such as using more target words or priming items. Using larger samples would provide more data but would not provide richer data sets for each participant that would produce a more robust average.

5.4.2 Affect Heuristic

Another of the key aims of the thesis was to investigate the affect heuristic at an implicit level. Attempts have been made to do this previously (e.g. Townsend et al., 2014) but without definitively demonstrating an implicit level affect heuristic. This thesis aimed to investigate this issue by combining the results from the new EPTs in a more direct manner. Initially it was necessary to investigate the affect heuristic at an explicit level and this was done in four of the studies (the target word generation questionnaire, cyber-security priming terms generation questionnaire, and the questionnaires that were included within the two EPT studies). All of these studies showed a clear affect heuristic effect based on the initial sets of target words, priming items, and smaller sets of priming items that were used for the EPT studies. In line with the affect heuristic (Slovic et al., 2007) these all showed that high risk was associated with negative affect, and low risk with positive affect.

The more interesting and novel findings, however, were the evidence for the affect heuristic at an implicit level, as shown with the EPT results. In the food health EPT the affect heuristic effect was not found for food product (priming) items when no traffic lights were included, but it was found when traffic lights were included. It seemed that the risk information provided by the traffic lights was necessary for this affect heuristic effect to be elicited at an automatic level. The cyber-security EPT also found the necessary significant correlation between risk and affect responses. Given that both EPTs demonstrated the affect heuristic at an automatic (implicit) level this provides notable evidence supporting the notion that the affect heuristic does also operate at an implicit level. It also provides support that the EPTs were effective in capturing automatically activated attitudes. These results also suggest that both EPTs are definitively capturing different implicit processing data. One issue that may have emerged could have been that the two EPTs are possibly capturing similar information using different specific components (i.e. target words) but the significant negative correlations (from both EPT studies) refute this possibility. It is worth noting that these correlations were relatively weak which would seem unlikely if the different EPT methods were simply measuring the same construct.

5.4.3 Conclusions

The main aims of Chapters 4 and 5 were to develop two new versions of the EPT, with one measuring implicit risk attitudes and the other implicit affect attitudes. There was a clear rationale for the benefits of these new methods both as research tools of implicit attitudes and for investigation of implicit measurement generally. Through systematic generation of materials, logical variations to the method, and an adherence to relevant prescribed approaches, this was achieved. Within two different contexts these new methods were demonstrated and used for investigation. While further refinements may be inevitable and further research that uses these methods will be necessary, the basis for these new methods has been explained and the process for using them described. Ideally this will lead to these methods being used in future research and they can make a contribution to risk research.

The secondary aim of these chapters was to investigate the affect heuristic at an implicit level. In both EPT studies the affect heuristic was shown at an implicit level representing a notable contribution to understanding of how and when the affect heuristic operates. Future research should aim to further investigate the nature of the affect heuristic at an automatic or implicit level in order to more fully understand how it functions.

These chapters were concerned with attitudes but there remains the question of risk-taking behaviour in relation to automatically activated attitudes. In particular, since the EPT uses brief exposure priming to facilitate automatic activation a point of interest was whether a similar facilitation may be possible with risk-taking behaviour. The next chapter describes the development of another new method that uses priming in order to automatically activate risk attitudes (or risk perception) and collects data on risk-taking behaviour directly.

Chapter 6:

Balloon Analogue Risk Task

– Priming Version (BART-P)

6.1 Introduction

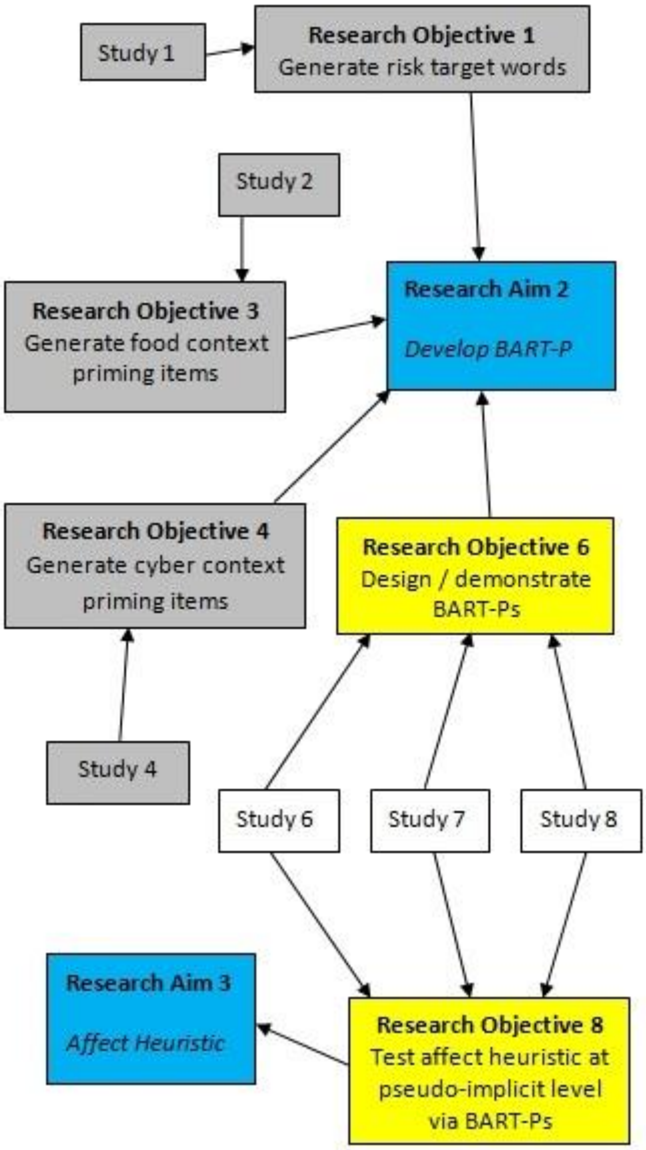
Research Aim 2 of the thesis was the development and demonstration of a modified version of the Balloon Analogue Risk Task (BART) that measures changes in risk-taking behaviour driven by automatic processing (via priming). The BART is a risk-taking behavioural measure that, in original form, measures stable risk propensity (Lejuez et al., 2002). In order to capture changes in risk-taking behaviour a version of the BART was developed that incorporated a priming component similar to that used in the EPT. As such, this is equivalent to the principles of the Bona Fide Pipeline in that the automatic risk attitude activation may spread to risk-taking tendency and thus produce changes in risk-taking behaviour.

The primes (words flashed briefly on the screen) were risk-related words, images related to food health, or terms associated with cyber-security. As the BART is a risk-taking task, differentiation was made between levels of risk-taking (i.e. high risk or low risk) rather than between risk-taking and risk-avoidance. Unlike other priming studies involving risk-taking behaviour (e.g. Erb et al., 2008; Fischer et al., 2008) a within-subjects design was used to investigate the malleability of risk taking behaviours. This method allows for investigation of changes in risk-taking behaviour to different types of risk prime (e.g. high risk prime or low risk prime). This method, therefore does not measure stable risk propensity (as in the original BART) but rather changes in risk-taking behaviour based on implicit memory effects via several different primes (i.e. high/low risk-related words/terms/images).

In order to meet the demands of Research Aim 2, several research objectives were identified. These objectives were achieved via three studies that are presented in this chapter. See Figure 6.1 for a schematic that displays the flow from each study to each research objective. Research Objective 6 (*The Balloon Analogue Risk Task method will be designed and demonstrated in a domain independent context (risk-related words, and two domain dependent contexts (food nutrition context and cyber-security context*) was the basis for meeting the demands of Research Aim 2. This was achieved by a combination of all three studies in this chapter (Study 6, Study 7, and Study 8). Study 6 provided the domain independent context (risk-related words), while Studies 7 and 8 provided the domain dependent contexts (food nutrition and cyber-security). These two latter studies also used the same priming items as used in the two EPT studies of this thesis, which provided an opportunity to compare the effect of these priming items in both an attitudinal and behavioural method.

As shown in Figure 6.1 (within the grey boxes) there were other studies that were also relevant to this chapter. These were the studies that were used to generate materials for the EPT tasks. Studies 2 and 4 were used to generate priming items for the EPT and the same priming items were also used for the BART studies in this chapter (i.e. food nutrition and cyber-security contexts). Study 1 initially was used to generate risk-related words that could be used as target words in the EPT tasks. In this chapter (for Study 6) a slightly different set of words was selected from Study 1 for use as priming items. The words selected and reasoning for selection will be explained in Study 6.

Figure 6.1: Schematic showing the relationship between the studies conducted (in white), research objectives (in yellow), and research aims (in blue), for Chapter 6.



Note: Grey boxes show studies and objectives that were presented in a previous chapter but are still relevant for this chapter.

This chapter describes the development of a risk-taking behavioural method but there was no equivalent affect method (unlike with the EPT studies). As such, there was less scope to investigate the affect heuristic (Research Aim 3) in this chapter. Nonetheless, some complimentary data was gathered in order to add to the data gathered in Chapters 4 and 5 regarding the affect heuristic. This involved Research Objective 8 (*The new version of the Balloon Analogue Risk Task that provides a measure of changes in risk-taking behaviour driven by automatic processing (via priming) will be tested for relationships with explicit measures of affect (questionnaire) to discern if an affect heuristic effect is evident*). Unlike in the EPT studies this did not mean specifically investigating the affect heuristic at an implicit or automatic level but did include risk-taking behavioural data based on automatic processing. Research Objective 8 was achieved via all three studies in this chapter. Study 6 also included two priming items that did not follow affect heuristic tendencies (i.e. high risk was associated with positive affect for one item, and low risk was associated with negative affect for another of the items). This provided an additional opportunity to add data regarding the investigation of the affect heuristic at an automatic level (Research Aim 3). More details regarding this will be given in Study 6.

Given that all three studies presented in this chapter all involved the use of the priming version of the BART, the following section explains the procedure for the method development.

6.1.1 Developing the BART-P (Balloon Analogue Risk Task – Priming)

The BART is a behavioural risk measure which has been shown to correlate with sensation seeking, impulsivity, and several real-life risky behaviours like gambling and drug use (Lejuez et al., 2002). On each trial, a participant is required to accumulate as many points as possible by ‘pumping’ an on-screen balloon (by pressing a button) and ‘banking’ those points (by pressing another button) before the balloon bursts. The balloon gets gradually larger with each pump a participant makes, and this is accompanied by a ‘pumping’ sound effect. One counter displays the number of points (or cash) accumulated for each trial and another counter displays the total number of points ‘banked’. If a balloon bursts, a participant loses any points accumulated on that trial, and he/she is advanced to the next trial. If a participant ‘banks’ his/her points on a trial, those points are added to the existing ‘banked’ points, and then he/she is advanced to the next trial. Thus, the more participants pump, the more they stand to gain so long as they bank their points before the balloon bursts. The point at which a balloon bursts is generated randomly by the computer program. The burst point is distributed uniformly between one and 128 pumps, giving an average burst point of 64 (although the actual average amount of pumps administered by participants tends to be around half of this) (Lauriola et al., 2014).

The BART has previously been adapted for several differing purposes. One such example is the BART-Y, which is a youth version for use with adolescents (Lejuez et al., 2007). Another variation (called the Balloon Analogue Insurance Task, BAIT) involved participants deciding on a monetary amount they were willing to use to insure their winnings to that point (Essex et al., 2011). This study found that the BAIT could complement the BART (rather than replace) since it provided information about different underlying processes (e.g. obsessive compulsive tendencies). In a study of sexual behaviour (Prause & Lawyer, 2014), a variant (BART-S) gave participants the option of viewing a brief clip of erotic film rather than receiving a monetary gain for each balloon pump. This study found that the monetary gain version was more predictive of gambling behaviours than the BART-S, but contrary to the researchers’ expectations, the BART-S was not a better predictor of the number of sexual partners. Both variants were, however, similarly predictive of financial risk-taking in general, suggesting that the BART is effective at predicting general risk-related decision-making regardless of the reward used in the task. Considering all of the examples, it seems that the BART and its existing variants measure stable traits or predict stable tendencies. While being able to measure and predict risk-taking traits / tendencies is of considerable value, the aim of this research was to develop a method for measuring changes in risk-taking behaviour when driven by automatic processing. In order to do this, the BART-P was developed, a BART variant that incorporated priming.

The key novel component of the BART-P is the inclusion of a prime before each balloon trial, and as such it can be thought of as a hybrid of an EPT and the BART. In an EPT, a prime (word or image) is presented briefly before each categorization / decision-making trial. In the BART-P, a prime (high or low risk-related word) is flashed in the middle of the screen for a fraction of a second, equivalent to the EPT (Fazio et al., 1995). In the food health EPT study (in Chapter 4) the stimulus onset asynchrony (SOA) was equivalent to the original EPT studies as the primes (food packaging sometimes including food nutritional labels) contained a lot of information. It was deemed wise to maintain this length of SOA in order to ensure there was sufficient time for the details to be processed, even though this was investigating automatic processing. The food health version of the BART-P (Study 7) also used this length of SOA for similar reasons. The other BART-P studies in this chapter (Study 6 and Study 8) used words or terms as the primes so a shorter SOA could be used. As in the cyber-security EPT study (in Chapter 5) the SOA was 200ms (150 milliseconds for the flashing of the prime, with 50ms of blank screen) as per the guidelines for EPT timings which suggest shorter SOAs are optimal (Wentura & Degner, 2010). After a prime is flashed, the participant completes the pumping task for one balloon. Thus, in the BART-P, one trial (in the priming phase) consists of the presentation of a prime and the subsequent pumping task for one balloon. Once a trial is completed (because the participant has either 'banked' or the balloon has burst) another trial begins.

In order to be able to measure the effect of priming, Baseline phases were included at the beginning and end (to control for any practice effects) of the BART-P. Trials in the baseline phases did not include any primes so that a difference score could be calculated by subtracting the average number of pumps during the baseline phases from the average number of pumps for a prime in the priming phase. Thus, a positive difference score (hereafter referred to as 'facilitated average pumps') represents more risk-taking due to priming, whereas negative facilitated average pumps represents less risk-taking due to priming.

Beyond adding a priming component, other adjustments were made when designing the BART-P. A minimum burst point of nine pumps and maximum burst point was set at 121 pumps was set. Consistent with other studies (e.g. Essex et al., 2011), this was done to prevent a participant being made unduly cautious due to a balloon bursting almost immediately but to maintain an average burst point of 64. The balloon was also displayed without any counters. This was done in order to prevent participants engaging in any response strategies that may be based on the number of pumps or ‘banked’ points, given that this could negate the effects of priming. See Figure 3.3 (in Chapter 3) for an example of a traditional layout and the modified layout used in the studies. Lastly, participants were incentivized by awarding those with the most ‘banked’ points with cash prizes as per Fischer and Hills (2012). The BART-P was administered via SuperLab 5.0 on a standard PC with a Model RB-530 response box.

The following section describes the approach that was taken for analyzing the data collected via the BART-P.

6.1.2 Analysing the BART-P

The two main measures from the original BART were ‘adjusted mean pumps’ and ‘balloon bursts’ (Lejuez et al., 2002). The higher the number of pumps or bursts, the higher a participant’s risk-taking, and this is thought to be indicative of a stable trait. In order to investigate the effects of priming, the ‘facilitated average pumps’, and ‘facilitated bursts’ were calculated for each prime in the BART-P.

In calculating ‘facilitated average pumps’, only trials in which participants ‘banked’ were used, in line with standard practice. The median pumps were used for each prime instead of the mean. This was done to minimize any outlier effects as there were a somewhat small number of trials per prime (e.g. in Study 6, there were 64 trials in the priming phase but only eight trials for each of the eight primes). The average number of baseline pumps (from the two blocks of baseline trials) was subtracted from the median number of pumps for a prime to derive the facilitated average pumps for that prime (this method is similar to calculating a facilitation score in an EPT) for every participant. Thus, the higher ‘facilitated average pumps’, the more risk a participant took due to the effect of the prime. A similar process was used to calculate ‘facilitated bursts’ but used the percentage of trials in which a balloon burst in calculating this score.

