Commensurability in Decision Making

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Abstract

The thesis has established that commensurability encourages behavioural biases in decision making; moreover, incommensurability discourages behavioural biases in decision making. Commensurability is the proposal that two values can be placed on a single common dimension for comparison. In contrast, incommensurability dictates that two values or items cannot be placed on a single common dimension for comparison - incommensurable items cannot be compared. Recent theories of decision making have identified that comparative processes rather than calculative mechanisms underlie decision making. Moreover, these theories have sought to account for behavioural biases within the constraints of calculative processes. The current thesis has examined over eight experiments, the effect of commensurability and incommensurability on behavioural biases; establishing that preventing comparisons with incommensurability reduces decision makers propensity to display behavioural biases. The effect of commensurability/incommensurability on behavioural biases occurs, as commensurable decision tasks encourage decision makers to use biased comparative decision-making processes, whereas incommensurability discourages decision makers from using biased comparative processes. The ability for incommensurability to reduce behavioural biases has been established across three areas of decision making; risky decisions with loss aversion, multi-attribute choice and choice blindness. The first experimental chapter examined the impact of task commensurability on loss aversion by introducing incommensurability between the task (initial presentation of the gamble) and the judgement (evaluation of the gamble). Prevented comparisons with task commensurability between the two stages of the decision making task reduced the proportion of loss averse judgements made by decision makers. The second experimental chapter examined the effect of introducing incommensurability between choice options, preventing options from being compared, on the attraction and compromise effects. Introducing incommensurability between choice options reduced participants biases in exhibiting the attraction and compromise effects. Finally, the third experimental chapter utilised commensurability in exploration of the choice blindness phenomenon; introducing incommensurable choice options and also incommensurability between the initial decision and the secondary justification of the decision. Introducing both forms of incommensurability preventing comparative strategies from being used in the decision-making task, reduced the number of participants who exhibited choice blindness. Whilst various theoretical perspectives of decision making have touched on the role of commensurability or comparisons, the findings of this thesis stand in contrast to utilitarian theories of decision making, revealing that commensurability does not facilitate utilitarian decision making. Specifically, commensurability allows decision makers to integrate decision content, which leads to biases in decision making. Finally, regarding proposals of decision making founded on biased comparative decision-making process, the thesis offers the other half of the picture - preventing comparisons with incommensurability reduces behavioural biases.

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Contents

Chapter 1: General Introduction

1.1. Overview of the General Introduction

The role of similarity and dissimilarity within decision-making has been evaluated at length. For example, research conducted by Slovic and Lichtenstein (1968) has revealed that decision-makers struggle to use and integrate different sources of decision-making information; in other words, decision makers cannot make comparisons on different dimensions to inform their comparisons. Importantly the inability to compare and integrate different attributes, has been suggested to shape the strategies used by decision makers, such as focusing on one prominent attribute of the task (Slovic and Lichtenstein, 1968). Moreover, researchers have suggested the role of compatibility and comparability in influencing and shaping decision-making. For example, the cue response compatibility hypothesis (Lichtenstein & Slovic, 1973) and the later scale compatibility (Tversky et al., 1988), and structure compatibility hypotheses. The compatibility hypothesis (Lichtenstein & Slovic, 1973) proposes that compatible dimensions in decision-making tasks will be over weighted by decision makers. This suggestion has been supported by decision-making research across several domains, such as financial instruments (Slovic, Griffin & Tversky, 1990). Furthermore, compatibility has been suggested to play an important role in predicting behaviour, Azjen's (1988, cited in Sutton, 1988) principle of compatibility argues that for decision-making behaviour to be effectively predicted, and in turn anticipated, there must be compatibility i.e. the action, target, and time of both attitudes and behaviour must be similar and comparable.

Research has shown the implications of using comparisons within decision-making processes; not only for guiding and educating decision-making (Gigerenzer & Seletan, 2002; Stewart et al., 2006), but importantly for biasing decision-making (Kusev & van Schaik, 2011). Moreover, research conducted by Kusev and van

Schaik (2011) has explicitly emphasised that decision maker's preferences are biased by their ability to compare current decisions against past experiences.

In its simplest form incommensurability has been defined by Sunstien the presence of marked differences so distinct in modality, representation or form, that they cannot be placed onto a single universal scale for evaluation (Sunstein, 1994). Moreover, Sunstein's (1994) definition of incommensurability reiterates early proposals of incommensurability, indicating that incommensurable values are those that do not share a common dimension or scale for evaluation. Additionally, attempts to make comparisons between incommensurable values is argued to do harm to the representation of value (Sunstein, 1994).

Theorists in psychology have made proposals regarding the impact of incommensurability. Slovic and MacPhillamy (1974) argue that incommensurable values bias decision makers; decision makers overweight commensurable dimensions compared to incommensurable dimensions. As a result of incommensurability decision makers in effect make choices based only on the commensurable dimension. Several explanations were offered by the authors which ranged from decision makers using the commensurability of the values being considered as an indicator of importance, to decision makers' perceived inability to assess incommensurable values, which results in a compensatory overweighting of the incommensurable values. Reiterating the impact of incommensurability in shaping decision maker's judgements, Vlaev (2011) suggests that the commensurability/incommensurability of task specific information in decision-making should be considered essential in shaping decision maker's judgements, specifically as behavioural biases arise as a direct result of a cognitive inability to compare qualitatively different decision-making information.

In light of recent proposals in decision-making research such as decision by sampling (Stewart et al., 2006) which emphasises the integral role of comparisons, and earlier work emphasising the impact of incommensurability (Slovic & MacPhillamy, 1972) on decision-making, the current research examines the hypothesis that commensurability in decision-making encourages the production of behavioural biases. Commensurability in the decision-making environment is proposed to allow and encourage decision makers to use biased comparative strategies, and in turn biasing decision-making. Moreover, it was also hypothesised and proven that preventing comparisons by introducing incommensurability into the decision-making task, would reduce respondent's susceptibility to behavioural biases.

Specifically, the research examines the potential for commensurability to fuel behavioural biases and in contrast for incommensurability to reduce behavioural biases. Presenting the proposal that commensurability within decision-making allows decision makers to rely on comparative strategies to inform their decision-making, which leads to variances in decision-making behaviour. Equally by the same token the forthcoming research also reveals the potential for incommensurability to prevent comparative strategies from being used in decision-making, reducing behavioural biases. The second chapter explores how introducing incommensurability into a decision-making task (a monetary gamble) and judgement prevents comparisons, reducing the proportion of participants who display behavioural biases. The third chapter examines the impact of option incommensurability (the ability for choice options under consideration to be evaluated and compared on a single shared dimension) on biases found in multi attribute decision-making (the attraction and compromise effects [Huber et al., 1982; Simonson, 1989]) and reveals that

presenting the decision options as incommensurable reduces both effects. The final, experimental chapter examined the impact of both option commensurability and also commensurability between the different stages of the decision-making task, upon choice blindness. Incommensurability between both the decision-making task and the decision-making judgement leads to a reduction in the proportion of participants susceptible to choice blindness.

1.2. Philosophy and Utility in Decision-Making

Early scholars such as Bentham (1780/2000) and Mill (1863/1990), when theorising about the motivation and strategies used by decision makers, proposed that decision makers should make choices to maximise their utility, choosing the option offering them the most pleasure and the least pain. These utilitarian scholars approached decision-making from a consequentialist perspective, which entails that the value of an action should only be considered with regard to its outcome. In other words, the context or the actions required are irrelevant to the decision or value, as long as the outcome provides the best possible set of circumstances or the greatest reward (Oxford Dictionary of Philosophy, 2016). Consequentialist thought in utilitarian decision-making is exemplified with Mill's (1806-1873/2015) greatest happiness principle, which advocates that actions are correct as long as they bring the greatest happiness to the greatest number of people. In contrast to the consequentialist approach, deontological approaches suggest that actions should be considered correct not by the extent to which they bring about advantageous circumstances, but rather based on the extent to which the actions are right or conform to rights (Oxford Dictionary of Philosophy, 2016).

Early utilitarian theorists placed an emphasis on maximising utility for society as a whole - increasing happiness for the greatest number of people. For example,

Bentham (1780/2000) provides the initial conceptualisation of the utility principle as a notion governing and guiding behaviour. Specially, people should behave with the intention and action to maximise their utility; guided by the pleasure and pain which they experience, seeking to increase the former and minimise the latter. Bentham (1780/2000) defines the principle of utility as being the single factor approving or disproving of any action, based on the ability or potential of the action to increase or decrease the happiness of the person(s) affected by the outcome. Specifically, utility is the potential for an outcome to lead to advantageous circumstance - giving pleasure, leading to happiness and equally reducing or preventing disadvantageous circumstances, which would lead to pain or unhappiness for the greatest number of people.

In contrast to the consequentialist perspective, deontological theorists argue that considering the extent to which an outcome will lead to good or advantageous circumstances fails to take into consideration the morality or intrinsic virtue of actions (Kant & Walker, 2007). For example, Kant's moral law argues that actions and motivations should not be considered right or correct based on the outcomes which they bring about, but rather by considering whether the actions themselves are correct or morally right. For example, hosting a loud party in a residential area would be appropriate from a consequentialist perspective. The party would be appropriate as it would produce enjoyment for the attendees, outweighing the displeasure experienced by a small number of the neighbours disturbed by the noise. However, from a deontological perspective the act of disturbing even a few neighbours in order to provide enjoyment to those at the party would be considered wrong, as the action required to provide enjoyment is of detriment to others (e.g., the neighbours).

Bentham's (1780/2000) utility principle provides several clarifications of how a community, government or individual can be deemed as behaving in line with the utility principle. A person is suggested to be following the utility principle if the approval or disapproval associated with a value or outcome is proportional to the extent to which the person believes it will increase or decrease their happiness. The evaluation of pleasures and pains occurs by considering four aspects of the event – it's intensity, whether it is certain or uncertain and whether it is occurring in the near or distant future. In addition to these considerations, the potential for a sensation to be followed by similar sensations or not be followed by similar sensations is also considered an important factor in the experience of pleasures and pains. Finally, Bentham (1780/2000) suggests that the evaluation of a choice, for example, one of a legislative nature should be made by assessing the tendency for the outcome to bring about good or bad for the stakeholders in the decision. In turn, the action which brings about the most positive effect or least negative effect should be considered the best course of action maximising utility for the group as a whole.

In contrast to Bentham (1780/2000), Mill (1806-1873/2015) suggests that utility is not a measure to distinguish between pleasure and pain, but rather utility is suggested to be pleasure itself, coupled with the absence of pain. Mill (1806-1873/2015) goes on further to define utility and in turn its measurement with the greatest happiness principle. The greatest happiness principle implies that actions are right in proportion to the extent to which they promote happiness. By the same token, actions are wrong in proportion to the extent to which they promote unhappiness (Mill, 1806-1873/2015). Happiness is defined as the presence of pleasure and the absence of pain, and vice versa for unhappiness. The greatest

happiness principle is suggested to be a guiding light for a decision maker, leading them to an existence, devoid of pain and bestowed with pleasure.

Mill (1806-1873/2015), however concedes that not all pleasures are of equal desirability or quality; this combined with differing quantities of information makes the assessment of pleasures a balancing act. As mentioned, many decisions involve the assessment of diverse sources of information, which can be challenging to compare and evaluate. However, Mill resolves this with two suggestions, “Of two pleasures, if there is one which all or almost all who have experience of both give a preference irrespectively of moral obligation to prefer it that is the more desirable pleasure.” (Mill, 1806-1873/2015, p.122). Secondly, “If one of the two is, by those who are competently acquainted with both, placed so far above the other that they prefer it, even though knowing it to be attended with a greater amount of discontent, and would not resign it for any quantity of the other pleasure which their nature is capable of” (Mill, 1806-1873/2015, p.122).

The first statement suggests that the ordering of pleasures can be established by considering the extent to which decision makers universally prefer one option or outcome to another, the outcome that is preferred by consensus being the preferable option. The second statement implies that to establish a preference for potential outcomes a decision maker must be fully acquainted with all the outcomes under consideration, if one is preferred regardless of the quantity of either, then that is the superior option.

Mill (1863/1990) provides proof of utility as a construct with the proposal that, just as the visibility of an item proves that it is visible, the same is applicable to utility. A person’s desire for an object proves that it is desirable; in turn, desirability is

proven by a person's desire. Finally, as happiness can be deemed desirable, as each and every person displays a desire to be happy - as a result, any action leading to an increase in happiness, can be deemed desirable.

When examining a person's motivation for behaviour, Mill (1863/1990) looks at the notion of virtue, suggesting that whilst virtue itself is not an initial motivator for behaviour; principally as virtue is a means to an end, not an end itself. However, for individuals who internalise this goal, virtue can become an end in itself for happiness. Effectively happiness can be assimilated with any number of outcomes, due to this outcomes can become utility in themselves. The same case can be made for money - whilst money is commonly seen as contributing to a goal or helping to research a point (e.g. acquiring money is viewed as an ingredient contributing to happiness, facilitating the purchase of desired goods or services), the desire for money to contribute to happiness can become internalised, and the accumulation of monetary wealth in itself can become equal to happiness. Specifically, this is suggested to occur when the desire to accumulate money and spend money as a means to achieve or increase happiness is overtaken by the desire to simply accumulate and retain money, as a way of deriving happiness - the accumulation of money becomes the ends. In light of this Mill (1863/1990) argues for the ability of benign facets of existence to contribute to happiness and in doing so become sources of happiness in themselves, surpassing basic sources of happiness and in doing so providing diversity and quality of life. Essential to the account proposed by Mill (1863/1990) is that the desire to increase happiness, and in turn reduce unhappiness, is derived from two aspects of the same utility function bipolar in nature, accounting for both negative and positive circumstances in one function.

Mill (1863/1990) however, does concede that a person may in some instances not act in line with their desires; as whilst a person's actions are directed by their desire to maximise their happiness, those actions are operationalised and maintained by their *will*. Moreover, a decision maker's *will* is suggested to be susceptible to being co-opted by their habits, and the actions carried out due to habituation may continue long after desire has reduced. However, Mill (1863/1990) resolves this contention against behaviour being solely shaped by utility, with the suggestion that in all instances *will* is formed as a means to happiness. However, habit of the *will* to do right and be virtuous is encouraged, it is suggested that *will* provides the means, but not the ends for good. Moreover, due to this, the power of *will* to guide behaviour as suggested by Mill (1863/1990) does not contradict the assumption that the only good for humans is accumulating pleasure and mitigating pain.