6.1.3 Explicit Measures (Questionnaire and Interview)

In all three studies, participants were asked to rate the selection of words / terms / images used as primes, based on how much they associated them with high or low risk (Risk), positive or negative affect (Affect), and how familiar they were with them (Familiarity). This was done using an on-screen slider which ranged from zero to 100. For Risk ratings, zero was labelled 'very low risk' and 100 was labelled 'very high risk'. For Affect ratings, zero was labelled 'very negative' and 100 was labelled 'very positive'. For Familiarity, zero was labelled 'not at all familiar' and 100 was labelled 'very familiar'. In Study 8, participants also used a slider to rate their information and communications technology (ICT) proficiency from zero (weak) to 100 (strong).

The studies in this chapter included a risk propensity measure (see Appendix 2), that was described in Section 3.4.1. This measure involved participants describing their own risk propensity on a scale from one to five. This measure is a short-form test so tends to only provide an indication of risk propensity but was included in the hope that some variation would still be evident. Unfortunately, there was little variation in the participants' responses. For all studies the majority of participants chose options one or two for all choices (i.e. 'never' or 'rarely'). Of the 42 participants in Study 6 this was 33 of the participants, for Study 7 this was 21 and 23 participants in each condition (of 30 for each condition), and for Study 8 this was 24 of 40 participants. Across the 12 choices (for all three studies) the mean result was always between 1.93 and 2.33, with 84% or higher of individual choices being either options one or two. This was 64% or higher for option two specifically which was by far the most common option chosen across all studies. This lack of variation, and suggestion that participants had perhaps quickly completed this section in order to finish the questionnaire, made any inclusion of the risk propensity data meaningless so it was not further analyzed and is not reported further.

Participants completed the questionnaire after the main BART task using the online questionnaire website Qualtrics. Following completion of the questionnaire, a short informal interview was conducted in order to identify any specific problems and to allow participants to make general comments. Participants were then debriefed.

6.1.4 Methodological Approach

Risk-taking is domain-specific (Hanoch, Johnson, & Wilke, 2006). For example, an individual who engages in high risk behaviours like rock climbing or other ‘extreme sports’, may take only moderate risks in other domains like financial investment. With this in mind three studies were conducted using the BART-P to demonstrate its efficacy across risk domains. The two domains investigated in the previous chapters (food health and cyber-security) were included. This was logical as materials (primes) were already developed and also meant that the results from the studies in this chapter could be compared with the results from the EPT study chapters. Study 6 examined the efficacy of the method by using high or low risk-related words as primes (domain independent context). Study 7 used the food health (food nutrition labels) items as primes, and Study 8 used cyber-security terms as primes (both studies were domain dependent contexts) to provide real-life contexts. The following section reports the first BART-P study (Study 6) that demonstrated the method in a domain independent context.

6.2 Study 6: BART-P – Risk Related Words

6.2.1 Introduction

In this study, high or low risk-related words were used as primes. These were chosen based on the results from Study 1 (Chapter 3) which generated risk-related words for use as target words in the risk EPTs. This was done to increase the likelihood that each prime would automatically activate either a high or low risk association from memory, and as such the primes are context (or domain) independent.

6.2.2 Method

This study consisted of three parts: the BART-P task, a questionnaire, and an interview. The BART-P tasks measured participants' risk-taking behaviour as measured via how many times they pumped the balloons, and how many balloons burst. The addition of primes meant changes in risk-taking behaviour could be measured. While not an implicit measure of risk-taking behaviour, this could be deemed a 'pseudo-implicit' measure as changes in behaviour were driven by automatic associations regarding the priming items. The questionnaire measured participants' explicit risk and affect attitudes towards the words. A short informal interview was included after the questionnaire which was used to clarify their explicit attitudes, to discern any additional relevant information, and to ensure instructions had been understood. The administration of the questionnaire and BART-P were counter-balanced and no task order effects were found.

6.2.2.1 Participants

In total, 42 participants comprised of 33 female and nine male participants were recruited. Their mean age was 21.2 years (*SD* = 3.39) ranging from 18 years to 34 years. All participants were undergraduate business students and received course credits for participating. The participants who accumulated the most points in the BART-P section of the study also received cash prizes.

6.2.2.2 Materials

In this study, eight different risk-related words were used as primes; four associated with high risk and four associated with low risk. These words were selected based on the results from Study 1. The four high risk primes were Dangerous, Hazardous, Unstable, and Daring. The four low risk primes were Certain, Safe, Reliable, and Unadventurous. Six of the words used as target words in the EPT studies were selected for use as primes in this study (three for each category of high risk or low risk).

In addition, two new words from Study 1 were included due to atypical risk and affect relationships. In line with the affect heuristic (Slovic et al., 2007), most words in Study 1 that received high risk ratings also received negative affect ratings, while most words that received low risk ratings also received positive affect ratings. There were, however, a small number of words that did not show this tendency. The only word that received a notably low risk rating but also a high negative affect rating was Unadventurous. This was subsequently selected for inclusion as the atypical low risk/positive affect priming word.

There were more words that received high risk but positive affect ratings, including Adventurous, Bold, and Daring. Daring had the highest risk rating of these words and Adventurous was discounted due to Unadventurous being used as the low risk/negative word. Daring was subsequently selected as the atypical high risk/positive affect priming word. The inclusion of these two atypical priming words was in order to see if this may impact the priming effect on risk-taking behaviour. For instance, if these two words produced significant risk-taking effects but the other words did not it would suggest that the effect may not be directly related to affective associations. Conversely, if these were the only words that did not produce effects this may suggest the affective association was crucial. Even if less consistent effects were found this would still contribute to the understanding of the importance or relevance of affective associations, in conjunction with risk associations. The total number of priming words used was limited to avoid task fatigue.

6.2.2.3 Procedure

For the BART-P task, each prime was used eight times in the priming phases (i.e. there were eight trials in the priming phases when Dangerous was used as the prime). Participants completed a block of eight baseline trials before and after the priming phases. Thus, baseline measures were calculated from the results of 16 baseline trials. The priming phase consisted of four blocks of 16 trials in which each of the primes was shown twice in a mixed order. Across both baseline and priming phases there were 80 trials, with 64 total trials in the priming phases. Participants were able to take short breaks in between blocks of trials. Full instructions were provided on screen and participants were asked to remember the words (i.e. priming words) for a separate memory test. They were also informed that they would receive points based on how many times they pumped the balloon, while avoiding bursting balloons and the participants with the most points would receive cash prizes. This encouraged them to be more risk-taking in general and made it less likely that they would focus on how the priming words may be influencing them.

The questionnaire was completed online via Qualtrics but this was done in the experiment room. All of the words (used as priming words) were rated for risk and affect. Ratings were made using the on-screen slider that produced a value between zero and 100. Each extreme of this scale (zero and 100) was labelled. For the risk ratings, the two extremes were 'very low risk' and 'very high risk'. For affect, these were 'very positive/good' and 'very negative/bad'. Various demographic details along with familiarity with the terms were also collected. This process was largely similar to the questionnaires completed as part of the EPT studies.

Short interviews (around five minutes) were conducted after the BART-P and questionnaire had been completed. Initially participants were asked if they had any specific issues while completing the earlier tasks and had understood what they had to do. Participants were asked if they knew the meanings of the words used. They were asked if they knew what the purpose of the task may be (i.e. that the priming words may influence their risk-taking behaviour). After these questions participants could add any further comments freely. Notes were taken of their responses and this information was used to identify key issues, trends, or common responses.

6.2.3 Results

6.2.3.1 Questionnaire Data

There were no significant differences or associations relating to gender (all p >.23), age (all p >.35), or native language (all p > .18).As can be seen in Table 6.1, all 'high risk' word primes were given risk ratings greater than 50 (neutral), and all 'low risk' word primes were given risk ratings less than 50. All 'high risk' primes also received negative affect ratings, other than Daring which received positive ratings. All 'low risk' primes received positive affect ratings, other than Unadventurous which received negative affect ratings. All word primes were given high familiarity ratings.

Table 6.1: Questionnaire Risk, Affect, and Familiarity ratings (Means and Standard Deviations) for all risk-related words.

	Risk			Affect			Familiarity		
	Mean	*SD*	*N*	Mean	*SD*	*N*	Mean	*SD*	*N*
Dangerous	88.9	10.9	42	20.5	21.6	42	92.3	16.6	42
Hazardous	84.1	18.1	42	18.8	15.1	42	87.9	18.3	42
Unstable	73.1	18.7	42	22.8	12.2	42	87.6	19.4	42
Daring	64.1	13.7	42	58.1	20.6	42	83.5	21.1	42
Certain	22.2	26.7	42	82.8	17.9	42	93.6	13.5	42
Safe	6.8	12.9	42	89.6	15.04	42	91.3	17.4	42
Reliable	15.3	15.5	42	85.7	18.02	42	91.8	14.8	42
Unadv	18.9	14.5	42	35.1	20.4	42	87.2	20.3	42

All scores range from zero to 100; Risk from zero (low risk) to 100 (high risk), Affect from zero (negative) to 100 (positive), Familiarity from zero (not familiar) to 100 (very familiar).
(Unadv = Unadventurous)

Table 6.2 gives the results of one-sample t-tests. All ratings were found to be significantly different than a neutral rating of 50.

Table 6.2: Questionnaire Risk, Affect, and Familiarity results from one-sample t-tests (test value of 50) for risk related words.

			Risk		
	t	*df*	*p*	CI low	CI high
Dangerous	23.02	41	**<.001**	35.5	42.3
Hazardous	12.2	41	**<.001**	28.4	39.7
Unstable	8.04	41	**<.001**	17.3	28.96
Daring	6.7	41	**<.001**	9.8	18.4
Certain	-6.7	41	**<.001**	-36.1	-19.5
Safe	-21.7	41	**<.001**	-47.3	-39.2
Reliable	-14.5	41	**<.001**	-39.6	-29.9
Unadv	-13.9	41	**<.001**	-35.6	-26.5
			Affect		
	t	*df*	*p*	CI low	CI high
Dangerous	-8.9	41	**<.001**	-36.2	-22.8
Hazardous	-13.4	41	**<.001**	-35.95	-26.5
Unstable	-14.5	41	**<.001**	-31.04	-23.4
Daring	2.55	41	**0.014**	1.7	14.5
Certain	11.9	41	**<.001**	27.2	38.3
Safe	17.1	41	**<.001**	34.9	44.3
Reliable	12.9	41	**<.001**	30.1	41.4
Unadv	-4.8	41	**<.001**	-21.3	-8.6
			Familiarity		
	t	*df*	*p*	CI low	CI high
Dangerous	16.5	41	**<.001**	37.1	47.4
Hazardous	13.4	41	**<.001**	32.2	43.6
Unstable	12.5	41	**<.001**	31.5	43.7
Daring	10.3	41	**<.001**	26.9	40.1
Certain	20.97	41	**<.001**	39.4	47.8
Safe	15.4	41	**<.001**	35.9	46.7
Reliable	18.4	41	**<.001**	37.2	46.4
Unadv	11.9	41	**<.001**	30.9	43.6

CI low and CI high refer to the 95% Confidence Interval results (difference from 50).
(Unadv = Unadventurous)

6.2.3.2 Interview Data

No participant said that they had any specific issues or problems understanding the task or in completing the BART-P. No participant said that they had any issues understanding the meanings of the words used as primes. After the task was explained, no participant suggested that they had guessed that risk-taking changes due to the presence of the primes was the purpose of the task. No participant stated they had any issues with the length of the task but three participants said that they were either glad it had not been any longer or that a longer task may have caused issues with concentration. No other common themes emerged.

6.2.3.3 BART-P Results

Table 6.3 shows the mean 'facilitated average pumps' (Pumps) and 'facilitated bursts' (Bursts) for each prime. It can be seen that all 'facilitated average pumps' were positive suggesting that all (high and low risk-related) primes led to more pumps than during the baseline phases. In order to examine these findings further, one-sample t-tests were conducted. As seen in Table 6.4, only the primes Dangerous and Daring led to significantly more pumps (i.e. risk-taking).

Table 6.3 also shows a considerable amount of variation for 'facilitated bursts' (Bursts). There did not appear to be an effect on facilitated bursts for the high risk-related word primes but there seemed to be a trend toward lower facilitated bursts for the low risk-related word primes. In order to investigate these findings further, one-sample t-tests were conducted. As seen in Table 6.4, Certain was the only prime that had a significant effect on facilitated bursts. When primed with the prime Certain participants burst fewer balloons, which suggests less risk-taking.

Table 6.3: Descriptive statistics of 'facilitated average pumps' and 'facilitated bursts' for each risk-related word prime.

	Dangerous	Hazardous	Unstable	Daring	Certain	Safe	Reliable	Unadv
Pumps								
Mean	4.4	1.8	0.63	3.01	1.2	1.4	3.3	1.3
SD	9.2	11.3	15.1	7.9	9.6	9.3	10.8	12.6
Min	-15	-19.5	-64.5	-16.5	-17.5	-25.5	-19	-33
Max	26	33	35.5	24	31	21.5	37	48.5
Bursts								
Mean	-2.98	-0.89	1.2	-1.2	-6.6	-2.4	0.595	-0.595
SD	17.3	17.2	19.1	16.2	15.4	17.02	16.6	16.5
Min	-37.5	-37.5	-37.5	-43.8	-43.8	-37.5	-43.8	-56.3
Max	43.8	37.5	37.5	31.3	25	43.8	31.3	25
N	42	42	42	42	42	42	42	42

Mean Pumps = baseline balloon pumps subtracted from balloon pumps after prime.
Mean Bursts = proportion of baseline balloons that burst in baseline phase subtracted from bursts after prime (proportion converted to a %).
(Unadv = Unadventurous)

Table 6.4: One-sample t-test results (test value of zero) for each risk-related word prime.

			Pumps		
	t	*df*	*p*	CI low	CI high
Dangerous	3.1	41	**0.004**	1.5	7.2
Hazardous	1.1	41	0.298	-1.7	5.4
Unstable	0.27	41	0.788	-4.1	5.3
Daring	2.5	41	**0.018**	0.55	5.5
Certain	0.8	41	0.441	-1.8	4.2
Safe	0.97	41	0.339	-1.5	4.3
Reliable	1.96	41	0.056	-0.095	6.6
Unadv	0.66	41	0.515	-2.7	5.2
			Bursts		
	t	*df*	*p*	CI low	CI high
Dangerous	-1.1	41	0.27	-8.4	2.4
Hazardous	-0.34	41	0.738	-6.2	4.5
Unstable	0.403	41	0.689	-4.8	7.2
Daring	-0.48	41	0.637	-6.3	3.9
Certain	-2.8	41	**0.009**	-11.3	-1.8
Safe	-0.91	41	0.37	-7.7	2.9
Reliable	0.23	41	0.818	-4.6	5.8
Unadv	-0.23	41	0.816	-5.7	4.6

CI low and CI high refer to the 95% Confidence Interval results (difference from zero).
(Unadv = Unadventurous)

6.2.3.4 Affect Heuristic and Relationships in the Data

Correlation analyses were conducted in order to investigate the affect heuristic at an explicit level (i.e. based on the questionnaire data). Risk and affect ratings were significantly negatively correlated, $r(334) = -.68$, $p < .001$, in line with the affect heuristic. There was no "pseudo-implicit" affect data that could be compared with the BART-P data ("pseudo-implicit" risk data) in order to investigate the affect heuristic at a "pseudo-implicit" level. In order to investigate if the BART-P risk-taking results showed a relationship with the affect rating results from the questionnaire further correlation analyses were conducted. Affect ratings from the questionnaire did not correlate significantly with the 'facilitated average pumps' measure, $r(334) = .06$, $p = .336$, nor the 'facilitated bursts' measure, $r(334) = -.02$, $p = .783$.

Correlation analyses were also conducted between the BART-P results and the risk ratings results from the questionnaire to investigate if the BART-P results were related to the explicit (questionnaire) risk ratings. Risk ratings from the questionnaire did not correlate significantly with the ‘facilitated average pumps’ measure, $r(334) = -.02$, $p = .66$, nor the ‘facilitated bursts’ measure, $r(334) = .04$, $p = .414$. The ‘facilitated average pumps’ results were not significantly related to the ‘facilitated bursts’ results, $r(334) = .08$, $p = 161$.

6.2.4 Discussion

The main aim was to develop then test a new priming version of the BART (BART-P). The first aim was to investigate if the BART-P captured changes in risk-taking behaviour as opposed to stable traits. The second aim was to investigate whether there were asymmetrical effects of high risk and low risk primes on risk-taking behaviour, i.e. to investigate if high risk primes facilitate high risk-taking behaviour to a greater extent than low risk primes facilitate low risk-taking behaviour.

The new method produced relevant results since two of the words produced significant results based on the ‘facilitated average pumps’ which was the main measure of interest. In both cases (Dangerous and Daring) the results showed that participants tended to pump the balloon more after these words than in the baseline phase. This is in line with previous work (e.g. Bargh et al., 1996) where exposure to a particular prime results in a change in behaviour that is in a congruent direction (i.e. priming for high risk produced higher risk behaviour). The one significant result from the secondary measure, ‘facilitated bursts’, also produced an effect in a congruent direction. Specifically, the prime Certain resulted in fewer balloons being burst (i.e. lower risk word produced lower risk behaviour).

Based on the primary measure of ‘facilitated average pumps’ there was an indication that high risk words had relatively more impact than low risk words (which related to the second aim) since the two primes that produced significant effects were both high risk primes. This finding is in line with the notion that high risk information is more salient than low risk information (Covello & Sandman, 2001). This conclusion must be considered with caution, however, since the only significant example from the ‘facilitated bursts’ analysis was actually one of the low risk terms. Clearly further work is required to clarify the respective influences of high and low risk words/terms on the primary and secondary measures (‘facilitated average pumps’ and ‘facilitated bursts’).

The third aim was to investigate the affect heuristic. The explicit measures revealed that high risk was associated with negative affect and low risk with positive affect, in line with the affect heuristic. This was also equivalent to the explicit measure results from Study 1 which used a larger set of risk-related words. Since there was no equivalent “pseudo-implicit” affect measure to test for relationships with the BART-P data, the only affect heuristic test that was possible was between the BART-P data and the explicit (questionnaire) affect data. No relationship was found. It is worth noting that in the EPT studies there was a lack of correlation between implicit and explicit measures. One of the atypical words (i.e. words that did not receive risk and affect ratings in line with the affect heuristic) did produce a significant BART-P effect: Daring. This word was rated as positive for affect and high risk, and also produced significantly more risk taking based on the primary measure of ‘facilitated average pumps’. This suggests that the priming influence did not require primes that were in line with the affect heuristic (i.e. one high risk prime produced a significant effect despite also being rated as positive for affect). This suggests that for risk-taking behaviour at least, automatic risk associations may be sufficient to produce a behavioural change.

While some words produced significant results there were several other words that did not. One explanation is that the significant words simply had stronger risk associations. Indeed, Dangerous received the highest overall risk ratings in the questionnaire. Daring, however, had a relatively lower risk rating yet produced a significant effect for ‘facilitated average pumps’. Some of the words are also more readily associated with behaviour than others. Daring, for instance, can be understood as a behavioural state but some other words (e.g. Hazardous or Unstable) more readily describe a situational state. This distinction between words that suggest either behavioural or situational states suggests a possible direction for future research. It may be that the functioning of the BART-P can be more fully understood when this is more directly incorporated in the design (e.g. if all priming items suggested behavioural states).

This study provides the first demonstration of the BART-P. Specifically, this study provides a demonstration in a domain independent context. This is important because it suggests that any effects found are not simply due to a peculiarity of the potential attitudes held regarding specific real-world issues. In order to more fully provide the demonstration the BART-P was applied in domain dependent context studies, to investigate whether the method was efficient despite the inevitable additional attitudes that real-world contexts will elicit.

6.3 Study 7: BART-P – Food Nutritional Labels

6.3.1 Introduction

Study 6 used the BART-P to investigate the effects of priming on changes in risk-taking behaviour in a domain independent context. In order to investigate whether the BART-P can be used to measure changes in risk-taking behaviour in a more ecologically valid, domain dependent context, this study was conducted using food health items (specifically food nutritional labels in the form of food traffic lights) as primes. This also provided further data regarding this domain that could be compared with the food health EPT study in Chapter 7.

6.3.2 Method

This study was set-up in the same way as Study 6, with three parts: the BART-P task, a questionnaire, and an interview. The administration was the same and the only key differences were the differing priming items and slight changes to the organization of the blocks and trials in the BART-P task, which are subsequently explained.

6.3.2.1 Participants

A new sample of participants was recruited for this study. The participants were 60 undergraduate business students and they received course credits for their participation. They were randomly allocated to one of two conditions: ‘images with traffic lights’ and ‘images without traffic lights’, with 30 participants in each condition. In the ‘with traffic lights’ condition, there were nine males and 21 females, with mean age of 21.8 years ranging from 19 to 32 years (*SD* = 2.4). The ‘without traffic lights’ condition included six males and 24 females, with mean age 21.8 years ranging from 20 to 31 years (*SD* = 1.93). The participants who accumulated the most points in the BART-P section of the study also received cash prizes.

6.3.2.2 Materials

To compare the results from this study with the results from the food health EPT study (Study 3), the same priming items were used. These were the five food products used previously: Mackerel Fillets, Crumpets, Ice Lolly, Cod, and Spaghetti Carbonara. As in the food health EPT study these were shown to one group without any nutritional information on the front of the packaging (i.e. without traffic lights), while another group were shown the same products but with nutritional information present on the front of the packaging (i.e. with traffic lights).

6.3.2.3 Procedure

For the BART-P task, the block and trial configuration was slightly different from the previous BART-P study. This was due to the inclusion of less priming items. Each prime was used ten times in the priming phases (i.e. there were ten trials in the priming phases when Crumpets ‘with traffic lights’ included was used as the prime). Participants completed a block of ten baseline trials before and after the priming phases. Thus, baseline measures were calculated from the results of 20 baseline trials. The priming phase consisted of five blocks of 10 trials in which each of the primes was shown twice in a mixed order. Across both baseline and priming phases there were 70 trials, with 50 total trials in the priming phases. This was slightly fewer trials overall (and for the priming phases) than the previous BART-P study that investigated risk-related words. Participants were able to take short breaks in between phases / blocks of trials. Full instructions were provided on screen and asked participants to remember the words (i.e. priming words) for a separate recognition test. Participants were also informed that they would receive points based on how many times they pumped the balloon, while avoiding bursting balloons, and the participants with the most points would receive cash prizes. This encouraged them to be more risk-taking in general and made it less likely that they would focus on how the priming words may be influencing them.

The questionnaire was completed online via Qualtrics but this was done in the experiment room. All of the words (used as priming words) were rated for risk and affect. Ratings were made using the on-screen slider that produced a value between zero and 100. Each extreme of this scale (zero and 100) was labelled. For the risk ratings, the two extremes were 'very low risk' and 'very high risk'. For affect, these were 'very positive/good' and 'very negative/bad'. Various demographic details along with other details, such as specific dietary requirements or restrictions were also collected. This process was largely similar to the questionnaires completed as part of the food health EPT study.

Short interviews (around five minutes) were conducted after the BART-P and questionnaire had been completed. Initially participants were asked if they had any specific issues while completing the earlier tasks and had understood what they had to do. Participants were also asked if considered any of the food products to be particularly indicative of high or low risk, and what they thought risk meant in this context. They were asked if there were any personal reasons (such as food allergies or dietary restrictions) that influenced their attitudes. Participants were then asked if they were familiar with the traffic light system, how well they understood the system, and which aspects of the system tended to drive their attitudes. They were asked if they knew what the purpose of the task may be (i.e. that the priming words may influence their risk-taking behaviour). After these questions participants could add any further comments freely. Notes were taken of their responses and this information was used to identify key issues, trends, or common responses.

6.3.3 Results

6.3.3.1 Questionnaire Data

There were no problematic differences or associations relating to gender (all p >.24), age (all p >.32), or native language (all p > .37). Table 6.5 reports the risk ratings descriptive statistics for the questionnaire data. In the 'with traffic lights' condition both Crumpets and Cod show averages that appear notably below the neutral level of 50 (i.e. low risk ratings). Spaghetti Carbonara shows a notably high risk rating, while both Mackerel and Ice Lolly do not appear to be far from neutral. In the ‘without traffic lights’ condition the only item that shows a risk rating above neutral is Spaghetti Carbonara. Mackerel and Cod seem to show notably low risk ratings, while Crumpets and Ice Lolly do not appear very below neutral.

Table 6.6 reports the affect ratings descriptive statistics for the questionnaire data. In the ‘with traffic lights’ condition Crumpets, Ice Lolly, and Cod are all above the neutral level of 50 (i.e. positive affect ratings). Spaghetti Carbonara and Mackerel are both below neutral (i.e. negative affect ratings) although Mackerel seems relatively close to neutral. In the ‘without traffic lights’ condition all items are above neutral with Ice Lolly and Cod receiving the highest (most positive) affect ratings.

In order to test the differences based on presence of traffic lights, independent-samples t-tests were conducted (see Table 6.7). Mackerel and Spaghetti Carbonara showed significantly higher risk scores when the traffic lights were present, while Crumpets and Cod showed lower risk scores. For affect judgements, only Spaghetti Carbonara showed a significant difference (with Ice Lolly marginally non-significant and more negative with traffic lights included). In line with expectations, Spaghetti Carbonara was judged as more negative when traffic lights were present.

Table 6.5: Means and standard deviations (*SD*) for the risk questionnaire ratings when participants viewed food product images with or without traffic light nutrition information.

		Mean	*SD*	N
With Traffic Lights	Mackerel	46.7	26.03	30
	Crumpets	28.9	23.2	30
	Ice Lolly	50.3	25.8	30
	Cod	7.1	10.3	30
	Spaghetti Carbonara	81.4	14.6	30
Without Traffic Lights	Mackerel	17.7	16.9	30
	Crumpets	45	29.4	30
	Ice Lolly	41.9	29.2	30
	Cod	17.3	17.9	30
	Spaghetti Carbonara	62.4	29.3	30

Risk scores range from zero (low risk) to 100 (high risk).

Table 6.6: Means and standard deviations (*SD*) for the affect questionnaire ratings when participants viewed food product images with or without traffic light nutrition information.

		Mean	*SD*	N
With Traffic Lights	Mackerel	47.1	31.1	30
	Crumpets	65.8	23.2	30
	Ice Lolly	62.1	28.5	30
	Cod	71.4	28.4	30
	Spaghetti Carbonara	37.7	32.9	30
Without Traffic Lights	Mackerel	55.6	30.8	30
	Crumpets	59.4	26.9	30
	Ice Lolly	73.7	20.9	30
	Cod	62.6	25.4	30
	Spaghetti Carbonara	58.5	22.7	30

Affect scores range from zero (very negative) to 100 (very positive).

Table 6.7: Questionnaire Independent samples t-test results for all food products (both Risk and Affect judgements) based on differences between 'with traffic lights presented' and 'without traffic lights' conditions.

	t-stat	p-value	df	Mean Diff	95% CI of diff	
RISK						
Mackerel	5.14	**<.001**	58	29.07	17.74	40.4
Crumpets	-2.35	**.022**	58	-16.07	-29.76	-2.38
Ice Lolly	1.19	.24	58	8.43	-5.79	22.66
Cod	-2.71	**.009**	58	-10.2	-17.74	-2.66
Spaghetti Carbonara	3.18	**.002**	58	19	7.03	30.97
AFFECT						
Mackerel	-1.07	.291	58	-8.53	-24.55	7.48
Crumpets	0.98	.33	58	6.37	-6.61	19.43
Ice Lolly	-1.79	.078	58	-11.57	-24.49	1.36
Cod	1.26	.211	58	8.8	-5.13	22.73
Spaghetti Carbonara	-2.84	**.006**	58	-20.77	-35.38	-6.15

CI low and CI high refer to the 95% Confidence Interval results (difference from 50).

6.3.3.2 Interview Data

No participant said that they had any specific issues or problems understanding the task or in completing the BART-P. Seven participants suggested they had been unsure what was meant by risk in the context of food products and that they had found it difficult to make a judgement (in the questionnaire). One participant said that they felt the traffic lights for Mackerel were misleading as it was a healthy food. There were no additional dietary issues that were highlighted in the interviews. All participants said they had heard of the traffic light system or recognized it. Only four said they felt they had a strong understanding of how they worked, however. Three participants said they felt red traffic lights were most important but most participants did not specify any strategy for how they considered the traffic light information. After the task was explained, no participant suggested that they had guessed that risk-taking changes due to the presence of the primes was the purpose of the task. No participant stated they had any issues with the length of the task. No other common themes emerged.

6.3.3.3 BART-P Results

Table 6.8 shows the mean 'facilitated average pumps' (Pumps) for each prime in both conditions. It can be seen that most 'facilitated average pumps' were positive suggesting that the presence of primes led to more pumps than during the baseline phases. The only primes that produced negative results (i.e. where the presence of the prime led to fewer pumps) were Cod and Spaghetti Carbonara in the 'without traffic lights' condition.

Table 6.8: Means and standard deviations (*SD*) for the facilitated average pumps (in the BART-P) when subjects viewed food product images with or without traffic light nutrition information.

		Mean	***SD***	**N**
With Traffic Lights	Mackerel	2.5	8.5	30
	Crumpets	1.8	8.7	30
	Ice Lolly	2.7	8.5	30
	Cod	0.5	8.2	30
	Spaghetti Carbonara	1.9	9.7	30
Without Traffic Lights	Mackerel	0.01	5.3	30
	Crumpets	1.2	7.6	30
	Ice Lolly	0.24	5.8	30
	Cod	-0.36	6.6	30
	Spaghetti Carbonara	-0.37	8.9	30

Mean Pumps = baseline balloon pumps subtracted from balloon pumps after prime.

Table 6.9 shows the mean 'facilitated bursts' (Bursts) for each prime. It can be seen that most 'facilitated bursts' were negative suggesting that most primes led to fewer balloons bursting than during the baseline phases. The only primes that produced positive results (i.e. where the presence of the prime led to more balloons being burst) were Mackerel (in the 'with traffic lights' condition), and Spaghetti Carbonara (in the 'without traffic lights' condition).

Table 6.9: Means and standard deviations (*SD*) for the facilitated bursts (in the BART-P) when subjects viewed food product images with or without traffic light nutrition information.

		Mean	*SD*	N
With Traffic Lights	Mackerel	0.33	18.2	30
	Crumpets	-5.3	14.9	30
	Ice Lolly	-1.7	14.9	30
	Cod	-7	13.8	30
	Spaghetti Carbonara	-4.7	15.4	30
Without Traffic Lights	Mackerel	1.3	13.5	30
	Crumpets	-1.7	16.4	30
	Ice Lolly	-5	12.3	30
	Cod	-1.7	18.1	30
	Spaghetti Carbonara	0.01	17.02	30

Mean Bursts = proportion of baseline balloons that burst in baseline phase subtracted from bursts after prime (proportion converted to a %).