Moore (1903/1990) provides a critique of Mill's proof of utilitarianism, arguing that just because something is desired, does not necessarily make it desirable. In other words, desirability is not a precursor for desire. Furthermore, it is suggested that if as argued by Mill (1863/1990), whatever is desired is good, then as a result there does not need to be any mention of desire as a motivation for behaviour. Mill's (1863/1990) suggestion that actions being considered good as the motive for behaviour, makes establishing the motivation for behaviour challenging. Specifically, as it cannot simply be said that what is desired is good, because as noted previously desire is one and the same as good. To this end Moore (1903/1990) argues that Mill's (1863/1990) proof of the existence of utility is little more than a fallacy, as that which is desirable is deemed good, and that which is desired is also deemed good. However, desired and desirable are fundamentally different - the latter meaning

something that is the object of desire and the former, something which ought to be the object of desire yet is not necessarily desired. Furthermore, Moore (1903/1990) highlights that following Mill's assumptions that a person desires his happiness, therefore their happiness is desirable, and this happiness alone is desired, should mean that only their happiness is desirable. However, if this rule is applied to every person, then every person's happiness alone is desirable; in effect suggesting that all happiness is desirable, but only in the singular applied to an individual.

1.3. Economic Theories of Utilitarian Decision-Making

In contrast to the philosophical approaches towards utility advocating for the greatest happiness of the greatest number of people (Bentham, 1780; Mill, 1863/1990) economic theories of utilitarian decision-making instead account for the maximisation of personal utility. Specifically, advocating that decision makers should make decisions to increase their own personal state of wealth or welfare, rather than society's as a whole.

Bernoulli (1954) provides an account of utility, taking into consideration the balance between an expected outcome and likelihood of the outcome occurring. Bernoulli (1954) proposed that the probability of an outcome occurring should be used to correct its expected value. "Expected values are computed by multiplying each possible gain by the number of ways in which it can occur, then dividing the sum of these products by the total number of possible cases." (Bernoulli, 1954, p.1). Bernoulli (1954) goes further examining the properties of utility, offering an account of marginal utility, painting utility as a relative construct dependent on relative states of wealth or welfare. The value of an object is suggested to be defined not by its monetary value, as price is equal to every person and therefore cannot account for the intrinsic value of an object. Intrinsic value, and in turn utility is instead said to

reflect the positive or negative affect, which an outcome can produce; rather, the value of an object is defined by the utility of the object - the object's ability to appreciate or depreciate a positive or negative state respectively. In other words, whilst the direction of a change in utility either depreciating or appreciating, does not vary due to personal circumstance or wealth, the magnitude of the change will vary as a function of personal circumstances or wealth. For example, take two winners of a lottery both paying the same amount to enter (£1), and both receiving the same reward (£1000); however, the first earns £12,000 per year, and the second earns £120,000 per year. Based on these facts, Bernoulli (1954) would anticipate that the first recipient would assign a higher value to the prize, as receiving a value equivalent to 8% of their yearly earnings would bring about a greater level of happiness compared to the second recipient for whom the prize is only equivalent to 0.8% of their yearly earnings. In other words, Bernoulli (1954) suggests that whilst an increase in wealth will always lead to an increase in utility, the magnitude of the increase is in fact inversely proportional to the recipient's current state of wealth.

When considering decision-making under risk, the relationship between the mathematical calculation of the probability and the psychological estimations of probability have been assumed to be equivalent. However, Ramsey (1926) argues that the belief in an outcome's occurrence cannot be established based on the measurement of probability. Ramsey (1926) suggests that there is a degree of variability in the fixedness and measurement of beliefs, arguing that some beliefs can be measured more effectively than others; moreover, the measurement of beliefs is argued not to be an accurate process. Specifically, the manner of measurement is proposed to lead to variations in the measurement of beliefs. Ramsey (1926) suggests a theory of decision-making not assuming the additivity

and measurability of values. Instead, it is proposed (Ramsey, 1926) that a definite degree of belief can be established, incorporating utility and uncertainty where the attitudes towards a gamble are established based on the attitudes towards the prospects and the perception of the outcome's likelihood. Bradley (2001) offers an informal explanation of Ramsey's (1926) reasoning, first establishing a person's attitudes to the possible prospects and assigning a numerical value to each prospect. Following this, a person's attitudes to the highest and lowest ranked outcomes in the form of a 50/50 probability of either outcome occurring is established - in this scenario the utility of the gamble reflects the decision makers desire for either outcome to occur, combined with the belief that either outcome will occur. Hence, a gamble where both the best and worst outcomes are equally probable possessing a utility of .05, and any gamble consisting of the bottom and top ranked prospects will possess a value between 0-1 (Bradley, 2001). Additionally, this measurement of utility facilitates the measurement of beliefs. Specifically, as attitudes towards mixed prospects are suggested to be constructed based on the likelihood of an outcome occurring, removing a person's attitudes towards an outcome from its utility leaves only a person's degree of belief pertaining towards the occurrence of the outcome (Ramsey, 1926). Moreover, this measurement of a definitive degree of belief implies only a certain measure of consistency in the decision maker's preferences, as decision makers should be willing to play gambles with the same odds but different stakes, with consistency assumed only between the odds deemed acceptable in different propositions.

Von Neumann and Morgenstern's (1953) expected utility theory (EUT) builds on Bernoulli's (1954) proposal that a decision maker should consider the likelihood of an outcome occurring, when evaluating the worth of a risk and make decisions with

the intention to maximise their expected utility. With this approach, it is assumed that both utility and probability are transformed into numerical values by the decision maker. Underpinning this approach is the comparability assumption, which emphasises that utilities from different outcomes can be compared and evaluated against each other (i.e. there is no differentiation between utilities borne from different experiences). Simply, the expected utility of an outcome can be characterised as the value of an outcome integrated with the likelihood of the outcome being realised (von Neumann & Morgenstern, 1953). For example, when calculating the expected utility of a choice between 50% chance of winning £100 (outcome value/outcome likelihood = expected value £50) vs a 10% chance of winning £1000 (outcome value/outcome likelihood = expected value of £100), a decision maker should choose the second option, as whilst there is a lower likelihood of winning the increased magnitude of the outcome means it has a greater expected value (von Neumann & Morgenstern, 1953). Therefore, the construction of preferences is contingent on: first being able to quantify the value of the outcome, and then the likelihood of the outcome occurring; secondly, the ability to perform these computational processes to integrate different values (von Neumann & Morgenstern, 1953).

Underlying the proposals made by von Neumann and Morgenstern (1953) are several axioms hypothesised to underpin rational decision-making; shaping the behaviour of a rational decision maker. The completeness axiom assumes that individuals have well defined preferences and should choose consistently between options or be indifferent between options ($a > b, b > a, a = b$). For example, a decision maker should always be able to select one option over another and should do this consistently, e.g., if option A is chosen over option B, option A should always

be chosen over option B. Secondly, the transitivity axiom adds to the completeness axiom stating that decision makers should decide consistently between options ($a > b, b > c\ implying\ a > c$). Specifically, if a decision maker selects option A over option B, then option B over option C, then given the opportunity they should prefer option B to C. Finally, the continuity axiom dictates that when there are three gambles - A, B and C, and A is preferred over B and B is preferred over C, then there should be no combination of gambles A and C, where an individual is indifferent between them and gamble B.

With the axioms of expected utility theory, the independence of irrelevant alternatives axiom is frequently proposed to be part of the theory; however, Fishburn (1989) has highlighted that the initial iteration of expected utility theory did, in fact, not offer the independence axiom. Instead, Fishburn (1989) attributes the independence axiom to several scholars (e.g., Samuelson, 1952 cited in Fishburn, 1989) who suggests that decision makers will maintain the order of their preferences, and these preferences should not be altered or swayed when additional irrelevant options are added to the choice set. For example, if gamble A is preferred to gamble B, the addition of an irrelevant gamble C should not change the initial preference of gamble A over gamble B.

The axiomatic logic of expected utility theory assumes that a compatible relationship exists between decision prospects, allowing them to be compared on a level playing field, facilitating the assessment of the items. In turn, the decision maker will behave in a normative manner making decisions with the sole intention to maximise their expected utility. However, as the utility function is suggested to be concave, it acknowledges a diminishing marginal utility. Specifically, decision makers may display risk averse preferences, as they will not be aiming to maximise their

monetary income but rather the utility of their income. As a result, the utility derived from a relatively large but risky prospect is closer to the associated utilitarian cost of playing the gamble, than in fact, the potential monetary outcome would imply, leading to risk aversion (see appendices A).

Friedman and Savage (1948) reiterate the proposals made by von Neumann and Morgenstern (1953), proposing a series of hypotheses for the behaviour of decision makers, accounting for variations in behaviour between risky decisions involving lotteries and risky decisions involving insurance. However, the authors do suggest some key changes to the treatment of risk, specifically, that behaviour towards risk is not uniform through the utility function, instead risk attitudes change with income, as proposed by Bernoulli (1954).

(a) it had a consistent set of preferences; (b) these preferences could be completely described by a function attaching a numerical value-to be designated "utility"-to alternatives each of which is regarded as certain; (c) its objective were to make its expected utility as large as possible (Friedman & Savage, 1948, p.287-288).

With decision-making under risk, it is also suggested (Fishburn & Savage, 1948) that decision makers should select the option that has the greatest expected utility. However, expected utility is deemed to be separate from the utility of the monetary income, as it takes into account variations in states of wealth. Specifically, they (Fishburn & Savage, 1948) suggest that all increases in income result in an increase in utility. However, the increase is not uniform, instead the size of the increases is moderated by the decision makers consideration of circumstances where they may be risk seeking, or equally risk averse; specifically, the range of incomes is divided into thirds with two inflection points. The initial third encapsulates

a rise in income, resulting from a diminishing marginal utility with each additional unit of income leading to a reduction in the magnitude of the increase of utility, whereas for increases in the middle third there will be an increase in the marginal utility (i.e. additional increases in income will result in a greater increase in monetary value). Finally, in the range of larger incomes there will also be diminishing marginal utility. The three predictions across a range of income states are reflected in a utility function which is convex, concave and then convex again (see appendices B) for large states of wealth (Friedman & Savage, 1948). This function incorporates variations, which may be exhibited in decision-making preferences between risky domains, for example lotteries and insurance. In the initial state, a decision maker will display risk aversion, and therefore may be inclined to purchase insurance to avoid such a risk; whereas in the middle portion, due to the increasing marginal utility, they will be risk seeking and so are willing to play a gamble. Finally, for larger amounts they will be risk averse again. As a result, rather than being fixed, the relationship between income and risk is suggested to be relative depending on potential outcomes or changes to income (Friedman & Savage, 1948).

Previous theories have assumed a general parity in the utility of outcomes across positive and negative domains, taking into consideration the risks associated with the outcomes, and assuming that risk is relative to a final outcome position (Friedman & Savage, 1948; von Neumann & Morgenstern, 1953). Markowitz (1952) however, offers an alternative account of decision-making, proposing that the utility of an outcome is established based on a change from a neutral reference point, such as a customary state of wealth or welfare. Outcomes falling below this point are losses and above are gains. An important point to emphasise regarding the customary state of wealth or welfare is that it need not be a person's current level of

wealth, but rather it refers to the state of wealth with which a person is most commonly familiar with. Specifically, the utility function is suggested to have three inflection points (in contrast to the two inflection points suggested by Freidman & Savage, 1948), the first inflection point reflects a decision makers customary wealth position; under this point accounts for losses, and above accounts for gains, with the slope of the utility function beginning as concave then becoming convex, then concave and finishing as convex. This pattern accounts for the prediction that decision makers will display risk averse attitudes for small losses and large gains, and as the magnitude of losses increases decision makers become risk averse, equally as the magnitude decreases for gains decision makers will become risk seeking. By viewing the utility function as a change to a fixed income position, Markowitz's (1952) utility function is able to explain how preferences may change as a function of the framing of the question, explaining the difference in behaviour between insurance and lottery decisions as examined by Friedman and Savage (1948) (Appendices B). Specifically, the choice to take out insurance protects against a negative departure below a customary state of wealth, whereas the choice to play a lottery is associated with a change above a customary state of wealth. Additionally, Markowitz (1952) suggests that decision makers tend to avoid mixed bets, those that give an equal chance to lose and win equivalent amounts. The aversion to mixed gambles is suggested to occur as the value falls quicker to the left below the customary level of welfare, indicating that decision makers may experience an aversion to losses. Markowitz (1952) proposes that this behaviour occurs due to the positive skew of the probability distribution towards an outcome as result of the final asset's position. In contrast however, for small equal mixed bets it is proposed that the increased aversion to losses will not occur, as the utilitarian pleasure derived

from playing the gamble (experiences irrespectively of potential outcomes) outweighs the potentially negligible costs associated with losing the gamble.

Savage (1954) builds on the proposals made by von Neumann and Morgenstern (1953) maintaining that decision makers should act in a manner which maximises their expected utility. However, an essential distinction is made; specifically, decision makers are argued to act as though they are maximising their subjective expected utility. Subjective expected utility is established by weighting the utility of the outcome by the subjective or personal probability of the outcome occurring. Hence, decision makers are proposed to be able to infer probabilistic and numerical information from the decision-making environment around them. Even in lieu of concrete decision information such as probabilities decision makers should behave as though they are maximising their expected utility, behaving in a manner consistent and commensurate to this end. Moreover, Savage (1954) also suggests the sure thing principle, which implies that if a person prefers option A over option B, regardless of either outcome associated with option A then they should also prefer option A if they do not possess information regarding the outcomes.

Edwards (1955) presents partial support for the role of subjective expected utility in predicting and anticipating decision maker's judgements. However, essential to this account is that the subjective probability established by decision makers is far more crucial to the education of decision maker's judgements, than the utility offered by the outcome. Edwards (1955) found that decision makers' choices could be predicted effectively using subjective expected utility incorporated with the subjective probability of the outcome. Specifically, participants were required to choose between bets and from this the utility function was inferred (Edwards, 1955). Edwards (1955) discovered that the utility assigned to a monetary value by

participants was correlated with its monetary value. Moreover, the subjective expected utility, could then be used to predict respondent's judgements. With a choice between two gambles the gamble with the greater subjective expected utility was more likely to be chosen, indicating that respondents were attempting to maximise their subjective expected utility. Despite the effectiveness of the subjective expected utility to predict respondent's behaviours, expected utility theory (von Neumann & Morgenstern, 1953), on the other hand, did not. In addition, Edwards's (1955) findings reveal several interesting features of the decision-making processes; specifically, how the discriminability of stimuli shapes whether decision makers conform to utility maximisation. Regarding expected utility theory (von Neumann & Morgenstern, 1953) it is suggested that as utility possesses a linear relationship to money within the range of values in Edward's (1955) study, the relative difference in expected value between the gambles is relatively small, as a result, they are not used to inform decision-making. In support of this explanation, the difference in subjective expected utility between the options was found to predict the likelihood that a decision maker would select the option with the greatest expected value. In light of these findings, Edwards (1955) suggests that probabilistic information should be given precedence over utilitarian information when anticipating and predicting decision maker's behaviour.