One-sample t-tests were conducted on the results from each individual prime and only two items produced significant results. Cod, in the 'with traffic lights' condition, produced significantly fewer 'facilitated bursts' when the prime was shown compared with baseline, $t(29) = -2.8$, $p = .01$, 95% CI of diff [-12.2,-1.8]. Ice Lolly, in the 'without traffic lights' condition, produced significantly fewer 'facilitated bursts' when the prime was shown compared with baseline levels, $t(29) = -2.2$, $p = .033$, 95% CI of diff [-9.6,-0.43]. All other primes produced non-significant results (all $p > .097$).

Part of the focus for the food health investigations was on how much difference was caused by the specific presence of traffic light information on the packaging. In order to investigate any differences between the conditions (with or without traffic lights) in the BART-P data, independent-samples t-tests were conducted. See Table 6.10 for all results for both ‘facilitated average pumps’ and ‘facilitated bursts’ measures. No significant results were found for any items meaning that there were no differences that were caused specifically due to the presence of traffic light information on the packaging, in the BART-P data.

Table 6.10: BART-P Independent samples t-test results for all food products (both facilitated average pumps and facilitated bursts) based on differences between ‘with traffic lights presented’ and ‘without traffic lights’ conditions.

	t-stat	p-value	df	Mean Diff	95% CI of diff	
Facilitated Pumps						
Mackerel	-1.4	.175	58	-2.5	-6.2	1.2
Crumpets	-0.29	.775	58	-0.61	-4.8	3.6
Ice Lolly	-1.3	.202	58	-2.4	-6.2	1.3
Cod	-0.45	.653	58	-0.87	-4.7	2.98
Spaghetti Carbonara	-0.94	.35	58	-2.3	-7.1	2.5
Facilitated Bursts						
Mackerel	0.24	.81	58	1	-7.3	9.3
Crumpets	0.91	.369	58	3.7	-4.4	11.8
Ice Lolly	-0.95	.347	58	-3.3	-10.4	3.7
Cod	1.3	.205	58	5.3	-2.99	13.7
Spaghetti Carbonara	1.1	.27	58	4.7	-3.7	13.1

6.3.3.4 Affect Heuristic and Relationships in the Data

Correlation analyses were conducted in order to investigate the affect heuristic at an explicit level (i.e. based on the questionnaire data). For images with traffic lights included, risk and affect ratings were significantly negatively correlated, $r(148) = -.53$, $p < .001$. For images without traffic lights included, risk and affect ratings were also significantly negatively correlated, $r(148) = -.19$, $p = .022$. Both were in line with the affect heuristic.

In order to investigate if the BART-P risk-taking results showed a relationship with the affect rating results from the questionnaire further correlation analyses were conducted. For images with traffic lights included, affect ratings from the questionnaire did not correlate significantly with the ‘facilitated average pumps’ measure, $r(148) = -.02$, $p = .824$, nor the ‘facilitated bursts’ measure, $r(148) = -.11$, $p = .187$. For images without traffic lights included, affect ratings from the questionnaire did not correlate significantly with the ‘facilitated average pumps’ measure, $r(148) = .07$, $p = .374$, nor the ‘facilitated bursts’ measure, $r(148) = .01$, $p = .92$.

Correlation analyses were also conducted between the BART-P results and the risk ratings results from the questionnaire to investigate if the BART-P results were related to the explicit (questionnaire) risk ratings. For images with traffic lights included, risk ratings from the questionnaire did not correlate significantly with the ‘facilitated average pumps’ measure, $r(148) = -.08$, $p = .318$, nor the ‘facilitated bursts’ measure, $r(148) = -.06$, $p = .459$. For images without traffic lights included, risk ratings from the questionnaire also did not correlate significantly with the ‘facilitated average pumps’ measure, $r(148) = -.14$, $p = .078$, nor the ‘facilitated bursts’ measure, $r(148) = .15$, $p = .061$.

For images with traffic lights included, the ‘facilitated average pumps’ results were significantly negatively correlated with the ‘facilitated bursts’ results, $r(148) = -.22$, $p = 008$. This meant that as the amount of balloon pumps increased the amount of balloons that burst decreased. For images without traffic lights included, the ‘facilitated average pumps’ results were not significantly correlated with the ‘facilitated bursts’ results, $r(148) = -.07$, $p = 363$.

6.3.4 Discussion

Following Study 6, which used the BART-P in a domain independent context, this study used the BART-P in a domain dependent context: food health. This is the second study within the thesis that investigated food health (specifically food nutritional labels in the form of food traffic lights). The first aim was to investigate if the BART-P captured changes in risk-taking behaviour as opposed to stable traits. For this study, there were no significant effects that were found when comparing primes with or without ‘traffic lights’ present on the food packaging. This was true for both the primary measure of 'facilitated average pumps' and the secondary measure of 'facilitated bursts'.

Two of the primes did produce significant results when considered in isolation (i.e. when comparing each separate prime with baseline only). Both of these instances involved participants bursting fewer balloons, and therefore showed less risk-taking. One of the primes was Ice Lolly (without traffic lights) which was initially chosen as a neutral option. The other prime was Cod (with traffic lights) and finding a significant result with this prime is more in line with what may have been expected. The traffic lights for Cod were all green so this additional information, along with Cod generally being rated as low risk, may have been enough to produce the effect (i.e. led to lower risk rating). Cod received the lowest risk ratings, for both conditions, in the questionnaire. It also received significantly lower risk ratings when the traffic lights were present than when they were not present. No other prime produced a significant effect, however. This could suggest lack of sensitivity in the measure but could also suggest that food products will generally not elicit strong risk attitudes, or influence risk-taking behaviour to the same extent as other priming items.

The second aim was to investigate whether there were asymmetrical effects of high risk and low risk primes on risk-taking behaviour, i.e. to investigate if high risk primes facilitate high risk-taking behaviour to a greater extent than low risk primes facilitate low risk-taking behaviour. No significant effects were found for any 'high risk' items so this was not supported. While one of the significant effects based on 'facilitated bursts' was for the neutral prime (Ice Lolly), the other prime that produced such a result was a 'low risk' prime (Cod). So while this study produced limited results in general, the results suggest that 'low risk' primes may drive risk-taking behaviour to a greater extent than 'high risk'.

The third aim was to investigate the affect heuristic. The explicit measures revealed that high risk was associated with negative affect and low risk with positive affect, in line with the affect heuristic. The effect size was greater for the 'with traffic lights' condition which may suggest that this effect was largely driven by the traffic light information itself. No relationship was found between the BART-P results and the explicit (questionnaire) affect ratings. As with the previous BART-P studies it is not clear how meaningful this lack of correlation is, given that the EPT studies revealed a lack of correlation between implicit and explicit measures. It is also worth noting that again the BART-P results did not correlate with the explicit risk ratings suggesting that the BART-P is not simply driven by explicit risk attitudes.

This was the first study to use the BART-P in a domain dependent context: food health. Significant effects were found for two of the primes but overall most primes did not produce such results. It is worth noting that ‘average pumps’ is normally considered the primary measure for the regular BART (Lejuez et al., 2002), but the only significant effects found in this study were for the secondary measure (Bursts). Nonetheless, significant effects were still found, even in a domain that may not necessarily be commonly associated with risk. In order to investigate the efficacy of the BART-P further (particularly in a domain dependent context) the next study used the method to investigate cyber-security.

6.4 Study 8: BART-P – Cyber-security

6.4.1 Introduction

Following the domain dependent context Study 7, this study provides another domain dependent context for investigation using the BART-P. This study was conducted using cyber-security terms as primes. This also provided further data regarding this domain that could be compared with the cyber-security EPT study in Section 6.5.2.

6.4.2 Method

This study was set-up in the same way as Studies 6 and 7, with three parts: the BART-P task, a questionnaire, and an interview. The administration was the same as Study 7 and the only key differences to Study 6 were the differing priming items and slight changes to the organization of the blocks and trials in the BART-P task, which will be explained below.

6.4.2.1 Participants

A new sample of participants was recruited for this study (separate samples were used across the BART-P studies). In total, 40 participants comprised of 33 female and seven male participants took part in Study 2. Their mean age was 19.7 years (*SD* = 1.82) ranging from 18 years to 26 years. All participants were undergraduate business students and received course credits for participating. The participants who accumulated the most points in the BART-P section of the study also received cash prizes.

6.4.2.2 Materials

For this study five different cyber-security terms were used as primes. The same primes that were used in the cyber-security EPT study were used for this study.

This was done in order to provide more scope for comparison of the EPT and BART-P results in the Section 6.5.2. The high risk primes were Virus, Identity Theft, and Hacking, and the low risk primes were Firewall and Encryption.

6.4.2.3 Procedure

Given that there was the same amount of primes as in Study 7 (five), 10 trials were used in each baseline phase and 10 trials for each prime across the priming phase. As per Studies 6 and 7, participants completed one block of baseline trials before and after the priming phase. Thus, baseline measures were calculated from the results of 20 baseline trials. The priming phase consisted of five blocks each containing 10 trials; the primes were distributed randomly across the blocks such that each prime was presented 10 times. There were 70 trials in total. The interview data regarding task length from Study 6 and Study 7 suggested that maintaining this length of task was logical.

The questionnaire was completed online via Qualtrics but this was done in the experiment room. All of the words (used as priming words) were rated for risk and affect. Ratings were made using the on-screen slider that produced a value between zero and 100. Each extreme of this scale (zero and 100) was labelled. For the risk ratings, the two extremes were ‘very low risk’ and ‘very high risk’. For affect, these were ‘very positive/good’ and ‘very negative/bad’. Various demographic details along with familiarity with the terms were also collected. Participants were also asked to state their self-reported knowledge of information communication technology. This was also done using the slider with higher levels (nearer 100) suggesting strong knowledge, and lower levels (nearer zero) suggesting weak knowledge.

Short interviews (around five minutes) were conducted after the BART-P and questionnaire had been completed. Initially participants were asked if they had any specific issues while completing the earlier tasks and had understood what they had to do. They were asked if they knew the meanings of the cyber-security terms used. They were then asked if they knew what the purpose of the task may be (i.e. that the priming words may influence their risk-taking behaviour). After these questions participants could add any further comments freely. Notes were taken of their responses and this information was used to identify key issues, trends, or common responses.

6.4.3 Results

There were no significant differences or associations relating to gender (all p >.67), age (all p >.42), or native language (all p > .12). The mean score for self-reported ICT knowledge was 42.9 (SD = 23) with 50 meaning neutral. Based on one-sample t-test results, this was not significantly different from neutral, $t(39) = -1.95$, $p = .058$, 95% CI of diff [-14.5,0.25]. There were no notable associations of ICT knowledge and the main measures of the BART-P.

6.4.3.1 Questionnaire Data

As can be seen in Table 6.11, all designated ‘high risk’ terms (Virus, Identity Theft, and Hacking) were given risk ratings greater than 50 (neutral). The ‘low risk’ terms were given more neutral or low risk ratings. The ‘high risk’ terms were given low affect ratings (meaning negative affect), with one ‘low risk’ term, Firewall, receiving a positive affect ratings, and the other ‘low risk’ term, Encryption, receiving an affect rating close to neutral. The ‘high risk’ terms were all given high familiarity ratings while again the ‘low risk’ terms were given more neutral or low ratings for familiarity.

Table 6.12 gives the results of one-sample t-tests. The risk, affect, and familiarity ratings for all ‘high risk’ terms were significant. The results were less consistent, however, for the ‘low risk’ terms. ‘Encryption’ was not rated as significantly different from neutral for risk or affect but it should be noted that this term was also rated as significantly lower than neutral for familiarity. ‘Firewall’ was rated as significantly lower than neutral for risk, and significantly positive for affect, but not rated differently from neutral for familiarity.

Table 6.11: Questionnaire Risk, Affect, and Familiarity ratings (Means and Standard Deviations) for all cyber-security terms.

		Virus	Firewall	Identity Theft	Encryption	Hacking
Risk	Mean	79.3	37.95	82.4	54.9	83.7
	SD	16.2	23.9	18.6	23.8	15.1
	N	40	40	40	40	40
Affect	Mean	16.8	65.1	6.6	46.1	11.9
	SD	21.7	23.6	9.63	22.9	14.9
	N	40	40	40	40	40
Familiarity	*Mean*	83.6	52.6	81.6	30.1	81.7
	SD	14.9	32.2	19.2	27.6	18.1
	N	40	40	40	40	40

All scores range from zero to 100; Risk from zero (low risk) to 100 (high risk), Affect from zero (negative) to 100 (positive), Familiarity from zero (not familiar) to 100 (very familiar).

Table 6.12: Questionnaire Risk, Affect, and Familiarity results from one-sample t-tests (test value of 50) for cyber-security terms.

		Virus	Firewall	Identity Theft	Encryption	Hacking
Risk	*t*	11.4	-3.2	11.02	1.3	14.1
	df	39	39	39	39	39
	p	**<.001**	**.003**	**<.001**	.205	**<.001**
	CI low	24.1	-19.7	26.4	-2.76	28.9
	CI high	34.4	-4.4	38.3	12.5	38.5
Affect	*t*	-9.7	4.1	-28.5	-1.1	-16.1
	df	39	39	39	39	39
	p	**<.001**	**<.001**	**<.001**	.293	**<.001**
	CI low	-40.1	7.6	-46.5	-11.2	-42.8
	CI high	-26.3	22.7	-40.4	3.5	-33.3
Familiarity	t	14.3	0.501	10.4	-4.6	11.1
	df	39	39	39	39	39
	p	**<.001**	.619	**<.001**	**<.001**	**<.001**
	CI low	28.8	-7.7	25.5	-28.8	25.9
	CI high	38.3	12.8	37.8	-11.1	37.5

CI low and CI high refer to the 95% Confidence Interval results (difference from 50).

6.4.3.2 Interview Data

No participant said that they had any specific issues or problems understanding the task or in completing the BART-P. No participant said that they had any issues understanding the meanings of the terms used as primes, other than

Firewall and Encryption. Despite Firewall receiving a neutral average rating for familiarity in the questionnaire, only two participants specified that they were not sure what this term meant. Also given the questionnaire results, relatively few participants (seven) said they did not know what Encryption meant with none of them suggesting any possible meaning. After the task was explained, no participant suggested that they had guessed that risk-taking changes due to the presence of the primes was the purpose of the task. No participant stated they had any issues with the length of the task. No other common themes emerged.

6.4.3.3 BART-P Results

Table 6.13 shows the mean 'facilitated average pumps' (Pumps) and 'facilitated bursts' (Bursts) for each prime. It can be seen that all 'facilitated average pumps' were positive suggesting that all cyber-security terms led to more pumps than during the baseline phases. In order to examine these findings further, one-sample t-tests were conducted. As seen in Table 6.14, only two of the designated 'high risk' terms, Identity Theft and Hacking, led to significantly more pumps (i.e. risk-taking).

Table 6.13: Descriptive statistics of 'facilitated average pumps' and 'facilitated bursts' for each cyber-security prime.

		Virus	**Firewall**	**Identity Theft**	**Encryption**	**Hacking**
Pumps	Mean	0.88	2.1	4.6	2.5	2.7
	SD	8.8	7.3	9.9	9.1	8.2
	Min	-19	-12	-13	-19	-13
	Max	25	24	27	22.5	23.5
Bursts	Mean	-1.1	-4.4	-2.1	-3.1	0.13
	SD	17.5	15.6	15.8	13.6	17.5
	Min	-35	-30	-40	-25	-35
	Max	30	30	35	30	50
	N	40	40	40	40	40

Mean Pumps = baseline balloon pumps subtracted from balloon pumps after prime.
Mean Bursts = proportion of baseline balloons that burst in baseline phase subtracted from bursts after prime (proportion converted to a %).