Initial support for utilitarian decision-making is tentatively supplied by Mosteller and Nogee (1951). Mosteller and Nogee (1951) discovered that utility curves constructed from decision makers' choices in simple gambles could be used to an extent to predict future behaviour. However, the authors noted that predictions derived from the utility curves were not as effective as hoped. Moreover, several of the findings were contradictory to utilitarian decision-making. Specifically, the authors

(Mosteller & Nogee, 1951) found individual differences between participants from a student population who displayed diminishing marginal utility; however, the second sample population made up of a group of national guardsmen did not.

Further evidence of the validity of expected utility theory is provided by Hauser and Urban (1979) who suggest that expected utility theory (von Neumann & Morgenstern, 1953) can affectively predict consumer behaviour. Specifically, the authors (Hauser & Urban, 1979) argue that the assumption of risk aversion built into expected utility theory provides an essential contribution to predicting consumer decision-making behaviour, accounting for a consumer's unwillingness to switch products, even in the face of potentially superior alternatives. Furthermore, the authors found that expected utility theory outperformed two alternative models in predicting decision maker's preferences, specifically, as it accounted for risk aversion and a reluctance to switch products.

Finally, Brookshire, Thayer, Tschirhart and Shulze (1985) offer evidence from an applied decision-making setting illustrating the potential for expected utility theory to predict real world decision-making. The authors (Brookshire et al., 1985) provide evidence of expected utility theory's effectiveness at predicting low probability, high cost natural events - earthquakes. Brookshire et al. (1985) found that property owners self-insured, taking into consideration the associated costs of falling prey to an earthquake consistent with the maximisation of their expected utility. The authors (Brookshire et al., 1985) identified that the potential cost of the damage to a house was in proportion to the house's value. Moreover, in conjunction with expected utility theory the potential cost of damage to the houses could be used to accurately predict the difference in the perceived cost of living between those inside the earthquake zones and those outside of the earthquake zones. Moreover, the authors

present additional evidence revealing that houses within earthquake zones in Los Angeles were half as susceptible to earthquakes as houses in earthquake zones in San Francisco. Based on this the authors (Brookshire et al., 1985) anticipated that the difference in price between houses in and outside of earthquake zones in Los Angeles should be half as much as in San Francisco due to the reduced risk of an earthquake; this prediction was supported by the actual difference in the increase in value of houses outside of the earth quake zones in Los Angeles and San Francisco.

1.3.1. Experimental Evidence against Normative Assumptions (early stages)

Allias (1953) examines normative utilitarian assumptions of decision-making, questioning some of the stringencies and assumptions of rationality outlined previously (e.g., von Neumann & Morgenstern, 1953). Specifically, Allais (1957) argues that monetary and psychological values are inherently connected; however, despite this connection monetary and psychological values represent separate and distinct properties and measures. Due to the connection, but equally the inherent separation between monetary and psychological values, Allais (1953) argues that a utility function cannot effectively be established simply by examining risky decisions. Instead, a utility function can be established with introspection regarding the level of satisfaction with regard to the possible potential outcomes of the decision. In other words, the outcome of the decision is not the sole factor in evaluating prospects and educating decisions; specifically, as the psychological assessment of the response may not accurately reflect the actions of the decision maker. However, their feelings towards the outcome encompasses this evaluation. Additionally, Allais (1953) argues that decision makers do not interpret probabilities objectively, but rather decision makers rely on subjective probabilities. As decision-making is informed by subjective

probabilities, rationality is redefined and not seen as the adherence to an external system of rationality following axiomatic rules to maximise utility (von Neumann & Morgenstern, 1953). Rationality is proposed by Allias (1953) to be best defined in terms of internal consistency, does the decision maker adhere to or display a pattern of behaviour coherent with their desired outcome. Moreover, Allais (1953) suggests that rationality can be established by observing decision makers who can be considered to be acting in a consistent rational manner; a consistent strategy being one where the decision maker uses objective probabilities when possible and follows the axiom of absolute preferences. The axiom of absolute preferences implies that between two outcomes one is preferable, if under all possible circumstances it leads to a greater gain.

Allais (1953) also provides a prominent early example of decision-making behaviour in violation of expected utility theory, or more specifically the independence axiom with the Allais Paradox (1953 cited in Machina, 1987). The Allais paradox details a phenomenon where decision makers prefer gamble A (100% of winning $1,000,000) over gamble B (10% of winning $5,000,000; 89% of winning $1,000,000; 1% of winning $0). However, when given the choice between a second pair of gambles gamble C (10% chance of winning $5,000,000; 90% chance of winning $0) and gamble D (11% chance of winning $1,000,000; 89% chance of winning $0) decision makers prefer gamble C (Allais, 1953 cited in Machina, 1987). This pattern of behaviour is in direct violation of the independence axiom (von Neumann & Morgenstern, 1953), as the axiom dictates that if a decision maker prefers gamble A, they will have steep indifference curves between the gambles. Therefore, decision makers should also prefer gamble D in the second stage. Instead the choice for gamble A, and then gamble D, indicates that indifference

curves (see appendices A) are not uniform running parallel to each other, but instead fan out moving away from each other past a point (Machina, 1987).

The stance taken by Allais (1997) regarding adherence to normative decision-making, anticipated by expected utility theory in light of the Allais paradox, is best summed up by the author himself in the speech he gave on receipt of the Nobel Prize. “The Allais paradox is paradoxical in appearance only, it merely corresponds to a very profound psychological reality, the preference for security in the neighbourhood of uncertainty” (Allais, 1997, p.6).

Ellsberg (1961) provides a further example of behaviour, which violates expected utility theory (von Neumann & Morgenstern, 1953) and in doing so seeks to introduce further the implications of psychological factors into utilitarian decision-making. Specifically, arguing that decision makers are averse to ambiguity and display preferences reflecting this attitude. In other words, with a choice between two prospects, they will select a prospect which has a clear likelihood of occurrence over a prospect for which the likelihood of it’s occurrence is ambiguous. This view stands in stark contrast to normative assumptions of decision-making, such as the proposition that decision makers assign probabilities to outcomes to inform their decision-making processes, as put forward by Savage (1954).

Ellsberg (1961) exemplified the implications of ambiguity on decision-making preferences with the urn paradox. In the task which gave the urn paradox it’s name, participants were told that in an urn there were 30 red balls and 60 black or yellow balls, all were evenly mixed so that there was an equal likelihood of selecting any one of the balls. Respondents were then posed two choices and asked to make two choices first between options A) $100 for a red ball or B) $100 for a yellow ball and

then a choice between C) $100 for a red or yellow ball or D) $100 for a black or yellow ball. Following a normative logic, a decision maker who prefers gamble A to gamble B should then also choose gamble C, over gamble D. This pattern of behaviour is dictated by the first gamble selection which indicates that a decision maker prefers their chances of choosing a red ball, since its quantity is known, and this pattern of preferences should follow through to the second pair of gambles. However, Ellsberg (1961) discovered that typically decision makers either initially preferred gamble A then gamble D, or preferred Gamble B then preferred Gamble C, suggesting that decision makers change their strategy partway through the task. In addition, Ellsberg (1961) argues that under ambiguous circumstances decision makers will violate Savage's (1954, cited in Ellsberg, 1961) axiom; specifically, as they do not attempt to infer probabilities to quantify uncertain or ambiguous events. Moreover, it is proposed that this reversal in behaviour is not erroneous but intended, as decision makers also display an unwillingness to reverse it. This choice strategy is defined by the following decision rule: as ambiguity in the decision decreases, reliance on probabilistic information increases. In other words, under ambiguity decision makers do not conform to axiomatic logic estimating probabilities and likelihoods. However, decision makers do learn from their prior experiences which reduces the ambiguity of the task, and as a result, decision makers educate their judgements based on probabilistic estimations.

In response to both the Allais (1953) and Ellsberg's (1961) paradoxes, utilitarian theorists have sought to provide revisions to expected utility theory and subjective expected utility to account for the axiomatic violations presented by both paradoxes. One example of this is anticipated utility theory (Quiggin, 1982; Segal, 1987).

In anticipated utility theory Quiggin (1982) suggests that future utility is only estimated, but not calculated with attitudes regarding the risk from both specific attitudes to risk and attitudes towards the outcome of the gamble. This suggestion incorporates a less stringent form of the independence axiom. Specifically, anticipated utility is constructed based on combined weighted utilities that are constructed from decision weights, rather than from the direct quantification of decision values as in expected utility theory (von Neumann & Morgenstern, 1953). Moreover, the decision weighting is derived from the range of probabilities under consideration not specific probabilities. First, all outcomes are ordered by the decision maker from best to worst, incorporating probabilities and outcomes.

$$V = h(p) \cdot u(x) = \sum_i h_i(p) U(x_i) \quad (1)$$

In the anticipated utility function (1), *U* represents a utility function similar to that of von Neumann and Morgenstern (1953); $h_i(p)$ refers to the probability weighting, dependent not only on the initial probability (p) but also on the range of probabilities in the task. Finally, (x) refers to the outcomes, as noted, anticipated utility incorporates a weaker set of axioms than expected utility theory, specifically, in relation to the independence axiom. The completeness axiom remains intact; however, the dominance and continuity axioms only apply to the outcomes of the gambles. Finally, the independence axiom is weakened by separating the probabilities from the outcomes being considered, i.e. two gambles cannot be considered equivalent if the likelihood of the outcome occurring and the outcome differ despite them having the same expected value.

Specifically, in relation to the Allais Paradox, mentioned previously decision weights are not constructed from individual probabilities, but rather from the total range of probabilities under consideration (Quiggin, 1982). Due to this, the weighting given to a probability is not a fixed entity; even if the probability remains fixed (Quiggin, 1985). For example, a probability framed as an extreme amongst other prospects will not receive the same weighting as the same probability framed as an intermediate option amongst the range of other probabilities (Quiggin, 1985). Specifically, in relation to the Allais paradox (Allais, 1953 cited in Machina, 1987) in the choice between gambles A and B, the low probability of not receiving an outcome is evaluated in relation to the range of probabilities. Moreover, due to its extreme positioned gamble B is over weighted making it appear less favourable, leading to a preference for gamble A with a sure outcome (Quiggin, 1985). In contrast, with the second set of gambles, as there is no extreme option to be overweighed the 1% greater likelihood of winning the $1,000,000 is negligible compared to the increased potential win of $5,000,000 at a cost of a 1% increased likelihood of not winning. Moreover, as anticipated utility theory relaxes the axiomatic assumptions of expected utility theory it is harder for the axioms to be violated. For example, the independence of the probabilities and payoffs means that axiomatic violations will occur only when outcomes are given within the same range and distribution of probabilities. Hence, axiomatic violations only occur if the scaling of the probabilities is the same, creating a uniform weighting of the probabilities. Whereas if the objective probabilities differ, the subjective expected utility remains the same, however, if the scaling and range of probabilities differs then the weighting assigned to the probabilities will differ (Quiggin, 1985).

Additionally, Segal (1987) provides an account of the Ellsberg's urn paradox utilising anticipated utility theory (Quiggin, 1982), the use of anticipated utility theory allows for the urn paradox to be viewed as two gambles, rather than two stages of the same gamble. Specifically, the initial lottery is ambiguous as decision makers do not know the probability of selecting a black or yellow ball. Due to the ambiguity the decision makers first conduct an imaginary gamble estimating the probability of them selecting one of the balls. Hence, decision makers do not reduce outcomes to a compound gamble, but instead view the gambles separately in two stages – first, evaluating the likelihood of selecting one of the balls, then evaluating the gambles as a whole. Specifically, these probabilities or estimated probabilities are initially constructed and then combined. The combined probabilities are not used to calculate the expected value of each possible gamble but instead a decision weight. The decision weight is shaped by the distribution of the probabilities rather than the objective probabilities. Whilst with the urn paradox decision makers display a reversal in their preferences between gambles, producing axiomatic violations in line with expected utility theory (von Neumann & Morgenstern, 1953), this violation does not occur in accordance with anticipated utility theory (Quiggin, 1982; Segal, 1987). Specifically, as the range of probabilities differs so the weighting assigned to the probabilities is expected to differ also (Quiggin, 1982; Segal, 1987).

Experimental evidence and theoretical proposals have indicated that decision makers do not conform to expected utility theory (von Neumann & Morgenstern, 1953), as exemplified by axiomatic violations of expected utility theory in the Allais (Allais, 1997) and Ellsberg (Ellsberg, 1963) paradoxes. Explanations offered have suggested that decision makers may not rely on a modified utility function; recent research has shown that the presence of behavioural biases may not be as clear cut,

with experiential monetary tasks and judgements potentially reducing the extent to which expected utility theory (von Neumann & Morgenstern, 1953) is violated. Specifically, recent research has suggested that experiences can increase a decision maker's adherence to decision-making preferences, which conform to expected utility theory (List, 2003; List & Haigh, 2005). For example, List and Haigh (2005) found that whilst both professional traders and student participants exhibited behaviour conforming to the Allais paradox (List & Haigh, 2005), the extent to which the participants displayed preferences in line with the Allais paradox was dependent on their occupation. Students exhibited stronger preferences in line with the Allais paradox, whereas this pattern of preferences was reduced in the behaviour of professional traders (List & Haigh, 2005).

1.4. Failures of Rationality: Descriptive Theories of Decision-Making

1.4.1. Pre-Prospect Theory

Moving away from theories of decision-making that have sought to explain decision-making with utility at their heart, various early psychological theories have suggested multiple psychological factors, such as the limited processing ability of decision makers (Slovic & Lichtenstein, 1968), which is suggested to impact decision-making processes.

Slovic and Lichtenstein (1968) suggest that decision makers do not give parity to all decision-making information. Specifically, the authors (Slovic & Lichtenstein, 1968) suggest that decision makers give greater weighting to the attributes they believe to be of more importance to the given task at hand. The focus on the attributes perceived to be of most importance is suggested to occur as decision makers have limited processing power. Due to the limited processing power decision makers attend to limited sources of information. Moreover, this limited attention is

directed by the perceived importance of the attributes under consideration. Specifically, Slovic and Lichtenstein (1968) suggest that decision makers face a challenge when trying to integrate multiple sources of information to educate their decision-making. As a result, decision makers are biased by what they perceive to be the most important source of information, for example, the superiority of probabilistic information over the value of the outcome when educating their decision-making. One of the simplified strategies used by decision makers is to divide the gamble into two stages (Slovic & Lichtenstein, 1968). Initially decision makers are suggested to evaluate the gamble assessing whether it is either attractive or unattractive, this guides adjustment in the second stage. The attractiveness or unattractiveness of the gamble is quantified when the task requires attributing a monetary value to the gamble with decision makers adjusting from the amount to be won and the amount to be lost. The reliance on the monetary dimension is suggested to occur due to the match between the monetary outcome of the gamble and the judgement of the gamble made in terms of monetary worth. Moreover, the authors (Slovic & Lichtenstein, 1968) suggest that changes to decision weights between decision-making tasks may reflect a change in decision-making strategies, with decision makers attempting to reduce the strain on their information processing. Moreover, Slovic and Lichtenstein (1968) draw on past research (Slovic, Lichtenstein & Edwards, 1965) highlighting that a decision maker's cognitive state shapes their decision-making. For example, inducing boredom resulted in changes to decision maker's preferences. The authors (Slovic et al., 1965) identified that under tedious and boredom inducing conditions a simple strategy was adopted; decision makers made decisions with little thought to the actual task, producing simple preference functions, whereas under less boredom inducing conditions such

as experiments using real money, decision makers used more complex strategies leading to multiple preference functions.

Further evidence that decision makers' cognitive faculties are not set up to make decisions in a normative fashion comes from Tversky's (1969) proposal that violations of the transitivity axiom in decision-making are not behavioural irregularities. Rather they occur as a function of decision-making mechanisms, specifically suggesting that small differences between decision prospects are discounted by decision makers. Tversky (1969) offers the example of a person in the market for a car who initially, when looking at a base model, readily accepts a series of small (relative to the overall cost of the car) price increases for upgrades. Yet, the same person will baulk at the total price of the combined upgrades, as the increase in cost is no longer negligible but substantial. Tversky (1969) proposes that under specific circumstances, where the information in the task is substantial, decision makers do not utilise computational processes; instead, decision makers rely on approximations such as disregarding small differences. However, disregarding small differences can lead to the intransitivity of preferences, as the difference between dimensional values changes as a result of the comparison of the attributes between choice options (Tversky, 1969).

Moreover, Tversky (1972) goes onto offer an alternative theory of decision-making, which captures the elimination of attributes shared between decision options. The elimination by aspects model (Tversky, 1972) characterises choice as a series of comparisons of the attributes of each decision option. Specifically, an aspect is selected from one prospect based on the probability of its appearance and options which do not include the attribute are eliminated, this process continues until one prospect remains. However, prospects sharing the same aspects remain and

are not eliminated; hence, common features between prospects do not contribute to the decision-making processes. In addition, Tversky (1972) argues that the same processes can occur for negative aspects but in reverse, for example, the selection of a negative aspect will lead to the elimination of all the aspects which share the same negative attribute. The elimination by aspects model accounts for the violations of irrelevant alternatives; as even an irrelevant alternative can shape the process of elimination, based on the individual aspects of a prospect and not the prospects total utility.

Portfolio theory (Coombs & Huang, 1972) proposes that the acceptable level of risk to a decision maker differs, based on the expected value of the outcome; specifically, this proposal is underpinned by three core assumptions.

Assumption 1: A game is characterised by its expected value and its perceived risk … Assumption 2: An Individual has a continuous preference function over the space of all games which for any fixed level of expected value is a- single-peaked preference function over risk … Assumption 3: In a choice between games which deviate equally in risk from optimum, the individual will maximise expected value (Coombs & Huang, 1972, p.23, 24)

In relation to the second assumption, it is important to note that a single peak reflects a decision maker's ideal level of risk given a specific expected value, whilst on the face of it would appear as though the ideal risk is considered minimal, and if the expected value were to remain the same, Coombs and Huang (1972) suggest that decision makers are attracted (to an extent) to greater gains, despite the potential to lose. Specifically, the trade-off between risk and reward is made in relation to the decision maker's ideal level of risk - the ideal point of tension between

winning or losing, which dictates the ideal level of risk for a decision maker. Finally, a decision maker will attempt to maximise utility between gambles, which exemplifies their ideal level of risk. Portfolio theory (Coombs & Huang, 1972) deviates from normative proposals of decision-making, specifically, rather than solely trying to maximise the expected utility of their outcomes, decision makers are suggested to make decisions based on their ideal level of risk, illustrating the role of preferences external to that of the desire to maximise utility. However, with risks that fall within a decision makers' preferences for risk decision makers do attempt to maximise utility.

Simon (1955, 1976) presents an account of decision-making, which considers both the computational limitations of decision makers; as well as the feasibility of accumulating and accessing all the information required to inform the respondents' decision-making, within bounded rationality, simplifications are proposed to relax the normative assumptions of decision-making. Instead of making a choice to maximise the utility of the outcome occurring, decision makers are suggested to make a choice to satisfy. Satisfying implies choosing an outcome, which decision makers are content with as opposed to searching for an optimal outcome. Simon (1955, 1976) has outlined several simplifications to the normative decision-making processes offered by von Neumann and Morgenstern (1953). Specifically, decision makers instead of making choices to achieve the maximum possible value, are proposed to establish an acceptable level or threshold of satisfaction, then select any outcome, which surpasses this threshold. Within bounded rationality pay-off functions are simplified; for example, outcomes can be considered either satisfactory or unsatisfactory, or a win, draw or loss depending on the task at hand. The boundary for whether an outcome can be considered satisfactory or unsatisfactory is established either by the aspirational level or the price a decision maker would be

indifferent between either selling or not selling the item (Simon, 1955). When gathering information and searching through the available options, the search processes is simplified, with decision makers not conducting an exhaustive search for an optimum option. Instead, decision makers are suggested to search for a feasible satisfactory outcome. Specifically, searching for an option that surpasses a threshold - once this threshold is met, decision makers do not look further afield for a superior option which may offer a higher payoff (Simon, 1955).

Bounded rationality proposes that pay offs are not ordered by decision makers in absolute terms, instead they are ordered as a scaled vector for pay offs, which allows for variances in preferences between different decision-making scenarios and decision makers. Each alternative in a decision is mapped to the consequence on a dimensional vector (Simon, 1955). In expected utility theory (von Neumann & Morgenstern, 1953) it is evident with the proposed computational processes and the completeness axiom that there should always be a superior option that the decision maker should be able to identify and select. However, the suggestion made (Simon, 1955) for the search for a satisfactory outcome option raises the question, what if the best option available is not deemed satisfactory? This concern is addressed, as the satisfactory option is suggested by Simon (1955) to not to be established in absolute terms, but instead in relative terms based on the aspirational level. The aspirational level is shaped by the availability of the options in the choice set. The aspirational level is also established by considering what can be hoped to be achieved, based on the availability of the options in the choice set. With this process a decision maker will always be able to establish a satisfactory outcome from any given set of alternatives, as the aspirational level held by a decision maker will alter as a function of availability in the choice set. For example, if the choice set

is poor, the aspirational level will reduce, meaning one of the options in the choice set will still surpass the aspirational level. As established, bounded rationality (Simon, 1955) steps away from normative models (given the decision makers cognitive limitations) with its rejection of absolute utility maximisation (von Neumann & Morgenstern, 1953) and proposal for satisficing behaviour.

1.4.2. Prospect Theory

Kahneman and Tversky's (1979) prospect theory provides a formalised account of decision processes based on actual decision-making behaviour, incorporating probability levels (risk) and the domain of decision-making. With prospect theory Kahneman and Tversky (1979) sought to provide an account of decision-making that successfully captures variations in decision-making under risk, taking into consideration variations in actual human decision-making behaviour. Despite their acceptance of decision maker's fallibility, the underlying processes within prospect theory (Kahneman & Tversky, 1979) are still reliant on computational mechanisms, just as theorists previously have proposed, however, instead it is viewed as relative to a current state of wealth or welfare (e.g., Bernoulli, 1954) and certainty or uncertainty. The construction of value in this manner is reflected by the process or assessment of value, specifically, the assessment of an outcome's worth is shaped by the domain of decision-making – gains or losses (Kahneman & Tversky, 1979) and the likelihood of an outcome occurring, be it likely or unlikely (Tversky & Kahneman, 1992).

In the initial iteration of prospect theory, the decision-making processes is divided into two stages - framing and evaluation (Kahneman & Tversky, 1979). In the initial framing stage, the decision maker forms a representation of the various outcomes, based on information relevant to the decision such as the value of the

outcome and the likelihood of the outcome occurring (Kahneman & Tversky, 1979). In the following evaluation stage, decision makers choose their preferred outcome based on a comparison of the representations of the outcomes. In the framing, stage decision makers establish the utility of an uncertain prospect, based on the sum of its utility multiplied by a decision weight, constructed with a monotonic transformation of the probability (Tversky & Kahneman, 1986). The monotonic transformation allows the ordering of the probabilities to remain intact; however, the individual scaling of values changes after the transformation. This weighting function has several key properties: first impossible events are discarded, and the scale is normalised (i.e. a probability of 100% a certain event has the greatest possible weighting). Secondly, low probabilities are over weighted, whereas medium to high probabilities are underweighted; finally, the probability weights of smaller probabilities more accurately reflect their actual probabilistic position. In addition, the certainty effect is also used to account for behaviour where sure outcomes are overweighed relative to merely probable outcomes (Tversky & Kahneman, 1986). For example, Tversky and Kahneman (1986) found that the majority of participants preferred a sure gain of $30 to an 80% chance of winning $45 coupled with a 20% chance of winning nothing. This effect is mirrored by the possibility effect, which describes behaviour where decision makers overweight unlikely but large outcomes, and in turn underweight small but sure outcomes (Tversky & Kahneman, 1986). For example, a 20% chance to win $45 and an 80% chance to win nothing is preferred over a 25% chance to win $30 and a 75% chance to win nothing (Tversky & Kahneman, 1986). The hypothetical value function (see Figure 1) depicts asymmetrical risk preferences above (gain) and below (loss) the reference point, with a steeper value function for losses than gain (Kahneman & Tversky, 1979). This occurs as the aggravation felt at

losing a sum of money is suggested to be greater than the pleasure experienced from gaining an equivalent sum of money. In other words, decision makers are loss averse; experiencing a greater aversion to outcomes, which result in a loss than they are attracted to outcomes of decisions which produce a gain. To this end, Kahneman and Tversky (1979) proposed that for decision makers “losses loom larger than gains” (p.279).

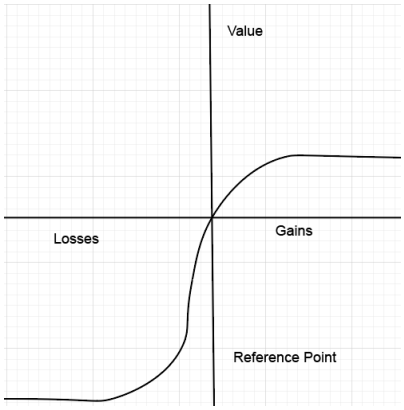


Figure 1. Hypothetical Value Function (Kahneman & Tversky, 1979)

The certainty and possibility effects produce a fourfold pattern of risk preferences across domains of decision-making (gains & losses) and the likelihood of the outcome. With low probability gains decision makers display risk seeking behaviour, whereas with low probability losses decision makers display risk averse behaviour. In contrast with high probability gains, decision makers display risk averse behaviour, whereas for high probability losses they display risk seeking behaviour. When presented with an outcome offering a potential gain, decision makers choose a certain outcome over a larger but merely probable outcome due to the certainty effect. However, with the choice between an unlikely option with a greater value than the certain option decision makers prefer the unlikely option, due

to the possibility of gaining a large amount of money (the possibility effect). When decision makers are faced with losses, this pattern is reversed with decision makers preferring a probable outcome over a certain outcome (certainty effect), to avoid a certain loss. Finally, with the choice between an unlikely option with a larger value (but the same expected value) and a certain option, decision makers prefer the certain option to avoid a certain loss (possibility effect).

Cumulative prospect theory (Tversky & Kahneman, 1992) makes much the same predictions for the outcomes of behaviour. However, different processes are suggested to underlie decision-making, specifically regarding the construction or estimation of value and the nature of the probability weighting function. In cumulative prospect theory the outcomes of decisions are initially framed in terms of the domain of the decision-making, allowing for separate decision weights to be used for gains and losses, with a two-part cumulative value function accounting for the increased aversion to losses in contrast to the attraction to equivalent gains.

Furthermore, the processes behind value weighting is argued not to be the product of an individual transformation of the probability (Kahneman & Tversky, 1979) but rather cumulative probabilities are transformed (Tversky & Kahneman, 1992). In other words, the combined change from a references point is transformed, as opposed to simply the likelihood of the outcome occurring. It is not the likelihood of the outcome that is transformed, rather, it is the final state that is transformed (i.e. the occurrence of the change). This assessment can be characterised with two statements for gains “the outcome is at least as good as” and “the outcome is strictly better than”, and for losses “the outcome is at least as bad as” and “the outcome is strictly worse than” (Tversky & Kahneman, 1992, p. 301). This modification provides better explanations of the overweighting of low probabilities (Tversky & Kahneman,

1992). Specifically, as it allows for the overweighting of extreme events - those that are likely to bring about the greatest change from a reference point, and not unlikely but less extreme events - those that do not result in a substantial change from the reference point.

Camerer (1998) has presented a review of research revealing the effectiveness of prospect theory in predicting real world decision-making behaviour. For example, Thaler and Ziemba (1988) identified that gamblers overweighed the likelihood of a longshot horse winning a race, just as prospect theory predicts risk seeking for low probability gains. Moreover, Kahneman and Tversky's (1979) proposal that decision makers are loss averse has been well documented across a range of contexts. For example, loss aversion is utilised to explain the endowment effect (Kahneman, Knetsch & Thaler, 1991) - a phenomenon where decision makers set a higher price with which they would be happy to sell an item compared to the price which they would be happy to pay for the item. Specifically, the endowment effect has been suggested to occur as the loss of the item by selling it is seen as more aggravating than the positive experience of receiving the item.

In recent years researchers have proposed third generation prospect theory. The earlier iterations of prospect theory relied on reference points and decision weights (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) (these are retained in the revised model); however, the use of uncertain reference points is introduced (Schmidt, Starmer & Sugden, 2008). The authors (Schmidt et al., 2008) suggest that one limitation of prospect theory is that the reference points for losses or gains is assumed to be certain. Specifically, as in many situations the reference point is uncertain (Schmidt et al., 2008). With the introduction of an uncertain reference point, third generation prospect theory is suggested to account for the

reversal in preferences between those elicited by choices and judgement/ratings tasks (e.g., Lichtenstein & Slovic, 1971).

Specifically, the reference point is proposed by the authors (Schmidt et al., 2008) to be the status quo, however, this is not a constant. Schmidt and colleagues (2008) adopt Munro and Sugden's (2003) relative value function, where the value of an outcome is established relative to the value of a consequence in the same state. This approach is based on state contingent reference dependence, implying that gain - loss comparisons are made separately. Specifically, the gain - loss preferences associated with any outcome depends on the proximity of the outcome and the reference point. Due to this, the weighting of each outcome is not considered in isolation, instead the outcome is considered relative to current circumstances.