Table 6.13 also shows that the mean ‘facilitated bursts’ (Bursts) was less than zero for all primes other than Hacking (i.e. on average, participants burst fewer balloons during most priming trials compared with baseline). In order to investigate these findings further, one-sample t-tests were conducted. As seen in Table 6.14, ‘facilitated bursts’ produced non-significant results for all primes.

Table 6.14: One-sample t-test results (test value of zero) for each cyber-security prime.

		Virus	**Firewall**	**Identity Theft**	**Encryption**	**Hacking**
Pumps	*t*	0.63	1.8	2.9	1.7	2.1
	df	39	39	39	39	39
	p	.534	.081	**.006**	.092	**.046**
	CI low	-1.9	-0.27	1.4	-0.43	0.05
	CI high	3.7	4.4	7.7	5.4	5.3
Bursts	*t*	-0.41	-1.8	-0.85	-1.5	0.05
	df	39	39	39	39	39
	p	.686	.084	.399	.153	.964
	CI low	-6.7	-9.4	-7.2	-7.5	-5.5
	CI high	4.5	0.62	2.9	1.2	5.7

CI low and CI high refer to the 95% Confidence Interval results (difference from zero).

6.4.3.4 Affect Heuristic and Relationship in the Data

Correlation analyses were conducted in order to investigate the affect heuristic at an explicit level (i.e. based on the questionnaire data). Risk and affect ratings were significantly negatively correlated, $r(198) = -.74$, $p < .001$, in line with the affect heuristic. Affect ratings from the questionnaire did not correlate significantly with the ‘facilitated average pumps’ measure, $r(198) = -.04$, $p = .543$, nor the ‘facilitated bursts’ measure, $r(198) = -.03$, $p = .674$.

Risk ratings from the questionnaire did not correlate significantly with the ‘facilitated average pumps’ measure, $r(198) = .07$, $p = .307$, nor the ‘facilitated bursts’ measure, $r(198) = .001$, $p = .992$. The ‘facilitated average pumps’ results were not significantly related to the ‘facilitated bursts’ results, $r(198) = .07$, $p = 329$.

6.4.4 Discussion

The results from this study demonstrate the efficacy of the BART-P, which was the first aim. The primes 'Identity Theft' and 'Hacking' led to significantly more pumps. Both of these primes were designated as 'high risk', and this was borne out in the questionnaire ratings. Thus, these findings are consistent with previous priming studies (e.g. Bargh et al., 1996) in that the direction of effect was congruent with the prime (i.e. a prime associated with high risk produced higher risk-taking behaviour). The result for 'Identity Theft' produced a stronger effect than either of the other high risk terms. One explanation is that this was considered a more imminent risk for participants, as mentioned previously (Williams, 2016). Also, Identity Theft may be more likely to be considered a personal level threat than Hacking, which may be more associated with organisations. The lack of any significant effect for Virus perhaps suggests that this term is relatively more ambiguous given that it may easily refer to contexts out with ICT. For the secondary measure of 'facilitated bursts', this study produced non-significant results for every prime.

Both of the designated low risk terms (Firewall and Encryption) were problematic in that they were not significantly familiar to participants. This was surprising given the results from Study 4 (that generated the cyber-security primes) albeit in Study 5 (the cyber-security EPT study) the familiarity ratings for Encryption were not significantly different from neutral. These familiarity results further highlight the need to make such measurements as familiarity can vary from sample to sample. It also suggests that this variation can cause issues in data analysis. It is worth noting, however, that relatively few participants specifically stated problems in recognizing these two terms and that the average self-reported ICT knowledge was not significantly different from zero. This leaves the possibility that the low familiarity results may have been partly driven by general confidence in ICT knowledge rather than only literal familiarity. These issues should be considered in future research that includes technical information or terms.

The second aim was to investigate whether there were asymmetrical effects of high risk and low risk primes on risk-taking behaviour. Initially the results from this study seemed to support the notion that high risk terms have a greater effect than low risk terms since the terms that produced significant results were both high risk. The lack of familiarity with both low risk terms, however, mean that while the results do not contradict this conclusion they do not specifically support it either. Future work using successfully recognized low risk terms is needed to address this.

The third aim was to investigate the affect heuristic. The explicit measures revealed that high risk was associated with negative affect and low risk with positive affect, in line with the affect heuristic. This was also equivalent to the explicit measure results from the cyber-security EPT study (Study 5). No relationship was found between the BART-P results and the explicit (questionnaire) affect ratings. As with the previous BART-P studies it is not clear how meaningful this lack of correlation is, given that the EPT studies revealed a lack of correlation between implicit and explicit measures. Nonetheless, the results do not contradict the possibility that risk-taking behaviour may less driven by affective attitudes than risk attitudes specifically. It is worth noting that again the BART-P results did not correlate with the explicit risk ratings suggesting that the BART-P is not simply driven by explicit risk attitudes.

As discussed earlier, Study 6 provided a demonstration of the BART-P in a domain independent context manner (i.e. significant effects were found in terms of risk-taking behavioural changes due to the presence of primes). This study provided the complimentary domain dependent context demonstration of the BART-P. It is reasonable to expect that participants may already hold attitudes to a particular domain and it was therefore important to consider how this may impact the efficacy of the BART-P. Cyber-security was chosen because it is a common and prevalent issue but also because it is a domain that may be expected to already elicit some risk-related attitudes. While context may still influence results when using this method, there was still a clear indication that the BART-P is capable of capturing changes in risk-taking behaviour due to priming in a domain dependent context.

6.5 General Discussion – BART-P Studies

The main aim in this chapter was to explain the development and provide a demonstration of the BART-P. This involved developing a new method that directly measured risk-taking behaviour when influenced by automatic attitudes. This provided a direct link between the automatic attitude activation and subsequent behaviour that was largely free from ambiguity regarding how much the behaviour was driven by differing types of attitude. This would then compliment the new EPTs and provide new research tools, along with new measures that could be used in other contexts, such as recruitment or work evaluations in risk-related workplaces. Another benefit of developing a separate risk-taking behaviour method was that this would allow for some level of comparison between the two types of method (EPTs and risk-taking behaviour measures) as they would be founded on a similar theoretical basis. This would then broaden the scope for evaluation of the EPTs. Comparisons of the results from both new methods will be included in the Section 6.5.2.

The first aim was to investigate if the BART-P can capture changes in risk-taking behaviour as opposed to stable traits. The second aim was to investigate if high risk primes facilitate high risk-taking behaviour to a greater extent than low risk primes facilitate low risk-taking behaviour (i.e. if there are asymmetrical effects of high risk and low risk primes on risk-taking behaviour). The third aim was to investigate the affect heuristic. This was done in three studies; a domain independent context study using general risk-related words as primes, and two domain dependent context studies using either food health images or cyber-security terms as primes.

The main measure of the BART-P was ‘facilitated average pumps’ which compared the number of times a participant pumped the balloon following a prime with a ‘no prime’ baseline condition. For two of the studies there were significant effects based on this measure. In Study 6 (risk-related words as primes), two of the four high risk primes produced significantly more pumps (or higher risk-taking behaviour) in the priming condition than in the baseline condition. This trend is in line with previous priming studies where there has been congruence in the direction of behaviour from specific priming (e.g. Bargh et al., 1996). Study 8 (cyber-security terms as primes) also showed significantly higher risk-taking behaviour for two of the three high risk primes.

The secondary measure of the BART-P was ‘facilitated bursts’ which compares the number of balloons that burst following a prime with the number of balloons that burst in the baseline condition. The equivalent measure in the original BART is generally considered less reliable than the ‘pumps’ measure (Lejuez et al., 2002) but is still normally included in analyses. Study 6 produced one significant result from the eight primes, with one low risk word resulting in fewer bursts (or lower risk behaviour); this effect is in line with previous priming studies. Study 7 (food packaging as primes) produced two significant results when considering the primes individually. One of these was initially considered a neutral prime and one was considered a low risk prime. Both led to fewer bursts and thus less risk taking. For the low risk prime this was in line with previous priming studies. Study 8 produced no significant results for any of the primes.

When taken together all studies produced some significant results suggesting that the presence of primes could have an impact on subsequent risk-taking behaviour. This also suggests that the method is capable of measuring such changes in risk-taking behaviour. The majority of primes did not produce any significant change in risk-taking behaviour, however. This may suggest that the method can be further refined but could also suggest that such changes will only occur for certain priming items. It is also worth noting that all but one of the primes produced an effect that was in line with how that prime was originally designated. Primes that were rated as ‘high risk’ led to more risk-taking, and primes rated as ‘low risk’ led to less risk-taking. This is in line with previous priming studies that have found congruence between the prime and the behaviour (e.g. Bargh et al., 1996). The only exception was the neutral prime in the food health study but this can be seen as ambiguous as it was not rated specifically as ‘high risk’ so did not produce a result that directly contradicts the above suggestion.

The second aim was to investigate whether there were asymmetrical effects of high risk and low risk primes. The significant results for the primary measure of ‘facilitated average pumps’ were for high risk words/terms so initially this seemed to support the notion that high risk information was more salient than low risk information (Covello & Sandman 2001). When the secondary measure, 'facilitated bursts' is considered though, the findings either contradicted or compromised this conclusion. Most of these significant results were for 'low risk' items. This means that it is not possible to take a clear position on the relative influence of either low or high risk primes. It also suggests that there may be a difference in how this influence operates depending on which measure is used. Perhaps 'high risk' primes tend to lead to more risk-taking in terms of pumping the balloon more but the influence of 'low risk' primes is better captured via how many balloons burst. It is also worth noting that the two measures did not correlate with each other in any of the studies suggesting they operate in different ways, or capture different types of changes in risk-taking behaviour. This is an intriguing aspect of the findings that should be investigated further.

Given that the research objectives and aims (i.e. Research Aim 2) of relevance to this chapter were mostly related to methodological development, the following section discusses this issue directly.

6.5.1 Method Development

When designing the BART-P, the number of trials were limited (eight per prime in Study 6, and 10 per prime in Studies 7 and 8) in order to avoid task fatigue. For the original BART, it has been suggested that as few as 10 trials are needed to establish reliability (Wallsten, Pleskac, & Lejuez, 2005). It is possible, however, that with fewer trials, sensitivity of the measures may have been compromised. Future studies that use a greater number of trials for each prime may be useful albeit this would need to consider issues of task fatigue. In the studies presented in this chapter the amount of trials was limited based on comments in the interviews but task length was not cited as a major issue so studies using more trials may be possible. It is also possible that the differences in effects from the two measures (i.e. pumps being driven by high risk primes and bursts being driven by low risk primes generally) may relate to the amount of trials. As such, longer versions of the BART-P may clarify if this is a consistent tendency or simply an artefact of the specific design used in this thesis.

Despite finding several significant results using the BART-P, developments and refinements to the method can be made. The task is currently lab based which limits the efficiency of data collection. An online system would aid the collection of large data sets but it would be unlikely that test conditions would be standard, and thus participants' concentration or motivation for completing the task may be affected. Another issue for future development is the length of the task in terms of how many primes are used. A benefit of the task is the ability to measure several separate primes during the same task but clearly the more primes that are used the longer the task becomes. This links with the issue of how many trials are used for each prime. Future studies could ascertain how long the task can become, both in terms of primes used and trials within each priming condition, before task fatigue becomes a problem.

Using more primes would increase the usefulness of the method but also presents another opportunity. Future studies could use some similar (but not identical) primes within the set which could be cross-referenced to see if similar effects occur. This would add weight to suggestions that the prime had caused a specific and consistent change in risk-taking behaviour. This would require a larger overall set of primes, however, to avoid participants becoming aware of the similar primes and then possibly guessing the aim of the method. This last point leads to a potential issue with the method more generally of how aware participants are of the purpose of the task. The interview data suggested that none of the participants in these studies were aware of the purpose but this could feasibly happen in future studies. It may be useful to conduct studies where the purpose is explained beforehand to see if this destroys the effect. If this was the case it would highlight the need to both check such awareness after the task and would limit the scope for using the method. If, however, an effect remained it would both solidify the usefulness of the method and suggest that the method is robust.

There are other limitations that can be addressed through future research. The samples have a limited age range and limited gender balance. It has been suggested that both age and gender can impact risk perception and behaviour (Byrnes, Miller,

& Schafer, 1999). While no differences or associations were found in either study this could be due to the limitations of demographic variation. Future work with a wider age range and greater gender balance would be useful to discern what relevance these factors may have. In these studies (as with the EPT studies) it was a deliberate choice to use younger participants. This provided relevant findings that could be considered in terms of future implications (e.g. of food nutritional labels or cyber-security perception). The limitations in sample characteristics, however, compromise the ability to generalize the findings to the general population. There were also some issues with participants' level of familiarity with certain primes. This highlights that familiarity should be measured and that efforts should be made to ensure primes are likely to be sufficiently familiar. This may not be a straightforward process, however, as all the primes had previously been rated as significantly familiar using a different but similar sample (students) via the previous material generation studies in chapters four and five.

The following section considers the findings from this chapter in contrast with the findings from the EPT studies (presented in Chapters 4 and 5).

6.5.2 Combining Results from the EPT Studies and BART-P Studies

Both the risk EPT tasks and BART-P tasks used priming in order to activate automatic risk associations. This was founded on the principle of the Bona Fide Pipeline (Fazio et al., 1995) that suggests evaluation spreads from the priming item to the response. In the EPT this response is the categorization of target words, and the equivalent for the BART-P would be the pumping of the balloons as a measure of risk-taking. Given this similar theoretical basis and the use of similar priming items across studies, comparison can be made of the findings.

Both methods were used to investigate food nutrition and cyber-security. For the food nutrition studies there were relatively diverging findings. The explicit results were broadly similar with most of the priming items producing similar results (i.e. items that were significant in the EPT tended to also be significant in the BART-P, and vice versa). The implicit results were less similar, however. The EPT produced one significant result via the risk version, and two via the affect version. The BART-P did not produce any significant results based on the differences caused by the addition of nutritional labels on the food packaging. This could suggest that one or other method may not be measuring implicit processing, or that implicit attitudes may not sufficiently influence behaviour. It is also possible that the strength of risk associations was simply too weak to either influence behaviour or be captured via the BART-P. This uncertainty clarifies the benefit of also having the other context (cyber-security) to compare.

The explicit results (via questionnaire) were similar for the EPT and BART-P results in the cyber-security context. Both studies highlighted familiarity issues with one priming item but all other primes produced broadly the same results. The cyber-security EPT study produced significant results for three primes in the affect version, with one significant result in the risk version. The BART-P produced two significant results based on the primary measure. The priming item that produced a significant result in the EPT was also one of the priming items that produced a significant result in the BART-P (which also produced the larger effect of the two in the BART-P). This similarity suggests that both methods could have been capturing data based on the same processing. The fact that most priming items did not produce significant results across both studies highlights that finding effects for the same priming item in both studies could mean they were capturing similar processes. In one example this was an automatic attitude and in the other this was risk-taking behaviour. This may suggest that the BART-P was capturing the behaviour associated with the automatically activated attitude. This could be seen as limited validation for the BART-P and perhaps provides evidence for the efficacy of both methods.

These suggestions must be taken with caution, however, as results from two studies (with limited findings therein) cannot be seen as more than an indication. What these results suggest, however, is that there would be value in conducting future studies with these methods to clarify if there is a consistent relationship between results across the methods. It also suggests that research that seeks to directly combine the methods may be useful in clarifying how they relate. This would present practical issues, however, as over-exposure to the priming items could confound results. This was one of the reasons why such a combination (i.e. the same participants completing both the EPT and BART-P) was not conducted for this thesis. While some discussion of the comparisons has been presented here, there is another aspect of the thesis' research that included combined data from both methods; the affect heuristic. The following section discusses the affect heuristic (relating Research Aim 3) in terms of the combined data from the BART-P studies, along with the combined data from all studies in the thesis.

6.5.3 Affect Heuristic

The third aim of this chapter was to investigate the affect heuristic. This related to Research Aim 3 of the thesis involving investigation of the affect heuristic at an implicit level. There was less scope for this than in the previous EPT chapters as there was no equivalent affect measure that could be compared with the BART-P results. This meant that only explicit comparisons could be made, along with comparison of the BART-P results with the explicit affect ratings from the questionnaire. The explicit results (questionnaire ratings) produced significant correlations across all the studies. These correlations showed that high risk was associated with negative affect and low risk was associated with positive affect, in line with the affect heuristic (Slovic et al., 2007). The comparisons of the BART-P results and the explicit affect ratings produced no significant correlations for any of the studies. This may appear to suggest that there was a lack of affect heuristic effect at an automatically influenced behavioural level but this cannot actually be claimed as the variables were not specifically "implicit".

The BART-P is arguably a "pseudo-implicit" measure as it is not possible to clarify that the effect of the priming was implicit. The interview responses and significant effects (in terms of changes to risk-taking behaviour) suggest that it was an implicit effect but this cannot be claimed definitively. Even so, the fact that the BART-P results did not correlate with the explicit risk ratings (from the questionnaire) does add further weight to the suggestion that the influence of priming in the BART-P is not simply based on explicit processing. The main reason, however, why this does not clarify the implicit level affect heuristic effect is that the comparison was made with the explicit affect ratings. The EPT chapters showed that implicit and explicit measures may not correlate so a relationship with the explicit affect ratings may simply be due to this differentiation of implicit and explicit processes.

When considering the affect heuristic across all the studies in the thesis (including the BART-P studies, EPT studies, and questionnaire studies used for material generation) certain trends are revealed. The affect heuristic was consistently revealed in all the questionnaires (explicit level) that included analysis of the heuristic. This amounted to seven demonstrations of the affect heuristic at an explicit level. This suggests that the heuristic is a robust phenomenon even in varying contexts. The scope for investigating the affect heuristic at an implicit level was limited mainly to the EPT studies, although some complimentary data was gathered via the BART-P studies.

In the EPT studies the affect heuristic was shown at an implicit level albeit the effect sizes were less than the equivalent explicit measure analyses. The BART-P did not produce demonstrations of the affect heuristic at an implicit level (or "pseudo-implicit"), but one of the priming items in the domain independent context BART-P study (risk-related words) produced an intriguing result. One of the words that produced a significant result (i.e. the priming term caused an increase in risk-taking when the priming item was shown) was chosen specifically because it did not receive ratings in line with the affect heuristic based on questionnaire ratings. I.e. it was rated as high risk but also positive rather than negative. While this can only provide limited complimentary suggestions it does lead to the question of whether the affect heuristic may be more relevant to perception than behaviour. The EPT studies showed that the affect heuristic can emerge based on implicit attitudes but the single result in the BART-P also suggests that priming items do not need to follow the affect heuristic to produce significant impacts on behaviour. Clearly these findings are too limited to suggest anything with clarity but it does lead to possible ways that future research could focus, and choose priming items.

6.5.4 Conclusions

This chapter met the demands of Research Aim 2 via Research Objective 6 (with Research Objectives 1, 3, and 4 already achieved in earlier chapters but of relevance for this chapter). This chapter also met the final demands of Research Aim 3 (via Research Objective 8). The BART-P was developed and demonstrated as a novel method that can measure changes in risk-taking behaviour driven by automatic processing. As with the new EPT methods, this only provides a starting point for the BART-P and further research using the method will be needed to clarify efficacy and validity. Nonetheless, the studies presented in this chapter provide a new research tool with characteristics and potential that have not previously been available.

Chapter 7: General Discussion & Conclusions

7.1 Introduction

It may feel intuitive that our risk attitudes and behaviour are a consequence of reasoned and rationale thinking. In some scenarios this may well be the case but this is not always true. Risk perception and risk-taking behaviour can often be driven by automatic (implicit) thought processing. Understanding how automatic processing influences risk perceptions or behaviour, or even clarifying what automatic cognition means, are complicated tasks. One key initial problem in the pursuit of investigating these issues is measurement. Developing and using methods that measure automatic cognition are difficult processes. The goal of this research was to develop new methods that could contribute to this problem of measurement, specifically in terms of risk attitudes and risk-taking behaviour. As such, the main contribution of this thesis was in method development and the demonstration of these methods.

One of the motivations for this research was a call in the literature for implicit measures of risk attitudes to be used more often (Siegrist et al., 2006; Visschers et al., 2007). The dominant approach in risk research has tended to be the psychometric paradigm that focuses on explicit measurement (e.g. questionnaires or interviews) (Slovic, 2010b). This approach cannot account for the full complexity of risk perception, however. There are many factors that can influence risk perception with emotion cited as a factor that will often drive thinking (e.g. Fischhoff et al., 1978; Lowenstein et al., 2001). Emotional reaction is arguably an automatic process so this highlights how explicit measurement will likely miss important aspects of how perception operates.

A related motivation for the development of new methods are findings that suggest implicit measures often show a lack of relationship when directly compared, and the call for various different measures to be used (e.g. Bosson et al., 2000; Brand & Schweizer, 2015). If different implicit measures were all measuring the same construct (implicit processing) it would be reasonable to expect relatively consistent correlations to be found when comparing them. Although such correlations are sometimes found, the regular dissociation suggests that more research is needed to clarify how they contrast and what is specifically being measured for any given method. The most commonly used implicit measure is the IAT and versions that measure implicit risk attitudes have been developed previously (e.g. Traczyk & Zaleskiewicz, 2015). In order to contribute to the area of implicit risk attitude research, and provide a contrasting method to the IAT, a new type of risk attitude method was developed.

The method that was chosen was the EPT (Fazio et al., 1995). This is a fundamentally different type of implicit measure to the IAT as it incorporates priming and via the Bona Fide Pipeline has a different theoretical basis. It has also been claimed that a key difference between IAT related measures and the EPT is that the mechanism in the EPT is more akin to spontaneous evaluative reaction (Brand & Schweizer, 2015; Gawronski & De Houwer, 2014). Two versions of the EPT were developed with one measuring implicit risk attitudes, and the other measuring implicit affect attitudes. These methods (particularly the risk version) contribute new methods that can be used in risk research, and implicit cognition research. This also provides a contrasting method that can be compared with the risk IAT, or other implicit risk measures that are developed in future, to broaden understanding of the field but also help clarify the underlying processes of this type of measurement. Given that these methods are needed to fully understand risk perception, aiding in providing this broader perspective is a valuable contribution.

Understanding of perception or attitudes (to risk) provides insight but often the main concern is how this may predict behaviour. The relationship between attitudes and behaviour, however, is not always clear (e.g. Ajzen & Fishbein, 2005). This is true even for explicit attitudes so how implicit attitudes relate to behaviour is an area that requires further research. The approach taken in this thesis was to develop a method that measures risk-taking behaviour when driven by automatic attitudes. The EPT design provided inspiration for this. It was notable that no such behavioural measure had been previously developed. The approach used priming to activate automatic attitudes in a new version of the BART. Like the EPTs, this method was capable of capturing data regarding multiple separate exemplars within one task. Given the similar theoretical basis to the EPT the priming version of the BART also provided a broader picture of the research contexts that were investigated. This approach could be adopted in other fields where it would be informative to measure from explicit risk processing, to implicit risk processing, to risk-taking behaviour. The priming version of the BART also presents a novel measure of risk-taking behavioural changes when driven by automatic processing.

With these methods developed and with emotion (or affect) highlighted as of importance in understanding both risk perception (Breakwell, 2014) and implicit cognition (Fazio & Olson, 2003), this presented an opportunity for the research. The affect heuristic is a prominent idea regarding risk perception that suggests high risk is often associated with negative affect, and low risk with positive affect (Fischhoff et al., 1978; Slovic et al., 2002). This has been found at an explicit level of processing but evidence is lacking at the implicit level (Townsend et al., 2014). Given that implicit measures of risk and affect were being developed this meant that the affect heuristic could be directly investigated at an implicit level within the research. The role of automatic processing in the behavioural method also meant that this could bolster such an investigation. This also provided a novel contribution beyond method development.

In order to meet the aims of the research, a research goal, research aims, and research objectives, were formulated. The overall research goal was *to contribute to the fields of risk research and implicit cognition research by developing and demonstrating new methods that can be used as research tools for investigating attitudes and behaviour driven by automatic thought processing*. This was achieved via several research aims and objectives. The following sections discuss how these aims and objectives were met.

7.2 Research Aim 1

To develop and demonstrate two novel versions of an implicit attitude method (the Evaluative Priming Task) based on risk and affect attitudes.

In order to meet the demands of this research aim, several research objectives were identified. See Figure 1.1 (in Chapter 1) for a schematic showing how the research objectives combined to fulfil the research aim, along with which specific studies achieved each research objective. Each research objective will be discussed in turn in the following sections.

7.2.1 Research Objective 1

Research Objective 1 was that *data sets will be generated containing words associated with either high risk or low risk for use as 'target words' in the new versions of the Evaluative Priming Task, and for use as 'priming items' in the Balloon Analogue Risk Task.* In terms of Research Aim 1 this meant generating target words for the EPT. The procedure for the EPT requires that words are categorized and it is necessary that these words will be categorized in the same way by most (ideally all) participants. In order to systematically generate these words to ensure that they were sufficiently strongly rated as high risk or low risk, and sufficiently familiar, a questionnaire study was conducted (Study 1).

From the results of Study 1 a set of words were generated that received strong ratings for either high risk or low risk. These words were all significantly familiar to the sample of participants. A set of five high risk words were selected and also five low risk words. This was a systematic approach and produced target words for use in the risk EPT that could reasonably be expected to produce consistent categorizations in the EPT task.

7.2.2 Research Objective 2

Research Objective 2 was that *data sets will be generated containing words associated with either positive affect or negative affect for use as 'target words' in the new versions of the Evaluative Priming Task.* The EPT studies required the use of both a risk EPT and an affect EPT. In order to generate a set of appropriate affect related words (i.e. words that would likely be categorized consistently in the EPT tasks) a set of exemplars were sought from Dr Russell Fazio (one of the EPT developers) that had been used in previous studies. The words received were scrutinized in order to produce a selection of words that were associated with affect specifically (rather than specifically valence which was what Fazio had used the words to measure). As with the target word selection for the risk EPT, five words were selected for each category (positive affect or negative affect). The details of this process were described within Study 1.

7.2.3 Research Objective 3

Research Objective 3 was that *data sets will be generated containing food products and nutrition labels for use as 'priming items' in the new versions of the Evaluative Priming Task and Balloon Analogue Risk Task*. In terms of Research Aim 1 this meant generating priming items based on food products and related nutritional labels for the first EPT study. The procedure for the EPT involves priming items that are briefly shown on screen prior to categorization of the target words. If the presence of the priming items changes the speed of categorization (relative to baseline categorizations when no priming items are used) this suggests that an automatically activated attitude towards the priming item is present. The EPT is therefore measuring implicit attitudes to the priming items.

In order to generate priming items that may be likely to activate automatic attitudes the procedure involved selecting items based on risk (and affect) ratings. If certain items received strong ratings for risk (either high risk or low risk) this potentially increased the likelihood that automatically activated attitudes would emerge. To generate the items a questionnaire study was conducted (Study 2).

Initially a set of food products were selected based on differing characteristics (e.g. varying nutritional levels or varying food types). Nutritional labels were created for each product using the food traffic light system, based on the genuine nutritional details of the products. Participants then rated the products without labels, the products with labels, and the labels were also rated in isolation. Analyses of the results revealed that there were products that were rated as high risk, products that were rated as low risk, and products rated as relatively neutral for risk. There were also some instances of products that received notably different ratings depending on whether the traffic light label was present or not. This provided the opportunity to have items that were consistently rated either high or low risk (i.e. they were rated in a similar manner with or without labels), and also items where the presence of the labels changed the risk ratings.

A set of five items were selected that included two items where the presence of labels did not change the ratings to a notable degree (one for high risk and one for low risk), two items where the presence of labels changed the ratings (one that became more high risk with labels and one that became more low risk with labels), and also a neutral item. This was a systematic approach and produced priming items for use in the first EPT study that suggested potential for producing automatically activated risk attitudes. Along with the target words that were generated in Study 1, this meant that the materials had been generated for the first EPT study.

7.2.4 Research Objective 4

Research Objective 4 was that *data sets will be generated containing cyber-security terms for use as 'priming items' in the new versions of the Evaluative Priming Task and Balloon Analogue Risk Task*. In terms of Research Aim 1 this meant generating priming items based on cyber-security terms for the second EPT study. As such, these items fulfilled the same role as the food products and nutrition labels in the first EPT study.

In order to generate the items a questionnaire study was conducted (Study 4). Initially a set of cyber-security terms were selected that included terms associated with high risk or danger (e.g. hacking), and terms associated with low risk or safety (e.g. firewall). Participants then rated the terms for risk, affect, and familiarity. A set of five items were selected that included three terms that were strongly rated as high risk and two terms that were strongly rated as low risk, with all items rated as familiar. This was a systematic approach and produced priming items for use in the second EPT study. Along with the target words that were generated in Study 1, this meant that the materials had been generated for the second EPT study.

7.2.5 Research Objective 5

Research Objective 5 was that *the Evaluative Priming Task methods will be designed, refined, and demonstrated in the food nutrition and cyber-security contexts*. This objective was met via two studies (Study 3 and Study 5). Study 3 reported the first demonstration of the new versions of the EPT in the context of food nutrition. The development involved initially combining the materials generated for use as target words and priming items in the EPT. For Study 3 this involved combining the materials generated in Study 1 and Study 2. Study 3 produced significant results for both new versions of the EPT. These were based on differences in either implicit risk attitudes or implicit affect attitudes to food products when nutritional labels were included or not. The results from the implicit methods were also dissociated from the explicit results (via questionnaire) which suggested the implicit measures were not simply a form of explicit measure. The results suggested that the methods were producing results that may be expected and provided the starting point for future research using these methods to investigate implicit risk and affect attitudes.

In order to further demonstrate the methods and refine them, a different research context was investigated in Study 5 (cyber-security). The refinements included adding more trials that provided a richer data set and this did not appear to cause any issues of fatigue for participants. Other refinements (such as conducting baseline measurements at both the beginning and end of the task) also did not cause issues in the data but meant that the method could compensate for practice effects if they had occurred. This second version would be more appropriate for future studies given the benefits were not accompanied by any clear costs. As with Study 3, Study 5 showed a dissociation of explicit and implicit measures, and produced significant results for both EPTs. While more research is needed to clarify the validity of the new EPTs, the demonstrations fulfil the demands of Research Objective 5 and suggested that the methods appeared to be operating as designed.

7.3 Research Aim 2

To develop and demonstrate a novel version of a risk-taking behavioural method (the Balloon Analogue Risk Task) that provides a measure of changes in risk-taking behaviour driven by automatic processing (via priming).

In order to meet the demands of this research aim, several research objectives were identified. See Figure 1.1 (in Chapter 1) for a schematic showing how the research objectives combined to fulfil the research aim, along with which specific studies achieved each research objective. Each research objective will be discussed in turn in the following sections.