Regret theory (Loomes & Sugden, 1982, 1987) provides an alternative explanation of decision-making focusing on how a decision makers' potential to imagine or anticipate outcomes can shape their decision-making. Regret theory suggests that introspection regarding the outcomes of the decision comes into play and influences decision maker's judgements (Loomes & Sugden, 1982, 1987). Regret theory suggests that decision makers do not only focus on the utility of the outcomes, but also on how respondents evaluate how an outcome compares to the alternatives in the choice set (Loomes & Sugden, 1982, 1987). Specifically, they reflect on what their experience could have been, had they selected an alternative option. Therefore, satisfaction is not only contingent on the utility of the chosen option, but also on an assessment of the outcome based on what could have been – the potential utility of the non-chosen option. Based on these processes, regret theory (Loomes & Sugden, 1982, 1987) assumes that when making a decision, decision makers initially rely on a choice less utility function, assigning a value to

each of the potential outcomes in the decision. The choice less utility is not constructed in response to ownership, but rather it is constructed based on a decision maker's perception of an outcome's potential to be beneficial, irrespective of ownership; just as initial proponents of utility characterised it as an outcome or an options intrinsic potential to increase or decrease happiness (e.g., Bentham, 1780/2000). The choice less utility can be modelled with a modified utility function which allows decision makers to display a preference between the available options, or in fact, an ambivalence between the options depending on whether the outcome produces regret or rejoice. A decision maker will experience regret if the outcome experienced did not match their anticipations. For example, purchasing a food item based on a favourable image on the packaging, only to find out upon opening the package that the product does not live up to its image - under these circumstances a decision maker will experience regret. However, if the image on the packaging accurately depicts the food item, the anticipated experience will match with their experience. The outcome is suggested to be evaluated by the decision maker with two simple questions - What is? and What could have been? Whereas a decision maker will experience rejoice if the chosen option is an improvement over their initial expectation, with decision makers still suggested to make choices which maximise their expectation of the modified utility function. Unlike prior theories reliant on the utility of the outcomes (von Neumann & Morgenstern, 1953), within regret theory the value of an outcome is viewed simply as positive or negative with the valence of an outcome derived from the relationship between their anticipated and experienced outcomes. In other words, decision-making is educated by regret and rejoice and is not contingent on the utility of the options considered in isolation, but rather it is

made through a process of comparing the potential outcomes (Loomes & Sugden, 1982, 1987).

The theories of decision-making discussed have focused on explaining decision-making processes by relying on computational mechanisms and cognitive processes and anticipatory experiences. However, Lowenstein, Weber, Hsee and Welch (2001) provide an alternative model of decision-making, which takes into consideration the emotional responses to outcomes with the risk-as-feelings hypothesis. The risk as feelings hypothesis highlights the disparity between the emotional responses to risky decisions and the cognitive experience of the risky decisions. Specifically, with the risk as feelings hypothesis decision makers are suggested to make decisions on two levels, cognitively and emotionally.

The cognitive response to risk is suggested to be shaped by the same factors as those proposed in earlier theories of decision-making (e.g., prospect theory, Kahneman & Tversky, 1979) such as the probability of the outcome and the domain of decision-making. The incorporation of emotions into the model occurs as separate process, influencing decision-making. The two factors are separated in the model, whilst emotional responses are sensitive to cognitive preferences and the nature of the outcome, the emotional reaction to the outcome is markedly different to the cognitive evaluation of the outcome (Lowenstein et al., 2001).

In the risk-as-feelings hypothesis the evaluation of a decision is shaped by three factors, which dictate how a decision maker will evaluate anticipated outcomes - subjective probabilities and additional factors, such as the background mood of the decision maker, and the context of the decision-making. The anticipated outcomes inform both the cognitive evaluation of the outcome and the feelings towards the

outcome. The subjective probabilities also inform both the cognitive evaluation of the target and the feelings towards the target. In addition, other factors such as the vividness and the immediacy of the decision, as well as the background mood of the decision maker, all inform a decision maker's feelings towards the target.

The cognitive evaluation of the decision and feelings towards the target then feed into behaviours and the decision made. The authors (Lowenstein et al., 2001) suggest that the emotional reaction to decisions is driven by two elements shared by cognitive models of decision-making - the anticipated outcome and subjective probability of the outcome. However, the emotional response also consists of additional factors such as the time between making the decision and the realisation of the outcome; the vividness of the outcome or its potential to evoke, or be associated with past similar experiences, and finally the evolutionary preparedness of the decision maker, their ability to deal with emotions which the situation may evoke. The risk, as feelings hypothesis posits, that the feelings component driving emotions explains the behavioural departure of decision maker's actions from what they consider to be their best course of action (Lowenstein et al., 2001).

As discussed, both the cognitive and affective evaluation of outcomes is informed by the likelihood of the outcome and its anticipated nature. However, the cognitive evaluation of the target is proposed to be objectively informed by the likelihood of the outcome occurring; whereas, the feelings assessment of a target is less accurate. For example, Sunstein (2002) has argued that decision makers are not finely tuned to probabilistic information, instead focussing solely on the outcome itself and its implications. The addition of factors, such as vividness, is argued to play a key role shaping decision makers feelings towards an outcome. Lowenstein et al. (2001) exemplify the role of vividness in shaping decision-making preferences

drawing on previous work by Nisbett and Ross (1980, as cited in Lowenstein et al., 2001), emphasising that the strength of anticipatory emotions towards an event is influenced by the vividness of the description of the events. The vivider the description of an outcome, the stronger the emotional response to the outcome is expected to be.

1.5. Psychological Factors Influencing Human Decision-Making

1.5.1. Sampling and Memory in Decision-Making

Building on proposals from bounded rationality, theorists (Gigerenzer & Selten, 2002) have suggested that decision makers utilise an adaptive heuristic tool box containing a series of specialised adaptive strategies for specific decisions/scenarios (Gigerenzer & Selten, 2002). Just as within bounded rationality Simon (1955, 1976) proposes that decision makers' aim to satisfy rather than necessarily optimise, with heuristic strategies used to achieve or reach approximate goals, as a result, the focus of the tool box of heuristic strategies is founded on domain specificity. Specific heuristics are matched to a given decision environment, scenario or type of task; just as the overarching proposals made in bounded rationality, an emphasis is placed on reaching an optimal outcome rather than achieving a perfect outcome given the decision or task in hand. To this end the account provides an adapted version of bounded rationality founded on three proposals (Gigerenzer, Todd & ABC Research Group, 1999) - psychological plausibility – understanding, appreciating and also incorporating how decisions are made rather than offering an idealised view of decision-making. Domain specificity – decision-making mechanisms are suggested not to be a one size fits all processes, instead the heuristics used are task specific. Finally, ecological rationality – the success of the strategies is not viewed in relation to the ability to optimise in absolute

terms (i.e. maximise utility) but rather, the success of a decision maker is viewed in relation to their ability to adapt to their current environment.

Many of the heuristic strategies used for decision-making, rely on the sampling of information from experiences to inform current assessments. For example, the recognition heuristic states that decision makers, when faced with a series of options, infer that the option they recognise is of a greater value, and will then choose this option (Goldstein & Gigerenzer, 2002). The recognition heuristic is followed by the fluency heuristic, which states that if several objects are recognised, then value is inferred based on the speed of recall, with objects recalled first inferred as having a higher value than those which are recalled later (Hertwig, Herzog, Schooler & Reimer, 2008). Whilst the speed of recalling objects may appear on the face of it as an inaccurate strategy for establishing a value, Hertwig et al. (2008) found that speed of recall can act as an accurate predictor of the real-world distribution of objects, and as a result the likelihood of an outcome occurring. Finally, the tallying heuristic (Dawes, 1979 cited in Goldstein & Gigerenzer, 2002) suggests that decision makers do not estimate value by establishing decision weights based on all the attributes of an option under consideration, instead decision makers are suggested to simply tally the attributes, which are favourable for an option. In other words, decision makers are suggested not to perform a computational assessment to establish value, but rather they establish an ordinal position based on the number of favourable attributes.

In light of proposals made previously Hertwig, Barron, Weber and Erev (2004) suggest that within decision-making there is a disparity in the decisions made, depending on whether the decision is made following the descriptions of task specific information or experiences. Specifically, with decisions made using the description of

the information available in the task, decision makers were found to adhere to predictions made in prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). For example, with decisions made from experience, decision makers underweighted low probabilities in their choices. Hertwig et al. (2004) suggest that in real life decision-making, decisions are frequently made based on experience, in lieu of descriptive information. Moreover, under these circumstances decision makers used approximations to inform their decision-making, and these approximations result in the disparity in decisions made from experience and decisions made from description. Specifically, decisions from experience are suggested to be influenced by two factors, a limited information search and the recency effect (Hertwig et al., 2004). Decision makers when sampling information to educate a choice from experience, do not conduct an exhaustive search, but instead conduct a limited search of the information, relying on a small sample of information to educate their judgements. Due to the limited nature of the search, decision makers do not sample all the possible information available to them, so rare or unlikely events are more likely to be missed out or omitted, and in turn are underweighted. Specifically, the authors found that when a rare positive event was sampled less frequently than expected, it was selected only 23% of the time; however, when it was sampled as much or more than expected - it was chosen 58% of the time. This indicates that in the domain of gains the under sampling of rare events leads to risk aversion, whereas sampling as much as or more than expected leads to risk seeking. However, this pattern is reversed for negative events - when a rare event was experienced less than expected, it was selected 92% of the time. In contrast, when it was sampled as much or more than expected it was chosen 50% of the time. However, when a rare negative event was under experienced decision

makers display risk seeking preferences, but when it was sampled as expected or more than expected, decision makers displayed risk aversion for negative events. Underpinning this explanation is that there is not a parity in the proportion of people who over or under sample rare events; the majority of participants under sampled rare events (in total 78% of participants sampled the rare events less than expected). Additionally, it is also argued that rare events have less of an impact on decision makers, as not only are the decision makers less likely to sample the events, they are also less likely to have experienced them recently, in a time frame close to the decision task, lessening their impact on decision-making behaviour. The authors (Hertwig et al., 2004) provide evidence to support this explanation, revealing that pay-offs featured in the second half of the sample more accurately predicted decision makers actual choices, when compared to the pay offs first presented to the participants.

An alternative account of sampling and comparative processes in decision-making is proposed by Stewart et al. (2006) decision by sampling, which argues that decision-making processes are comparative and dynamic in nature, with the attractiveness of the target being influenced not only by the other options available in the choice set, but also by comparable past events and experienced outcomes. The use of prior experiences to educate decision-making, regardless of their comparative or computational processes, focuses heavily on the ability of decision makers to compare the values in a decision.

Specifically, it is suggested that the subjective value of an outcome is constructed with binary ordinal comparisons of outcomes against a sample of similar outcomes drawn from the decision maker's memory, the current outcomes position in the sample is then used to infer its value. This sample is used to educate

comparisons, reflecting not only the immediate distribution of attributes derived from the current environment, but also from prior experiences (Stewart et al., 2006). Specifically, the attractiveness of an attribute is established with binary ordinal comparisons, assessing whether the outcome being considered is better or worse than the values drawn from memory. The count of positive favourable comparisons for outcomes is recorded and forms the rank position of the target within the sample of all possible outcomes (Stewart et al., 2006). A caveat of Stewart and colleagues (2006) proposal is that, as decisions are made using comparisons of the current outcome against previously experienced outcomes, the subjective value (i.e. the rank position) of an item is contingent on the distribution of similar experienced real-world values. This to a certain extent is akin to the suggestion made for the fluency heuristic with its proposals that speed of recall is used to infer distribution and value (Hertwig et al., 2008).

Support for decision by sampling comes from evidence examining the size and frequency of credits made to people's current accounts (Stewart et al., 2006 & Stewart, 2009). By establishing that the distribution of credits to current accounts followed a power law function, with a negative correlation between the frequency and size of credits, the number of credits decreased as the value of the credits increased. In other words, many small credits and fewer large credits. As an item's value was established based on its relative rank position to the sample, the same degree of monetary increase at either end of the spectrum (small or large value) will not lead to an equivalent increase in rank position. For example, whilst a large value will still be ranked greater than a smaller numerical value; however, as there are less high value reference points (due to the decrease in frequency as value increases), the extent to which the rank will increase is non-linear. The magnitude increase in rank position

decreases as value increases. The same pattern is followed when examining debits from current accounts - the frequency of debits decreases as the magnitude increases (Stewart et al., 2006). However, importantly, relatively more small losses were found in comparison to gains; as a result, the relative rank for the same sum of money is greater when framed as a loss than when framed as a gain, hence the rank position of losses is greater, leading to loss aversion.

In support of the decision by sampling account of loss aversion, Walasek and Stewart (2015) present experimental evidence revealing that manipulating the range of possible gains and losses experienced by a decision maker, could be used to shape their risk preferences. Specifically, manipulating the range of possible gains and losses experienced by the participants either reduced or produced loss aversion in participants (Walasek & Stewart, 2015). When the range of losses was less than the range of potential gains participants were loss averse. In contrast, when less gains were experienced than losses, loss aversion was reversed, and decision makers displayed a heightened sensitivity to gains as opposed to losses. However, when the range of possible gains and losses was equal, there was minimal evidence of loss averse preferences – respondents displayed loss neutrality. Importantly, the experimental findings support the assumption made in decision by sampling, that decision makers do not poses underlying preferences, as the biases were easily manipulated based on the range available for comparison. This reinforces the argument that decisions are comparative not computational in nature, as preferences changed not due to a change in attribute value, but rather due to changing the reference points used for comparisons.

Previous theories of decision-making discussed have touched on the role of past experiences, and in turn memory, in shaping decision-making preferences such

as heuristic (Hertwig et al., 2008) and comparative accounts of decision-making (Stewart et al., 2006). Strikingly however, early utilitarian approaches, which whilst emphasising consistency between past, present and future decisions do not place importance on memory in decision-making; specifically, as consistency in decision-making is accounted for through the use of computational mechanisms working consistently and effectively towards the same end - the maximisation of utility (von Neumann & Morgenstern, 1953).

The potential for memory, or more specifically recall to shape decision-making is exemplified by the effects of implicit memory and priming. Implicit memory is the process where people unintentionally, and at times unconsciously attend to and recall events (Schatcher, 1987). Priming describes a process where the exposure to information through implicit memory shapes decision-making and judgements. For example, Mandel and Johnson (2002) found that priming a decision maker to focus on one attribute of the available options shaped their judgements. Specifically, the primed attribute was weighted more heavily by decision makers in educating their judgements. For example, the authors (Mandel & Johnson, 2002) discovered that participants frequently preferred a cheaper car when primed with price, compared to when they were primed with quality.