7.3.1 Research Objective 1

The second component of Research Objective 1 (beyond developing target words for the EPT studies) was to generate risk-related primes for the BART-P. The data from Study 1 was re-analyzed and eight words were selected (four high risk and four low risk). Three words in each category (high or low risk) were selected from the words chosen for use as target words in the EPT studies. One other word was also included in each category (one other high risk word and one other low risk word). These words were chosen because, unlike the words chosen as target words in the

EPT studies, these two words did not follow the affect heuristic in their ratings. I.e. the high risk word was rated as positive (rather than negative) for affect, and the low risk word was rated as negative (rather than positive) for affect. This provided complimentary data for Research Aim 3 and also provided a contrasting priming item to the other priming items used in terms of the risk/affect relationship. As such, the materials required for the first BART-P study were generated.

7.3.2 Research Objective 3

The second component of Research Objective 3 (beyond developing priming items for the EPT studies) was to generate food nutrition primes for the BART-P. In order to allow for comparison of the EPT and BART-P results the same priming items were used for the BART-P as were used for the first EPT study. This provided the materials for the second BART-P study.

7.3.3 Research Objective 4

The second component of Research Objective 4 (beyond developing priming items for the EPT studies) was to generate cyber-security primes for the BART-P. As with the food nutrition EPT and BART-P, the same priming items were used for the BART-P as were used for the first EPT study in order to allow for comparison of the results. This provided the materials for the third BART-P study.

7.3.4 Research Objective 6

Research Objective 6 was that *the Balloon Analogue Risk Task method will be designed and demonstrated in a domain independent context (risk-related words), and two domain dependent contexts (food nutrition context and cyber-security context).* This objective was met via three studies (Study 6, Study 7, and Study 8).

Study 6 reported the first demonstration of the BART-P. This study used the results from Study 1 in order to generate the priming items. This was in a domain independent context using risk-related words as priming items. This study produced significant results (i.e. changes in risk-taking behaviour due to the presence of priming items) for multiple priming items. This was true for both the primary (balloon pumping) and secondary (balloons bursting) measures of the method.

Study 7 reported the first domain dependent context demonstration of the BART-P (food nutrition). This study used the same priming items are used in Study 3. No significant results were found based on differences when food products included nutritional labels or were presented without labels. Two priming items did produce significant results when analyzed in isolation (based on the primary measure). These latter two results suggested that risk-taking changes in a domain dependent context could be captured via the BART-P but the lack of significant results in the main analyses made this seem less convincing.

Study 8 reported the second domain dependent context demonstration of the BART-P (cyber-security). This study used the same priming items are used in Study 5. Significant results were found for one of the priming items from the primary measure. It should be noted that issues around familiarity meant that only four priming items could be reasonably included in the analyses. This suggested that risk-taking changes in a domain dependent context could be captured via the BART-P.

The three studies all produced significant results (i.e. changes in risk-taking behaviour due to the presence of priming items). As such, they met the demands of Research Objective 6. In terms of Research Aim 3 these studies provide the starting point for future research. As will be explained in Section 7.6, there remain questions regarding the validity of the method, particularly in terms of whether the changes in behaviour are caused by automatic processing. Nonetheless, the methods were developed and demonstrated, and could now be used in future research which may provide further validation.

7.4 Research Aim 3

To investigate the affect heuristic at an implicit (automatic) level of processing.

In order to meet the demands of this research aim, two research objectives were identified. See Figure 1.1 (in Chapter 1) for a schematic showing how the research objectives combined to fulfil the research aim, along with which specific studies achieved each research objective. Each research objective will be discussed in turn in the following sections.

7.4.1 Research Objective 7

Research Objective 7 was that *the new versions of the Evaluative Priming Tasks will be tested for relationships to discern if an affect heuristic effect is evident at an implicit level.* This objective was achieved via the two EPT studies (Study 3 and Study 5). Both of these studies included implicit measures of risk and affect that meant relationships between risk and affect could be made.

Both EPT studies (and several other studies in the thesis) included explicit measures of risk and affect (via questionnaires). In every study an affect heuristic effect was evident. This suggests that the items used were appropriate and clarifies the robustness of the effect at an explicit level.

Study 3 (food nutrition context) produced a significant correlation between implicit risk and affect results for food product images with nutritional labels included. No such effect was found for food product images without labels. This suggested that the risk information contained in the labels was required before an implicit affect heuristic effect occurred, or that this made the effect sufficiently strong to capture. The effect size (for the significant implicit result) was smaller than the explicit effect suggesting the affect heuristic may be weaker at an implicit level. Nonetheless, the results did show an affect heuristic effect at an implicit level.

Study 5 (cyber-security context) also produced a significant correlation between both the explicit and implicit measures. The implicit effect size was also smaller than the explicit effect size for this study. Between both studies the affect heuristic was revealed at an implicit level. As such, this met the demands of Research Objective 7.

7.4.2 Research Objective 8

Research Objective 8 was that *the new version of the Balloon Analogue Risk Task that provides a measure of changes in risk-taking behaviour driven by automatic processing (via priming) will be tested for relationships with explicit measures of affect (via questionnaire) to discern if an affect heuristic effect is evident.* This objective was achieved via the three BART-P studies (Study 6, Study 7, and Study 8).

The scope of this objective was limited as no implicit affect measure was available. Also the implicit risk-taking behaviour method was arguably a "pseudo-implicit" measure as the lack of time thresholds meant it could not be assumed the method was definitely driven by automatic attitudes. The analyses, however, still added complimentary data to the research aim. Across all three studies no significant effects were found when comparing the explicit affect data with the BART-P data. As such, these analyses did not support the EPT data in showing the affect heuristic at an implicit level (or as complimentary data for that purpose).

The first BART-P study included two priming items that were included specifically as additional complimentary data for this research objective (having not been used as target words for the EPT). These two priming items were unusual among the items in Study 1 as they showed an opposite trend to the affect heuristic (i.e. high risk word rated as positive and low risk word rated as negative). One of these words (the high risk and positive word) produced a significant change in behaviour based on the primary BART-P measure (balloon pumping). This suggested that while the affect heuristic emerged at an implicit level, automatic attitudes could influence behaviour without an affect heuristic effect being present.

These sections of the chapter have clarified the way the research sought to achieve the research objectives and aims but did not clarify all the implications of the research. The following discusses these implications.

7.5 Implications

7.5.1 Methodological Implications

This section will discuss the implications of the research. The main implications (and contribution) of the thesis were methodological. The first two research aims were to develop and demonstrate new methods. These new methods could be used as research tools in various ways. The field of implicit cognition research could be enhanced by incorporating these new methods in research designs. The BART-P in particular provides a way of including behavioural outcomes in implicit cognition research that have been previously unavailable. Questions regarding how implicit attitudes influence behaviour could be approached directly with the BART-P rather than by attempting to combine disparate data sources. This could clarify the relationship in a more flexible and straightforward manner than is currently the case.

The issues around implicit measurement could benefit from the incorporation of both methods in future research. Risk research, in particular, can now be investigated using differing implicit measures which would aid in clarifying the strengths and weaknesses of this type of measurement. Research suggests risk perception can be driven by emotion and/or implicit processing which has led to calls in the literature for more use of implicit risk attitude measures (Siegrist et al., 2006; Slovic et al., 2007). Currently there are limited options for measurement of implicit risk attitudes (e.g. Traczyk & Zaleskiewicz, 2015; Visschers et al., 2007). Furthermore, the currently available implicit risk attitude measures are variants of the IAT. It has been suggested that dominance from one type of implicit measure is not ideal and that a greater variety of options can aid in more fully understanding what is being measured (e.g. Brand & Schweizer, 2015).

This issue regarding what implicit methods are actually measuring is largely driven by the inconsistent correlations found when directly comparing results from different implicit methods (e.g. Fazio & Olson, 2003). The risk EPT method, developed in this thesis, can therefore provide a valuable new option for greater investigation of implicit measurement generally. Additionally, the risk EPT allows for risk attitude measurement to be incorporated into such investigation for the first time (i.e. the first time that contrasting implicit risk attitude methods can be compared). It may be that risk attitudes function differently from valence attitudes at an implicit level which would aid in clarifying whether investigation of implicit attitudes requires closer focus on the specific context or attitude type that is being measured.

A key issue in implicit attitude research is how it relates to behaviour (Fazio & Olson, 2003). The MODE model provides an approach to understanding the attitude to behaviour relationship in terms of implicit cognition. Currently, however, the relationship between implicit cognition and behaviour requires the use of separate perception and behaviour data sources. The ability to measure both attitudes and behaviour in relation to the same attitude objects provides scope for conducting research with a broader perspective than is possible when using attitude measures alone. Being able to investigate both perception and behaviour in this way also means that studies could control for extraneous factors more easily as all data could be collected in a laboratory environment with a quantified behavioural measure.

Beyond academic research the methods also provide an opportunity for human resources in the workplace. Risk-related occupations (e.g. construction, banking, or emergency services) could use the methods (or modified versions) as recruitment or evaluation tools. If workers in such occupations revealed differing implicit risk attitudes or risk-taking behaviour driven by automatic processing to their explicitly stated attitudes or intentions this could aid in safety, clarify suitability, suggest training needs, or be used to predict future outcomes. The BART-P may be a particularly useful tool for use in evaluating workers in risk related occupations. While the specific type of risk-taking would be different there may be a more direct relationship between risk-taking in their work and the method output given that it is specifically measuring risk-taking behaviour rather than making assumptions based on attitudes. This may be particularly true for risk-associated occupations that involve some form of gambling type behaviour, such as investment brokering. The relative simplicity of administration and ease for participants also make these methods a plausible tool for such purposes.

7.5.2 Theoretical Implications

Although the implications of the research were predominantly methodological, there were also other implications, such as theoretical implications. It is worth noting that the behavioural findings from this thesis (the BART-P studies) showed that priming with high risk can result in increased risk-taking. This seems to contradict what would normally be expected from risk information (i.e. that higher risk information would lead to greater caution) but is in line with the priming literature that suggests behaviour will tend to follow a similar direction to the priming (e.g. Williams & Bargh, 2008). This suggests that there is a gap in the literature regarding this mix of implicit risk communication (via priming at least) and subsequent behaviour. These findings suggest this leads to greater risk-taking when exposed to information denoting higher risk and that future research could seek to investigate how consistent or robust this effect may be, and whether it is specific to implicit cognition.

A second theoretical implication was in terms of the associations of explicit and implicit measures. The findings in the research showed a lack of correlation between implicit and explicit measures. This has been shown previously but results vary (e.g. Nosek & Smyth, 2007). This research adds evidence that these measures will sometimes dissociate and that this suggests they are qualitatively different. This could suggest that they are distinct and separate processes but alternatively may suggest that explicit processing somehow suppresses the implicit process. It is notable that this thesis has shown the lack of correlation using the EPT. This suggests that both the implications of the dissociation in terms of how the differing processes operate, and why the differing implicit measures often contrast in output, may benefit from further comparison of the EPT with other implicit measures. With the risk version now developed this could also expand this comparison beyond measures of valence.

The third aim of the thesis related to the affect heuristic. This was largely driven by literature that suggests emotion is often an important driver of risk perception (e.g. Slovic et al., 2007). This research represents the first time that the affect heuristic has been directly shown at an implicit level (see Townsend et al., 2014). This finding provides a third theoretical implication of the thesis. The results support the idea that the affect heuristic may operate differently at an implicit level compared to an explicit level, at least in the strength of the effect. It should be noted, however, that the weaker correlation that was found for the affect heuristic at an implicit level compared with explicit level could be due to the differential sensitivity of implicit and explicit methods rather than necessarily an indication of a fundamental difference in strength of effect. Nonetheless, demonstrating that the affect heuristic does still hold at an implicit level contributes to understanding of both implicit cognition and the affect heuristic itself.

7.5.3 Practical Implications

The finding that high risk information may lead to higher risk-taking behaviour raises a practical implication. This may suggest that safety information could sometimes have the opposite effect to what is desirable (i.e. communicating high risk issues could increase rather than decrease risk-taking). In reality it is likely that the warning message of safety information will still encourage safer behaviour but this is perhaps at an explicit level specifically. If workers are likely susceptible to relying on implicit processing however (e.g. when time is limited), these findings suggest this could lead to maladaptive risk-taking behaviour.

Another practical implication of the research includes the suggestion in the findings that red lights in food nutritional labelling will tend to have more impact on implicit cognition. In particular, the findings suggest that this will lead to attitudes of high risk and negative affect. The relatively weaker influence of other colours of food traffic lights may indicate that the labelling tends to be more effective as an avoidance guide rather than as an overall guide of relative healthiness (in terms of implicit cognition at least).

The findings from the cyber-security studies also suggested that implicit risk attitudes were relatively more activated when threats were more personally relevant. This may suggest that risk communication in this area (or perhaps in general) should ensure that the risks are perceived as of personal relevance in order to make them effective. It must be noted, however, that the findings regarding the contexts were limited so these implications can only be described as potential routes for future research rather than necessarily clear findings in themselves.

While these methodological, theoretical, and practical implications suggest future research and contributions to understanding or methodological approaches, much of the conclusions must be made with caution due to the limitations of the research. The following section discusses these limitations followed by a section with suggestions for future research.

7.6 Limitations

As explained in Section 3.6 (in Chapter 3) young students were specifically chosen as the sample for this research. This was deemed a worthwhile strategy for several reasons, such as the fact that these participants would be facing the risks investigated in the future to an extent that would not be true for older participants. There was also reason to believe that they may be more prone to holding strong implicit attitudes to the chosen research contexts than other types of sample. Additionally, this was a pragmatic decision based on requiring a large set of participants over the research and limiting this to one type of participant allowed for comparison across studies.

While these reasons clarified why such a sample was used it must be acknowledged that it limits the scope for generalisability. The sample were mostly young (between 18 and 24), female, and educated. All of these factors have been highlighted as potentially influential in risk perception or behaviour (e.g. Dosman, Adamowicz, & Hrudey, 2001; Finucane, Slovic, Mertz, Flynn, & Satterfield, 2000). As such, the findings can only be generalised in terms of young students (including predominantly female students) rather than the wider population. It was deemed worthwhile to focus on younger people as they will be exposed to the investigated risks in the future. Even so, a student cohort may not be representative of younger people generally so this limits generalisability even in terms of younger people.

The fact that the sample were also predominantly female further limits the scope as gender may be expected to influence risk-taking generally. It should also be acknowledged that risk-taking tendencies could change as people age so while the sample are relevant looking to the future it cannot be necessarily assumed that they will exhibit the same risk-taking behaviour in the future due to possible changes as they get older. In terms of the results, however, it should be noted that no differences or relationships were found within the studies in this thesis for these factors. This does not seem particularly surprising, however, as the limitations of the samples (e.g. little scope to compare age ranges) would make it unlikely that such effects would emerge.

Another potential limitation of the research was in the research contexts that were chosen. While there were various reasons for choosing these contexts it may be that they are not likely to elicit such strong risk attitudes as alternative contexts. In particular, while the potential for social desirability effects were suggested for the chosen contexts it is unlikely that such an effect would be as strong in these contexts as in some other contexts. One methodological issue that emerged was that some primes were not as well recognized in the EPT or BART-P studies as in the initial material generation questionnaire studies. This compromised some of the analyses and highlights that familiarity cannot be presumed when different samples are used, even when the samples are sourced from the same societal group. This is relevant as familiarity has been suggested as an influential factor on risk perception generally (Covello & Sandman, 2001).

A clearer limitation of the research is that it was not possible to clarify that the risk EPT was actually measuring implicit risk perception. Comparisons with the risk IAT would not clarify this as part of the purpose for developing the method was that divergent methods were needed in order to clarify what implicit methods, of all types, actually measure. While acknowledging that implicit measures often dissociate, Cunningham, Preacher, and Banaji (2001) claimed that these dissociations could be reduced via particular analytical techniques. This would require a more involved and time-consuming process than was possible for this thesis but provides a route for future research that could aid in validating the methods. It is also worth noting, however, that this was not for implicit risk measures specifically. The dissociation of explicit and implicit results does provide some initial validation but this only suggests the EPT measured something other than explicit processing rather than specifically implicit processing.