The Preferences as Memory (PAM) framework, proposed by Weber and Johnson (2006) offers an account of the role of memory in decision-making, reiterating the proposal, that preferences are neither stable nor fixed; rather, preferences are suggested to be constructed afresh for each new decision, as a product of the ability of the task to conjure connections and connotations to memories, and the direction which these memories take shapes decision-making. As a result, preferences may differ due to short term memory effects, notably priming

directing decision makers to recall and attend to certain aspects of events or outcomes of decisions. Furthermore, within the PAM model of decision-making, the evaluation of judgements or decisions is suggested to occur, as decision makers recall past experiences from memory; these then inform decision-making in the present. Weber and Johnson (2006) propose that rather than recalling prior preferences to establish a preference, decision makers attempt to retrieve previous reactions to situations and use these reactions to inform their decision-making. However, it is proposed that the ability to recall events is not an accurate uniform process, instead it is subject to various constraints placed on memory and recall processes. Weber and Johnson (2006) with the PAM frame work examine three core aspects of the role of memory in decision-making, recall process to inform decision-making, memory interrogation, the accessibility of memories relevant to the decision-making and finally the structural representation of memories i.e. how accurately do the memories reflect current decision-making. The interrogation of memories is argued not to occur in a fixed manner, but rather the queries posed by decision makers is suggested to be framed by the task. For example, this proposal is supported by the research of Birnbaum and Stegner (1979) who suggest that buyers and sellers of houses pose evaluatory queries in different orders, the latter pose negative, then positive queries and the former do so in reverse. Hence, the framing of the question leads to different sources of information being used to inform decision-making, leading to different outcomes. Specifically, memories that are more accessible, be it through priming processes or other cognitive mechanisms, are suggested by the authors (Weber & Johnson, 2006) to be of more influence in educating a decision due to their availability. Finally, the authors suggest that the structure of these memory representations, and in turn how they reflect or are in line

with the decision-making task is essential to the decision-making process. For example, a decision maker is suggested to easily be able to establish the price of a product, as price is considered a function of the product, i.e. when shopping people consider what they want to buy, then look at its price. In contrasts, a decision maker will be less able to establish a product based on its price, as it is less likely for a person to consider what they are going to buy as a function of its cost (Weber & Johnson, 2006). In other words, establishing a product based on price does not reflect real world decision-making. The PAM model offers an account of decision-making that attempts to integrate the role of implicit memory, relying on priming to inform information search and the role of long-term memories of events to shape the decision; in other words, implicit memories direct a decision maker to events in their long-term memory, these events then inform and shape decision-making.

Decision by sampling (Stewart et al., 2006) places a great emphasis on the potential for events to shape decision-making preferences, with previously experienced events informing decision-making processes. Specifically, based not on qualitative reasoning and the structure of the task and memory, but rather via binary ordinal comparisons to establish whether the present is better or worse than previous experiences, which informs decision-making (Stewart et al., 2006).

Del Missier et al. (2013) have documented the role of working, episodic and semantic memory in decision-making; highlighting that memory is implicated across several areas of decision-making. However, the extent of its impact is contingent on the type of memory required for a given task. Specifically, a decision maker's ability in cognitively demanding tasks, such as applying decision rules, was found to be positively associated with working memory ability; whereas, in experience-based tasks episodic memory predicted the decision maker's performance. Finally,

decision-making tasks contingent on knowledge, such as the consistency of a decision maker's risk perceptions was found to be positively associated with semantic memory. The authors (Del Missier et al., 2013) suggest that the findings emphasise the role of memory in judgement and decision-making in several ways. Working memory is suggested to be essential for processing and manipulating task specific information, whereas semantic memory supplies task specific knowledge aiding task comprehension. Episodic memory is proposed by Del Missier et al. (2013) to contextualise decision-making. Specifically, the experiences recalled act as a starting point in tasks requiring judgements or estimations.

Despite evidence towards the role of memory in all its guises shaping decision-making preferences, one phenomenon - choice blindness (Johansson, Hall, Sikström & Olsson, 2005) has called into question the extent to which decision makers may use or rely on past experiences and in turn memory to inform actions. Choice blindness details a phenomenon where decision makers, following an initial choice between two options fail to notice when presented with their chosen option and asked to evaluate their choice that their chosen option has been switched for their unchosen option (Johansson et al., 2005; Hall, Johansson, Tärning, Sikström & Deutgen, 2010). Moreover, decision makers in most cases provided justification of their choice, drawing on the features not of their initially preferred option, but instead based on features of the option they were presented with when asked to evaluate their choice. The role of memory is contested in choice blindness; researchers utilising different experimental procedures have argued that the experimental manipulation both does (Johansson, Hall & Sikström, 2008) and does not (Sagana, Sauerland & Merckelbach, 2014) alter participant's long-term memory of events. For example, Johansson et al. (2008) found that there was a difference in the proportion

of participants who managed to accurately select their chosen option in a secondary memory test, following the completion of the initial task; whereas, Sagana et al. (2014) found with a secondary memory test that only 3% of participants selected the switched option, moreover there was no significant difference in respondent's accuracy between manipulated and non-manipulated trials. However, one important distinction between the two studies is that Sagana et al. (2014) informed participants of the switch prior to asking them to reselect their chosen option; whereas, Johansson et al. (2008) did not. The phenomenon of choice blindness highlights the fallibility of decision-making preferences, specifically theorists have suggested that the findings reiterate previous proposals in decision-making research that decision makers do not possess stable underlying preferences, but rather are informed by the decision-making environment (Gigerenzer & Seleten, 2002).

1.5.2. Context, and Multi Attribute Decision-Making

The context dependent model of choice (Tversky & Simonson, 1993), provides an explanation of decision-making processes, not wholly reliant on computational mechanisms. Specifically, it incorporates the context free evaluation of the options being considered, the background (e.g., past experiences) and current contexts (e.g., the choice set being considered at that specific point in time). Variances in decision-making are explained with two components in decision-making, a contingent weighting model, taking into account the background context (for example, prior experiences) and a binary comparison model which incorporates local comparisons (i.e. the current task). The background context (similar previously experienced events and their outcomes) and the immediate context (the current decision and its choice set), with both contributing to the attractiveness of an outcome. Specifically, the background context, be it favourable or unfavourable

towards an attribute, allows a decision maker to update their preferences, altering the decision weights of the prospects. Therefore, the evaluation of an outcome is not based purely on the intrinsic value of the outcome when considered in isolation, but also on the background context (e.g., actual experiences), which informs decision weighting. For example, the willingness to pay for an item not only depends on the current pricing of the options under consideration, but it is also contingent on prior experiences and the pricing of similar products. Essential to this suggestion is that it does not require or place the same importance on computational mechanisms, instead of computational mechanisms, the decision weighting informs the ranking of options derived from experiences of similar outcomes. In the final stage of decision-making, when evaluating the current context, the decision maker is suggested to compare the options being considered, and the ranking of these attributes against each other (Tversky & Simonson, 1993).

Multi attribute decision-making refers to the process, by which decision makers distinguish then choose between options represented by two or more attributes (e.g., quality and taste). For example, how does a decision maker reconcile the differences in price and quality between a series of options under their consideration? Research examining multi-attribute choice has examined how preferences change and are altered by the addition of a third option to an initial choice set under consideration. Normative accounts of these processes argue that decision makers should make choices consistently, educated by the value of both attributes. For example, Luce's axiom (1977) proposes that a choice between several options should be made by establishing the combined utility of the attributes of each option, then selecting the option with the greatest utility. Furthermore, the independence axiom (von Neumann & Morgenstern, 1953) can be applied to multi

attribute decision-making; specifically, as the addition of an irrelevant alternative, which is not superior in a utilitarian sense and should not influence decision-making. Thirdly, McFadden (1973) proposes the assumption of proportionality, which assumes that the market share of an additional option to the choice set should reflect the total decline in market share of the two initial items in the choice set. Finally, the assumption of regularity (Tversky, 1972) assumes that the addition of an additional option to a choice set should not increase the market share of the initial items in the choice set.

Two effects, which violate these assumptions, are the compromise (Simonson, 1989) and attraction effects (Huber, Puto & Payne, 1982). The compromise effect describes a phenomenon, where the addition of a third (compromise) option to the choice set, which falls on both attributes between the two initial options under consideration is selected with a disproportionately high frequency, compared to the two initial options under consideration (Simonson, 1989). Whereas the attraction effect describes a phenomenon where the addition of a decoy option to a choice prompts the selection of the target option. Specifically, the decoy option is asymmetrically dominated by the target option, producing a change in selection preferences with decision makers preferring the target (Huber et al., 1982; Huber & Puto, 1983).

Several theories have explored mechanisms shaping multi attribute choice and have offered an insight into both the attraction and compromise effects. When examining the compromise effect Simonson (1989) suggests that in the case of choices, which present uncertainty (for example, equating value between the two different attributes) decision makers tend to select the option they believe is supported best by their reasons, also preferring the option which is most easily

justified to others. Additionally, the compromise option with its position in the centre on both attributes is proposed to reduce the conflict associated with comparing across attributes. Furthermore, when justifying the decision to others, the compromise option is suggested to be seen as a safe choice minimising potential error, again due to its position at the centre of both attributes (Simonson, 1989). This account is supported by evidence from think aloud protocols, indicating that decision makers who selected the compromise option commonly cited feeling that they were less likely to be criticised for choosing the compromise option. Furthermore, participants revealed feeling that choosing the compromise option demonstrated consideration of all alternatives (Simonson, 1989). In addition, the compromise effect was stronger for participants who knew that they would have to justify their preferences (Simonson, 1989). When examining the attraction effect Simonson (1989) also found that the attraction effect was stronger for decision makers who were expecting to justify their decision to another. It was proposed that this occurs (Simonson, 1989) as the asymmetrical dominance relationship between the target and decoy options provides the decision maker with a reason to select the target over the competitor. Specifically, this is emphasised when the decision maker is not cognisant to the preferences of the person they anticipate justifying their decision too. These findings fit with proposals that even with decision makers who are not anticipating having to justify their preferences, the dominance relationship between the target option helps to break the tie between the target and competitor, encouraging the selection of the target option.

The value shift and value-added processes account for multi attribute choice, by breaking down the explanation of the compromise and attraction effects into two processes. The value shift explanation of the decoy affect suggests that a change in

preferences occurs as the inclusion of the decoy option into the choice set results in a shift in the subjective weights of the stimuli on the dimension the judgement is being made on (Wedell, 1991; Wedell & Pettibone, 1996). The subjective value of a stimuli being considered is shaped both by its position in relation to the minimum and maximum values being considered – the range, as well as the frequency of the stimuli with which the item under consideration is better than it. The inclusion of the decoy option is suggested to increase the subjective value of the target on the attribute it is not dominant on; the decoy takes the position near the minimum value. However, with the competitor the decoy does little to change its subjective value, as it is already near the maximum on the value for the attribute, which it is dominant on. Additionally, on the dimension that the target is dominant on the decoy increases the number of attributes which the target is superior to further increasing the subjective value of the decoy option. However, the competitor's subjective value will be reduced as it is inferior to two items on the dominant dimension of the target. The value-added model presents an account of multi attribute decision-making, not founded in decision weights and added value, but instead focusing on the relative context in which the choice is made, producing the context effects (Wedell & Pettibone, 1996). Specifically, the closeness of the decoy option to the target is argued to add value to the target; this added value can be seen in the justifications given by participants. With Simonson's (1989) proposal that the dominance of the target over the decoy also adds to its perceived worth, helping break the tie between the decoy and the target options. Pettibone and Wedell (2000) argue that both the value shift and value-added processes may, in fact, work simultaneously complementing each other. This perspective is supported by Pechtl (2009); however, the value shift is suggested not to inflate the value of the target, but rather the value shift is suggested

to reduce the target's attractiveness. However, both the attraction and compromise effects are still suggested to occur, as the value-added process is stronger than the negative impact of the value shift (Pechtl, 2009).

An alternative suggestion of multi attribute decision by sampling comes from multi alternative decision field theory, which suggests that decision makers' preferences develop over time, through deliberation, combining options across their attributes over time (Roe, Busemeyer & Townsend, 2001). Whilst comparing between the attributes, the evaluation of each option is compared with the other options under consideration, in turn preferences for each of the options fluctuates up or down depending on whether the option being considered has either an advantage or disadvantage on the attribute being considered. Attention is then directed to attributes considered less important; the same comparisons then occur and are added to previous preferences. Moreover, attention is then directed back to the initial attributes under consideration, and preferences are updated based on the results of these comparisons. The decision process, switching between the attributes being considered continues until time constraints are reached or until the decision maker reaches a satisfactory threshold for their preferences. Multi alternative decision field theory is used by Roe et al. (2001) to explain the attraction effect with the following process; the dominated decoy is judged negatively compared to the two alternatives under consideration, this produces a negative preference for the decoy option. The negative preference for the decoy option results in a negative inhibitory association to the closely positioned target. The two negative effects combined are suggested (Roe et al., 2001) to have a bolstering effect, framing the target as the most favourable option. In contrast, the competitor does not benefit from this positive bolstering effect due to its distance from the decoy on the target attribute. In the case

of the compromise effect multi alternative decision field theory relies on the negative connection between the compromise and the competitors, and the negative correlation between both competitors and compromise. As a result, the difference between the competitor and the compromise is positively correlated with the difference between the compromise and the second competitor; this positive correlation gives the compromise option an advantage over the competitors being considered (Roe et al., 2001).

The leaky competing accumulator model of multi attribute choice suggests that information processing occurs through the gradual accumulation of noisy information sources (Usher & McClelland, 2001), as a result, the model acknowledges that the integration of information does not occur perfectly, instead information is damaged in the accumulation process. Specifically, as information is accumulated, it is proposed that some is lost due to factors such as leakage or the amplification of differences, which can occur due to having to repeatedly attend to the competition between the accumulators (Usher & McClelland, 2001). These processes occur on two levels. Initially inputs of information are indexed and accumulated. The accumulated units are characterised by two variables - initial activation, tied to the population being considered and the output that corresponds to the frequency within the population. Specifically, the activation of each accumulators determines the response. The time constraints of the task dictate selection; the option selected is the one activated when time allocated for the task has run out, whereas in the absence of time constraints, the unit which reaches a pre-set criterion passing a threshold is the chosen response. The Leaky competing accumulator differs in its explanation of how information is accumulated and condensed compared to multi alternative decision field theory (Roe et al., 2001). These different

processes result in different explanations of both the attraction and compromise effects; rather than establishing a position for an option based on how it matches up against the alternatives under consideration, advantages and disadvantages are calculated with a value function. The value function is suggested to be asymmetrical with losses being more heavily weighted than gains, with loss aversion being applied separately in both domains. With loss aversion in preferences, Usher and McClelland (2004) propose that both the extreme points will be penalised by decision makers. The aversion to the extreme options results in decision makers favouring the compromise option. Again, in relation to the attraction effect, whilst the decoy option does not garner any market share, importantly, it directs selection towards the target option increasing the market share of the target option.