With the BART-P there is an additional limitation in that it could only be described as a “pseudo-implicit” measure. The lack of time thresholds for responses meant that assumptions of implicit processing could not be presumed in the same way as with implicit attitude measures like the EPT.

7.7 Future Directions

The limitations suggest that there are various routes that future research could take. The limited demographic range (e.g. mostly female and young participants) suggest that future research that includes more varied samples may uncover moderating factors in the methods. It is also reasonable to suggest that, for instance, investigating food nutrition (particularly in terms of how this may influence shopping habits) would more meaningful if conducted using people more likely responsible for such activities, e.g. parents. Fundamentally, a broader range of participants would make it possible to generalise the findings to the population at large which would be more meaningful in terms of possible refinements to risk communication (e.g. communications to promote healthier eating or safer behaviour online).

The contexts that were chosen for investigation also seemed, in hindsight, potentially limiting in terms of likelihood for social desirability. This has been highlighted as a factor that can cause differences between explicit and implicit attitudes. Future research could focus on potentially more controversial contexts (where risk is still a key issue) such as voting. In the UK recently there was a referendum on EU membership which was somewhat controversial (Robins-Early, 2016). It is reasonable to expect that some participants may be susceptible to social desirability bias (or other biases) in terms of risk attitudes to this topic. The referendum also included much discussion of the risks faced so investigating risk perception would be more appropriate than in some other voting scenarios. The EU referendum was not an option for this thesis as it took place late in the research process but future studies could investigate equivalent contexts and these may prove more appropriate, particularly in terms of demonstrating the new methods.

Cunningham et al. (2001) described methodological and analytical procedures that can be incorporated into research designs when using implicit measures that may potentially improve reliability. These procedures can also produce stronger associations between implicit methods. Future research would benefit from seeking ways of incorporating these procedures (or other procedures that are developed) in order to improve the efficacy of the methods. This would be particularly useful as direct comparisons with other implicit risk measures would aid in validating the new methods.

The BART-P cannot be currently described as necessarily an implicit method. Future refinements of the BART-P could perhaps attempt to include a time threshold for responding. This may present practical issues, however, due to the basic design of the method. Alternatively, priming items could be presented subliminally (i.e. so quickly that explicit processing is not possible). This would make it more convincing that any effects found were based on automatic processing.

7.8 Conclusions

The research goal of this thesis was to contribute to the fields of risk research and implicit cognition research by developing and demonstrating new methods that can be used as research tools for investigating attitudes and behaviour driven by automatic thought processing. In order to achieve this goal, various research aims and objectives were formulated. Through eight studies each objective was fulfilled and these in combination met the demands of the research aims.

New implicit measures of risk attitudes, and of affect attitudes, were developed and demonstrated. These methods can now be used to enhance research in the fields of risk, implicit cognition, and provide potential tools for human resource management. A new method that measures changes in risk-taking behaviour when driven by automatic thought processing was also developed and demonstrated. This provides a means of directly measuring the effect of automatic attitudes on behaviour in a way that was not previously available. This can compliment implicit attitude measurement and provides new research opportunities.

While the findings using the new methods were encouraging it is clear that many questions remain regarding their efficacy and validity. Future research will be needed to further refine the methods and to more fully clarify how they operate. As the pioneer of hypothesis testing Ronald Fisher explained, a key component in the scientific method is replication and reproducibility (Fisher, 1935). The work in this thesis can only be seen as the beginning for the developed methods, the aim is now to replicate similar findings and build on the research contained here.

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Appendix 1

Figure A1.1: Ten Item Personality Inventory

University of Strathclyde Glasgow

Ten-Item Personality Inventory - (TIPI)

Here are a number of personality traits that may or may not apply to you. Please make a choice for each statement to indicate the extent to which you AGREE OR DISAGREE WITH THAT STATEMENT. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

I SEE MYSELF AS...

	Disagree strongly	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Agree strongly
Extraverted, enthusiastic.	○	○	○	○	○	○	○
Critical, quarrelsome.	○	○	○	○	○	○	○
Dependable, self-disciplined.	○	○	○	○	○	○	○
Anxious, easily upset.	○	○	○	○	○	○	○
Open to new experiences, complex.	○	○	○	○	○	○	○
Reserved, quiet.	○	○	○	○	○	○	○
Sympathetic, warm.	○	○	○	○	○	○	○
Disorganized, careless.	○	○	○	○	○	○	○
Calm, emotionally stable.	○	○	○	○	○	○	○
Conventional, uncreative.	○	○	○	○	○	○	○

Appendix 2

Figure A2.1 The Risk Taking Index (measure of risk propensity)

University of
Strathclyde
Glasgow

We are interested in everyday risk-taking.

Please could you tell us if any of the following have ever applied to you,
now or in your adult *past*?

Do any of these apply to you **NOW**?

	Never	Rarely	Quite often	Often	Very often
Recreational risks (e.g. rock-climbing, scuba diving)					
Health risks (e.g. smoking, poor diet, high alcohol consumption)					
Career risks (e.g. quitting a job without another to go to)					
Financial risks (e.g. gambling, risky investments)					
Safety risks (e.g. fast driving, city cycling without a helmet)					
Social risks (e.g. standing for election, publicly challenging a rule or decision)					

Have any of these applied to you **in your adult PAST**?

	Never	Rarely	Quite often	Often	Very often
Recreational risks (e.g. rock-climbing, scuba diving)					
Health risks (e.g. smoking, poor diet, high alcohol consumption)					
Career risks (e.g. quitting a job without another to go to)					
Financial risks (e.g. gambling, risky investments)					
Safety risks (e.g. fast driving, city cycling without a helmet)					
Social risks (e.g. standing for election, publicly challenging a rule or decision)					

Appendix 3

Table A3.1: Mean ratings (out of 100) for all risk-related words based on risk, affect, and familiarity presented in order from highest risk rating to lowest. (Category denotes whether word was synonym for "safe" / Low Risk, or "risky" / High Risk).

	Category	Word	Risk	Affect	Familiarity
1	High Risk	Deadly	91.8	10.7	92.8
2	High Risk	*Dangerous*	88.8	15.2	97.5
3	High Risk	Unsafe	87.4	15.4	97.9
4	High Risk	Risky	86.7	30.4	97.8
5	High Risk	Treacherous	84.0	19.2	77.3
6	High Risk	Untrustworthy	82.9	6.9	95.0
7	High Risk	*Hazardous*	82.5	19.6	91.2
8	High Risk	*Unstable*	81.3	16.4	92.7
9	High Risk	Jeopardous	80.1	21.3	71.1
10	High Risk	*Vulnerable*	79.6	21.4	93.5
11	High Risk	*Careless*	79.2	14.9	96.6
12	High Risk	Unreliable	78.9	22.5	96.6
13	High Risk	Undependable	78.0	17.3	86.6
14	High Risk	Perilous	77.9	25.6	52.0
15	High Risk	Shady	76.1	22.9	77.3
16	High Risk	Unforeseeable	75.9	29.5	85.2
17	High Risk	Unsteady	75.5	25.4	91.6
18	High Risk	Unpredictable	75.5	30.1	94.7
19	High Risk	Rash	75.1	28.7	80.7
20	High Risk	Scary	75.0	22.1	98.6
21	High Risk	Unsound	74.6	23.2	74.2
22	High Risk	Shifty	73.9	25.8	80.1
23	High Risk	Haphazard	73.2	32.8	64.2
24	High Risk	Uncertain	73.2	28.6	96.1
25	High Risk	Daring	72.9	55.8	94.5
26	High Risk	Slippery	72.8	28.4	90.5
27	High Risk	Endangered	72.8	25.7	93.6
28	High Risk	Breakneck	72.5	27.2	46.0
29	High Risk	Insecure	72.3	20.3	95.4
30	High Risk	Incautious	72.2	31.4	69.8
31	High Risk	Thorny	70.9	25.5	64.9
32	High Risk	Tricky	70.5	32.0	94.5
33	High Risk	Shaky	69.7	24.4	87.1
34	High Risk	Precarious	68.3	30.5	55.9
35	High Risk	Madcap	68.2	33.1	32.9
36	High Risk	Iffy	67.9	26.8	76.3
37	High Risk	Dicey	67.8	24.7	51.9
38	High Risk	Unsure	67.2	27.2	95.2
39	High Risk	Doubted	66.4	24.1	89.8
40	High Risk	Audacious	66.4	40.8	53.0

41	High Risk	Adventurous	64.9	73.6	95.8
42	High Risk	Bold	64.6	68.7	94.2
43	High Risk	Venturesome	64.6	60.2	59.2
44	High Risk	Speculative	63.0	42.8	81.9
45	High Risk	Headlong	60.8	39.7	36.7
46	High Risk	Impetuous	60.4	36.0	37.5
47	High Risk	Portentous	54.0	41.1	32.3
48	High Risk	Intrepid	53.1	45.5	40.0
49	Low Risk	Impervious	49.2	45.5	39.8
50	Low Risk	Unequivocal	47.3	42.8	40.4
51	High Risk	Undetermined	46.2	19.9	90.5
52	High Risk	Tentative	45.3	51.0	69.6
53	Low Risk	Irrefutable	44.4	43.2	45.2
54	Low Risk	Canny	42.9	54.8	64.0
55	Low Risk	Indubitable	42.3	45.2	32.7
56	Low Risk	Impregnable	40.3	47.7	42.0
57	Low Risk	Incontrovertible	39.1	51.4	48.2
58	Low Risk	Infallible	37.2	57.0	45.4
59	Low Risk	Prudent	37.2	47.7	57.9
60	Low Risk	Innocuous	35.9	46.2	34.4
61	Low Risk	Unambiguous	34.6	50.9	74.8
62	Low Risk	Shielded	33.1	50.8	81.6
63	Low Risk	Demonstrable	32.8	63.5	78.1
64	Low Risk	Acceptable	32.4	77.1	96.3
65	Low Risk	Cautious	31.1	56.4	95.9
66	Low Risk	Preserved	30.6	58.4	80.8
67	Low Risk	Conclusive	29.3	70.8	86.5
68	Low Risk	Conservative	29.2	51.1	82.3
69	Low Risk	Unadventurous	29.0	33.7	93.7
70	Low Risk	Confirmable	29.0	72.4	73.4
71	Low Risk	Guarded	28.8	63.7	90.7
72	Low Risk	Sheltered	28.0	61.2	90.2
73	Low Risk	Predictable	27.7	58.9	96.1
74	Low Risk	Invulnerable	26.7	66.1	77.4
75	Low Risk	Expected	24.8	66.4	96.7
76	Low Risk	Solid	24.8	78.5	92.1
77	Low Risk	Verifiable	23.9	69.6	78.1
78	Low Risk	Insured	23.4	78.4	85.3
79	Low Risk	Definite	23.0	79.1	95.3
80	Low Risk	Sound	22.8	75.8	88.1
81	Low Risk	Competent	22.7	80.1	89.3
82	Low Risk	Riskless	22.7	62.1	92.4
83	Low Risk	Foreseeable	22.7	72.7	86.2
84	Low Risk	Undoubted	22.1	75.5	88.6
85	Low Risk	Immune	21.1	78.1	94.1
86	Low Risk	Sure	20.6	83.3	97.5
87	Low Risk	Protected	20.0	78.6	95.3
88	Low Risk	Unthreatened	19.9	77.3	93.2
89	Low Risk	Dependable	19.8	81.1	94.8
90	Low Risk	Clear	19.0	85.3	97.7

91	Low Risk	Careful	17.8	76.6	98.1
92	Low Risk	Secure	17.6	80.1	96.1
93	Low Risk	Stable	17.0	78.3	94.9
94	Low Risk	Guaranteed	15.8	78.6	95.7
95	Low Risk	Trustworthy	14.9	94.7	96.0
96	Low Risk	*Trusted*	14.6	91.9	97.8
97	Low Risk	*Reliable*	14.6	91.5	96.5
98	Low Risk	*Certain*	14.5	87.3	96.7
99	Low Risk	*Safe*	12.7	86.9	97.8
100	Low Risk	*Harmless*	11.3	79.5	95.8

Appendix 4

Figure A4.1: Images of all food products and labels used in Study 2. Images for Spaghetti Carbonara, Mackerel Fillets, Crumpets, Cod Fillets, and Ice Lolly also used in Study 3.

Images on left: Product pack without traffic light label.
Image on right: Product pack with traffic light label.

Carrots

Back Bacon

Spaghetti Carbonara

Ice Cream Cones

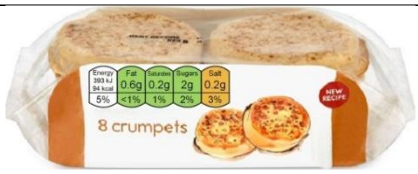
Tomato Side Salad

Apples

Muffins

Mackerel Fillets

Crumpets



Spaghetti Bolognese

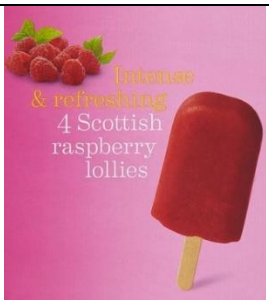
Continental Salad

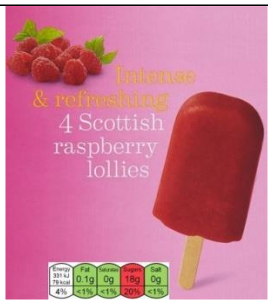
Mushrooms

Cod Fillets

Beef Burgers

Ice Lolly





Green Grapes

Appendix 5

Table A5.1: Mean ratings (out of 100) for all cyber related words/terms based on risk, affect, and familiarity presented in order from highest risk rating to lowest.

	Term	Risk	Affect	Familiarity
1	Virus	86.6	11.3	84.7
2	Hacking	81.0	15.7	73.3
3	Identity theft	77.0	18.8	80.8
4	Worms	76.8	19.5	60.3
5	Trojan horse	74.9	18.0	62.7
6	Malware	74.6	27.0	58.6
7	Spyware	71.8	26.7	63.7
8	Phishing	70.2	25.4	58.7
9	Illegal download	63.0	34.9	83.9
10	Botnet	62.8	31.9	36.5
11	Spam	62.3	18.4	80.4
12	Adware	59.7	27.7	53.0
13	Download	59.6	69.6	90.3
14	Electronic footprint	57.5	47.5	55.0
15	File sharing	57.3	66.8	84.6
16	Chatroom	55.0	52.1	83.3
17	Facebook	53.4	71.0	93.7
18	Torrents	53.0	51.3	60.7
19	Cookie	50.9	49.5	74.8
20	Cloud	47.8	67.2	68.4
21	Twitter	47.0	65.2	80.8
22	Hotmail	44.0	71.2	89.1
23	Google	41.9	84.3	93.6
24	Filtering	41.5	54.1	61.2

25	Upload	40.3	70.3	88.6
26	Firewall	39.3	69.5	78.8
27	Symantec	38.4	56.2	45.5
28	Email	38.1	78.4	93.4
29	Yahoo	37.4	67.9	83.0
30	Anti-virus software	36.9	78.1	85.9
31	Gmail	35.8	75.9	89.4
32	Encryption	35.1	62.4	76.3
33	Microsoft	34.3	83.2	92.8
34	Parental controls	32.8	66.1	71.8
35	McAfee	31.1	72.4	77.0
36	Norton	30.1	70.0	74.1
37	Apple	23.4	82.0	93.1