Brown and Heathcote (2008) propose the linear ballistic accumulator model of multi attribute choice suggesting that information is accumulated independently for each of the options under consideration. Information, about each of the options increases independently over time, continuing until a threshold is reached. The process of information accumulation is non-stochastic, with the initial trajectory of accumulation determining a continued path of accumulation. This accumulation continues until one option under consideration reaches the threshold, this then determines the response; the first item to reach the threshold determines the response. To account for variance in responses two random factors are incorporated into the model 1) the starting point of accumulation and 2) the drift rate, the variation in speed of evidence accumulation for a response between trials. The drift rate accounts for variances in decision-making preferences, as it accounts for the speed at which a decision maker will reach a threshold of information for any given accumulator, determining the response.

In the context of the attraction and compromise effects Trueblood, Brown and Heathcote (2014) propose the linear ballistic accumulator model (Brown & Heathcote, 2008) to account for the initial sampling of information from the choice set. Building on the linear ballistic accumulator model is the multi attribute linear ballistic accumulator, which provides an account of how the final choice is reached in a decision. As with the initial model, selection is determined by the drift rates, determining what option a decision maker will be fixed on following time constraints. The drift rate is determined by four factors. The effect of extreme or intermediate values, accounted for the transformation of objective to subjective values through a curve, if the curve is convex then extreme values are favoured, whereas if the curve is concave then intermediate - less extreme values will be favoured. Secondly, attention weights define how much attention is placed on comparing options, with greater attention being placed on similar rather than dissimilar options due to the increased effort required to distinguish between the former, these attention weights then inform the psychological weight assigned to the target. As well as the initial starting point, the threshold defines the stopping point and the drift rate noise.

Within the multi attribute linear ballistic accumulator model the attraction effect is accounted for with the attention weights (Trueblood et al., 2014). Specifically, as the difference between the decoy and the target is smaller than the decoy and the competitor, then the attention paid to the decoy and target is greater than the attention placed on the alternative comparisons (decoy & competitor; competitor & target). As a result of the increased attention paid to the difference between the competitor and the target, the difference in subjective value for the two is weighted more heavily. In effect as the target and competitor present the hardest comparison to differentiate between, more attention is paid to the two. As more

attention is placed on the attributes the weighting placed on the subjective value of the target inflates its worth and the weighting placed on the subjective value of the decoy diminishes its worth. However, the competitor does not benefit from weighting, due to its distance from the decoy. In turn, the distance from the decoy also dictates the ease, which it presents for differentiation between itself and the target, and so as a result it is attended to for less time. In the case of the compromise effect, two elements of the model are drawn on to explain the effect; decision makers are proposed to favour intermediate (compromise) options over extreme options (Trueblood et al., 2014). Additionally, as the competitors are easily differentiated between, minimum attention weights are needed to discriminate between the two. However, as the compromise option is closer to both competitors on both attributes, greater attention is needed to discriminate between each of the competitors and the decoy; as a result, the compromise option receives a greater attention weighting than both competitors under consideration.

Finally, multi attribute decision by sampling suggests that the value of an option is first inferred, then confirmed based on its relative rank position within the sample. Specifically, the value of a choice option is established by the number of comparisons, that the option under consideration dominates (Ronayne & Brown, 2017). Moreover, the selection of an option is governed by binary comparisons within attributes used to establish which option from a pair in the comparison dominates the other. This decision-making process is founded on three assumptions. Firstly, decision makers do not conduct an exhaustive search and comparison of options, instead they conduct a limited search, and so make comparisons against a limited sample of information. Secondly, the sampling process does not occur in isolation, instead the sampling of information is shaped systematically by the choice in

question. For example, the distribution of the options in the choice set shapes how decision makers infer the presence of unobserved options in the market which then informs their comparisons. Finally, the likelihood of a participant choosing an option can be predicted by dominance relationships between items in the sample. The dominance relationships are established using binary ordinal comparisons between the pairs of items being considered. The proposal that these affects occur with multi attribute comparisons is supported by Naguchi and Stewart (2014) who established, based on eye tracking data, that decision makers when comparing the options available in the choice option do not combine and aggregate both attributes of an option under consideration, instead they compare between the options with single attribute comparisons. Applied to the attraction effect, multi attribute decision by sampling suggests that the addition of a decoy option close to the target increases the sampling of information on the dominant dimension of the target, which increases the likelihood that comparisons occur on the targets dominant attribute; as a result, comparisons are predisposed to favour the target. When considering the compromise effect, in relation to the binary comparisons, each attribute possesses a dominant relationship with each of the options under consideration. However, the addition of the compromise option to the choice set is suggested to result in a shift in the sampling distribution which favours the compromise due to its central position (Roynaye & Brown, 2017).

1.5.3. Content and Decision-Making

Kusev and van Schaik (2011) have proposed a theory of content dependent decision-making that emphasises the importance of the decision-making content and context on risky decision-making. The authors (Kusev & van Schaik, 2011) distinguish between the context of the experience and the content, the content of

decision-making is experiential, relying on cognitive storage systems that represent experienced events and their frequencies, although not necessarily accurately.

Research by Kusev, van Schaik, Ayton, Dent and Chater (2009) has shown that the decision-making content and context, specifically how a risk is framed, shapes decision makers' judgements, indicating that decision makers do not have stable underlying preferences. Specifically, risk is exaggerated based on the accessibility of similar events in memory, with decision makers overweighting the risks accessible in their memory. The assessment of risky events differed between the context in which the risk was presented in either a gamble or a precautionary insurance decision. In other words, "people's experiences of events leak into their decisions even when risk information is explicitly provided" (Kusev et al., 2009 p.1). Risks framed in an insurance scenario elicited a protective effect; decision makers exaggerated the risk in contrast to when the risks were presented only as a gamble. More generally accessible risk scenarios are suggested to produce a protective effect with decision makers exaggerating decision weights for highly accessible precautionary decisions, compared to less accessible events and risky decisions.

In addition, research by Kusev, Ayton, van Schaik, Tsaneva-Atanasova, Stewart and Chater (2011) provides evidence that emphasises the influence of the decision-making content, the availability of events in decision maker's minds to influence their judgements. Decision makers were found not to rely on the absolute frequency of the events which they experienced to inform their assessment (Kusev, Tsaneva-Atanasova, van Schaik & Chater, 2012). Instead, they relied on a first run effect, over emphasising the frequency of the initial category to be repeated in the sequence. Decision makers also exhibited a disconnection between their frequency judgements and their actual recall of categories, judging one category to have

occurred with a greater frequency yet recalling more examples of alternative categories. With these findings the authors (Kusev et al., 2012) propose that decision makers do not make judgements recalling absolute frequencies, rather decision makers use the first item to be repeated as a cue to equate frequency, minimising the cognitive effort required to make a decision. This account is supported by Kusev et al. (2012) reiterating that decision maker's judgements are not informed by recalling the individual frequency of events in memory, instead as suggested previously, properties of the sequence configuration are relied on to inform the cue frequency; specifically, the first item to be repeated in the sequence is assumed to have occurred with a greater frequency.

1.6. Cognitive Similarity and Comparisons

The contrast model of similarity posits that the similarity between objects is established initially by forming a list of features associated with various objects. Following this the features are then contrasted with common features increasing similarity, and uncommon features reducing the similarity (Tversky, 1977). The contrast model of similarity can be formalised as $S(a, b) = \theta f(A \cap B) - \alpha f(A-B) - \beta f(B-A)$. The similarity between the two objects S (a, b) is characterised as a function of the features, which are shared by the two objects ($A \cap B$); the features which are present in A that are not present in B (A-B), and finally the presence of features, which are in B but not in A. The f scale accounts for the contribution of the dissimilar and similar features. Finally, θαβ accounts for the weighting of the similar and dissimilar features, depending on the type of task. Specifically, asking a decision maker to assess similarity is suggested to lead to an increased weighting of θ. However, asking a decision maker to assess dissimilarity will lead the decision maker to focus on either α or β, or both depending on whether the question is how

dissimilar is A to B, or how dissimilar is B to A (Tversky & Gati, 1978). Tversky and Gati's (1988) research supports this claim, revealing that in the eyes of the decision maker similarities and differences between objects are not fixed attributes per se, instead, they are established based on the context of the question. As mentioned, tasks requiring an evaluation of one option against another produces an overweighting of asymmetrical similarities or differences, whereas a task which asks for similarities or differences will lead to an overweighting of features relevant to the question (e.g., Birnbaum & Stegner, 1979). In other words, the comparison of items is not static but rather it is a relative process derived from the task at hand shaping the direction, nature and outcome of the assessment. Johnson and Horne's (1988) findings exemplify the contrast model of similarity, revealing that adverts which emphasise a comparison of products, encourage decision makers to compare the similarities between the two products under consideration. As a result, they can be beneficial to helping them gain a market share from an established brand, whereas for an established product the comparative effect can produce a reduction in its market share.

Theorists examining consumer choice also offer some insights into the implications of non-comparable comparisons in decision-making. Johnson (1984) suggests two potential choice strategies used to compare non-comparable alternatives, which also forms the basis of comparable attribute comparisons; specifically, across attribute comparisons comparing between the respective attributes to form a complete judgement of the stimuli, or alternatively simpler within attribute comparisons are used to establish a representation of the option being considered. When evaluating non-comparable information, decision makers are proposed to adjust the abstractness of their comparisons (Johnson, 1984). For

example, Johnson (1984) found that with moderately non-comparable pairs decision makers made comparisons based on “mobility”, whereas for more non-comparable pairs decision makers made comparisons based on more abstract representations, such as “necessity”. Furthermore, as comparability decreased, consumers shifted to using within attribute comparisons. Johnson (1986) explains this shift proposing that as the manner of the comparison becomes more and more abstract, due to incomparability increasing between the attributes being considered, the effort required increases, and after a point, decision makers switch to using attribute comparisons, as they struggle to keep track of the abstract comparisons.

Further research has indicated that comparisons in choices can play an influential role in biasing decision makers’ judgements; for example, Brenner, Rottenstreich and Sood (1999) revealed that in consumer choice the ability to make comparisons can damage consumer decision-making (Brenner et al., 1999). Specifically, Brenner et al. (1999) suggest that comparisons in their very nature harm evaluations. Moreover, they provide experimental evidence, indicating that allowing and encouraging comparisons reduces the amount that consumers are willing to pay for goods. Brenner et al. (1999) found that when participants were asked to state their willingness to pay for an item presented individually, a higher price estimation was given, compared to when participants were presented with a set of similar options and asked to state their willingness to pay for each of the items. When the comparative nature of the task increased further, with decision makers being asked to rank the options, their price estimations reduced further. Moreover, the authors (Brenner et al., 1999) discovered that decision makers were more likely to accept or reject options when presented in a manner, which promoted comparisons, opposed to when the items were presented individually. Moreover, it was discovered that

negative items were even more likely to be rejected than positive items were likely to be accepted in the case of comparisons. The authors (Brenner et al., 1999) suggest that with comparisons decision makers emphasise the disadvantages and advantages of the options being considered; specifically, comparisons emphasise disadvantages more strongly, as a result whenever options which possess both advantages and disadvantages are compared, disadvantages are felt more strongly damaging the choice.

1.7. Psychological Compatibility

Stimulus response compatibility dictates the extent that a stimulus or task is compatible with the required response (Fitts & Seeger, 1953). For example, when driving a car forwards, the relationship between turning the steering wheel and the direction of travel has high stimulus response compatibility, as turning the steering wheel to the right will move the car to the right; whereas, when reversing a car it can be argued that there is stimulus response incompatibility, as turning the wheel to the right will not turn the car to the right, but will turn the car to the left. Fitts and Deneininger (1954) have suggested that the rate at which a person can perceive and respond to stimuli is contingent on a match between said stimuli and the action they are required to do.

The dimensional overlap explanation of stimulus response compatibility suggests that when there is a match between the stimulus and response two processes will be activated (Kornblum, Hasbroucq & Osman, 1990). Specifically, automatic activation is followed by response identification (if a stimulus is compatible with the response), then the activation is allowed, and the action is executed. However, if the stimulus is not compatible with the response, then the action will have to be inhibited first, delaying a person’s ability to respond. In other words, the

inhibitory effect of stimulus response incompatibility is suggested to occur as the anticipated outcome of the decision-making task or scenario is that the stimulus, and response will match; in other words, decision makers assume that there will be compatibility which produces the bias in decision makers' judgements.

Lichtenstein and Slovic (1973) have proposed the cue response compatibility hypothesis, which implies that compatibility between cue and response dictates the perceived importance of the cues. Essentially, the dimension used to judge or evaluate stimuli dictates the importance placed on the stimuli by the decision maker. The general compatibility hypothesis (Lichtenstein & Slovic, 1973) and the more refined versions scale compatibility (Tversky, Sattath & Slovic, 1988), and the structure compatibility hypothesises (Montgomery, Selart, Gärling & Lindberg, 1994) have been used to account for reversals in preferences occurring between those elicited from choices and those elicited from quantitative methods such as judgements and ratings.

Slovic, Griffin and Tversky (1990) conducted a comprehensive piece of research on the compatibility hypothesis finding that across a wide variety of research topics, from stock market evaluations to time preferences, finding that an increase in compatibility between the stimuli attributes and the response mode produced an overweighting of the compatible attribute. For example, Slovic and colleagues (1990) found that when participants were asked to predict a company's market value, judgements were strongly based on the previous year's value of the company, instead of the current rank position of the company; whereas, when participants were asked to predict the market rank of the companies, there was almost a 50% reduction in the number of respondents who favoured a company with the highest value for the previous year.

Azjen and Fishbein's (1977) principle of correspondence (later named the principle of compatibility by Azjen [1988, as cited in Sutton, 1988]) states that decision makers' actions correspond to their attitudes towards behaviour. However, for this predictive nature to be effective several considerations must be met. Specifically, there has to be a correspondence or compatibility between the actions and the target, the context and time of both the attitude and behaviour before attitudes can accurately and effectively be used to predict behaviour. In other words, a person's attitudes towards a behaviour can be utilised to predict their behaviour accurately, only if the attitude is directed at the same target requiring the same action (Azjen & Fishbein, 1977). Moreover, if any elements are missing then the predictive ability of attitudes is reduced. For example, predicting a voting behaviour by asking voters to select who they intend to vote for will have a high degree of accuracy, as both the attitude and behaviour are directed at the same target using the same action, whereas asking voters which of the candidate's policies they prefer will reduce the ability of the question to predict voting intentions (as the target and action do not correspond with each other). Therefore, the principle of compatibility emphasises that it cannot be assumed that behaviours, actions or intentions cannot be generalised without considering the impact of compatibility. In other words, compatibility between contexts has the power to facilitate consistency in decision-making and behaviour.

Wisniewski and Bassok (1999) have argued that the compatibility of stimuli can shape how stimuli are compared, processed, and in turn evaluated. Specifically, items classified as belonging to the same taxonomic category are deemed compatible and can be compared. Whereas, objects that play different roles cannot be classified as fitting into the same categories, despite sharing a thematic

relationship - they are not compatible. When asked to explain similarity ratings for compatible align-able items from the same category, decision makers draw on both similar and dissimilar features between the two objects. For example, “similar consistency” (Wisniewski & Bassok, 1999, p.218) was provided as an explanation for a similarity rating between milk and coffee, whereas when objects are not compatible or align-able but thematically related, decision makers attempted to integrate the items by providing justifications for why the items may or may not be similar. For example, “a waitress may use a telephone” was provided as an explanation for the similarity between a waitress and a telephone (Wisniewski & Bassok, 1999, p.218).

1.8. Commensurability and Incommensurability in Decision-Making

In its simplest form the concept of incommensurability, meaning “no common measure” can be traced back to ancient Greek mathematics (Oberheim & Hoyingen-Heune, 2016). Specifically, the Pythagoreans realisation that absolute magnitudes were so large that they were fundamentally different and incomparable to numerical values (Pesic, 2003), making it impossible for them to be compared against each other. The implications and effects of incommensurable values have been debated, heavily focussing on whether commensurability does (Sunstein, 1994) or does not (Kelly, 2008) prevent or preclude comparisons from occurring between attributes. However, one stable feature when defining incommensurability is that values can be considered incommensurable, if they cannot be aligned onto a single universal scale for comparison (Sunstein, 1994; Slovic & MacPhillamy, 1964; & Vlaev, 2011). In essence, commensurability and incommensurability can be seen as the stronger cousins of comparable/incomparable, similar/dissimilar, as well as compatible and incompatible. Specifically, as whilst on some level all these terms imply the extent to which items are different, this difference effectively exists on one dimension allowing

a comparison to occur, whereas incommensurability suggests that items are so different that separate dimensions have to be used to evaluate the objects. For example, Tversky and Gati's (1988) model of similarity equates the extent to which items or objects possess shared features or equally lack shared features, contributing to dissimilarity.

In the forthcoming section the real and measured implications of incommensurability, as well as the hypothetical and theoretical implications of incommensurability are considered. Research has shown that decision makers adjust their decision-making strategies, based on the comparability of the attributes being considered. For example, as proposed by Johnson (1984) the comparability of the attributes being considered by the decision maker dictates the strategy used to utilise the information, informing respondents' judgements. Specifically, as the attributes being considered become less comparable the more abstract the comparison of the attributes becomes (i.e. decision makers rely on more tenuous links between attributes).

When considered in relation to the diversity and plurality of the information available to decision makers, the topic of incommensurability and the implications of said incommensurability need to be given consideration for their potential to impact decision-making. The challenge presented by potentially incommensurable information is exemplified in the current debates surrounding the increasing demand to use vehicles with a lower environmental impact and highlights this importance. Specifically, the need for vehicles with improved fuel efficiency (Hotton, 2015), balanced with the demand to reduce additional environmental costs, such as the emission of noxious chemicals. How do consumers, when purchasing a car, integrate two measures of a car's environmental credentials, the fuel efficiency and

the emissions ratings of a car? As to do so requires a trade off with consumers having to appreciate the value of the increased fuel economy of a diesel engine, combined with the increased emissions of noxious gasses compared to the potential reduction in fuel economy, accompanying a petrol engine coupled with the potential reduction in the emission of noxious chemicals (Cars and Fuel options, 2018).

1.8.1. The Incommensurability of Scientific Knowledge

When considering the principles of incommensurability, philosophical debates surrounding the commensurability of ideas illustrates the importance of incommensurability, specifically, in relation to its implications for the appreciation of the wider human experience. Can the advancement of scientific knowledge be considered the progressive accumulation of ideas (Putman, cited in Feyerabend, 1987) or are scientific theories incommensurable, meaning that scientific knowledge is not progressive but rather ideas exists in isolation (Kuhn, 1962, cited in Phillips 1975).

Kuhn (1962, cited in Phillips 1975) applies the principles of incommensurability to the development and the growth of scientific knowledge, making a case for theoretical incommensurability. Theoretical incommensurability implies that the advancement of scientific knowledge is not the result of an accumulation of past ideas which present thinking builds on, instead, past thinking is suggested to only be a record of thinking at the time in question. Specifically, Kuhn (1983) suggests that different or opposing theories in their very nature are incommensurable and not translatable. Incommensurability between theories exists due to a perceptual disparity between theories, inhibiting and preventing the realisation of meaningful comparisons between theories (Kuhn, 1983). In other words, a scholar from one field or school of thought will not be able to conceptualise

and chart the ideas of an opposing theory or past idea against their own. For example, a geographer in the present day would not be able to appreciate the explanations and reasoning suggested by flat earth theorists from the Middle Ages (Russel, 1991) in relation to current geological thought.

The proposal of theoretical incommensurability is not accepted universally. Putman (Cited in Feyerabend, 1987) argues that any elements of commonality between theories will allow for the commensurate appreciation of prior ideas allowing theorists to make comparisons. For example, a 17th century scientist's understanding of temperature may differ conceptually to a present-day scientist's, however, any shared elements of commonality will allow a present-day scientist to assess these past proposals in relation to their own work in a commensurable manner (Putman cited in Feyerabend, 1987). Beyond the implications that these two accounts have on the progression of scientific knowledge, opposing accounts of incommensurability exemplify debates surrounding how incommensurability can influence comparisons and how the affects can assimilate into and effect understanding. Either as Kuhn (1962, cited in Phillips, 1975) suggests that incommensurability prevents comparisons in totality, or as proposed by Putman (Cited in Feyerabend, 1987) that incommensurability does not preclude comparisons as any elements of commonality allows for comparisons on a basic level.

When examining the incommensurability of ideas, Sankey (1991) argues that an inability or failure to translate theories making them incommensurable, as suggested by Khun (1983), need not result in an inability to understand theories. Specifically, whilst specialist theoretical language may not be comparable between the theories, the non-specialist background language is and so can be used to allow for referential comparisons between the theories. Furthermore, Sankey (1991)

argues that the ability, or in fact, inability to translate between the language of theories is not even a relevant concern for the understanding of theories, as translatability is not a prerequisite for understanding. Specifically, translatability is argued to imply that the initial and target languages must share some semantic resources allowing for the formulation of equivalent expressions; however, it must be noted that this does not have to occur word for word. Understanding a message in a different language does not rely on their being or knowing a relationship between the languages being considered, instead, understanding is suggested (Sankey, 1991) to be contingent on knowledge of the syntax and semantic understanding of the languages; in other words, understanding only requires a cognitive appreciation between the speaker or listener and a language.

Sankey's (1991) argument that incommensurability need not prevent understanding as a result of an inability or failure to translate between theories provides an interesting reference point for the philosophy of ideas. Specifically, Sankey (1991) makes the case that on some level understanding is not precluded by incommensurability, but rather distinguishes between degrees of understanding. Moreover, translatability between theories allows for a commensurable understanding with the direct mapping of ideas against each other. For example, comparing ideas on a common dimension, can facilitate collaborations between theorists or the integration of theories; whereas, simply the ability to understand alternative theories only allows for the appreciation of that idea, but not a direct comparison.

1.8.2. Value Incommensurability

Following on from the debates surrounding the commensurability of scientific knowledge comes the proposal of value incommensurability; value

incommensurability seeks to establish how to quantify and determine whether values can be deemed as incommensurable. Theorists have provided different accounts of value incommensurable (Griffin, 1986; Sunstien, 1994; Wiggins, 1997) applying different levels of stringency on values, deemed as incommensurable.

Griffin (1986) outlines three forms of value incommensurability, each placing different stringencies on the effects of incommensurability. Placing different levels of constraint on comparisons before incommensurability between the two values can be said to occur. Incomparability is the most stringent form of incommensurability offered by Griffin (1986) and follows the classic definition. Incommensurability (incompatibility) is said to occur if two values cannot be ordered in relation to their value. Specifically, incomparability occurs if it cannot be said whether value A > value B, or vice versa, or in fact whether value A = value B. Griffin (1986) clarifies this account, arguing that true incommensurability occurs not when it cannot be decided how best to rank two values, but when it can be said that two values are un-rankable. Incomparability, whilst theoretically possible, is suggested by Griffin (1986) to be practically improbable. In search of a more probable form of incommensurability, Griffin (1986) proposes a second weaker form of incommensurability - trumping. Trumping allows for comparability, however, only in the sense that it can be established that one value trumps another as strongly as possible, irrespectively of the magnitude of each value. In essence, value A can be said to trump option B only if any amount of option A, no matter how small, is better than option B no matter how large it is. However, Griffin (1986) discounts trumping, specifically, as the effects of incommensurability are suggested to place unrealistic stringencies on decision-making; a third, even weaker form incommensurability is proposed - discontinuity. Discontinuity implies that incommensurability occurs only if

a sufficient amount of value A outranks any amount of value B. That is to say, values can be considered incommensurable if past a certain point, an option or value is superior irrespectively of the volume or size of the value which it is being compared against.

An alternative fourth account of value incommensurability is suggested by Wiggins (1997) who surmises that incommensurability occurs only if there is no true ranking of values (Wiggins, 1997). This proposal emphasises that the incommensurability of values depends on an inability to place values on one common dimension for comparison. This form of incommensurability is used to explain the conflicting of values. For example, if the gain of one value does not neutralise the loss of an equivalent value, then this comparison can, in fact, be deemed incommensurable. However, if the gain of one value does cancel out and neutralises the loss of an alternate value, then the two values can be considered commensurable (Richardson, 1994).

Sunstien (1994) goes further to exemplify the importance of appreciating the potential impact of incommensurability illustrating that the value placed on objects by humans are plural and diverse. Due to this diversity and plurality values cannot be reduced to a single generic all-encompassing value (for example utility) - human values cannot be considered inherently commensurable. This stance is appreciated fully when considered in relation to Sunstien's (1994) definition of incommensurability, that incommensurability occurs with goods or items that cannot be aligned onto a single dimension or matrix for evaluation, echoing the initial proposal of incommensurability as "no common measure" (Oberheim & Hoyingen-Heune, 2016). An example of the extent to which incommensurability extends to every day evaluations is time, specifically, the intersection between time - the

evaluation of time as monetary commodity and personal experience. On the one hand, people value their time in a commercial sense as how much they are paid or how much they feel they should be paid, yet this value may not match with the value they place on personal time. In addition, Sunstien (1994) argues that attempting to align incommensurable values on a single commensurate scale will damage the representation of the information. Information will be lost in translation, as the nuances of specific information is condensed and simplified when seeking to find a degree of commonality.

Kelly (2008), however, provides an argument opposing suggestions of incommensurability as a limiting factor in the assessment of value. Kelly (2008) suggests that the effects of incommensurability, if a reality would prevent every day comparisons and evaluations as only like for like items could be compared. Instead, Kelly (2008) proposes that conflicting values can still cause decision makers to struggle; however, as a result of this challenge decision makers make lists - weighing up the pros and cons of outcomes individually, whereas with commensurable values the closeness and similarity of the attributes is actually suggested to hamper decision maker's ability to rank and distinguish between values. In other words, commensurable values can cause decision makers to struggle when making decisions. Specifically, the problems which decision makers face arise not as a result of dissimilarity, but rather it is actually the similarity which inhibits decision makers. Moreover, Kelly (2008) proposes that desire can be used to convert between values. Specifically, as value is tied to desire, desire is argued to be directly proportional to value; so long as a decision maker can establish their desire for an outcome or option then no two items can be considered incommensurable. This proposal is based on the concept of merit connection. Merit connection captures

the connection between value and desire, as put by Oddie “good is what merits desire” (2009, p.38). For example, an outcome or item is considered good to the extent that it merits being desired by a person informed of its non-value attributes (Oddie, 2009). In other words, merit connection provides the potential to order or choose between items, based not on the comparison of their values, but rather through the comparison of their intrinsic merits. Kelly (2008) suggests that as long as a decision maker can establish how much they desire outcomes, the importance of whether they can directly compare the values is not important, as their intrinsic desire associated with each outcome fulfils this need.

1.8.3. Dimensional Incommensurability

Slovic and MacPhillamy (1974) provide experimental evidence of the impact of commensurability between decision attributes on decision-making behaviour. Dimensional incommensurability can be best characterised as a phenomenon, occurring when dimensional attributes of assessments do not possess common characteristics that allow for their uniform measurement and comparison (Slovic & MacPhillamy, 1974). This account of incommensurability is informed by research focusing on cue utilisation, specifically, how does commonality between cues affect; how the cues are utilised, and in turn used to inform judgements. Slovic and Lichtenstein (1968) have shown that the ability to judge a gamble in a format commensurable to one of the attributes of the gamble (either the probability or the outcome) anchors decision maker’s judgements to the commensurable attribute. When judging the attractiveness of a gamble, the probability of winning was found to be a factor informing participants judgements. However, when participants were asked to judge the attractiveness of the gamble (the amount of money they would pay to be indifferent between playing the gamble and receiving a sure outcome), the

judgement was informed by the outcome of the gamble. Put simply, decision makers were cued by the format of the judgement to focus on specific sources of information when making their judgements (Slovic & Lichtenstein, 1968).

Slovic and MacPhillamy (1974) also suggest that dimensional incommensurability affects how decision makers integrate attribute values, and in turn use the information to educate and inform their judgements. Participants in the study were asked to imagine that they were playing the role of a university college admissions tutor and were presented with pairs of students to choose between for admission to the college. Each of the hypothetical students was represented on two dimensions. One common dimension was shared by both students; for example, grade point average (a student's average performance across past assessments) and a second unique dimension that differed between the students (e.g., English ability or quantitative ability). The findings supported their proposal that the common (commensurable) dimensions would be valued more than the uncommon or unique (incommensurable) dimensions. Specifically, the student who was superior on the common dimension was chosen between 69% to 74% of the time irrespectively of the general equivocacy between the two students, when all dimensions were considered. These results indicate that decision makers do not or cannot integrate values onto a single common dimension to inform decisions, as proposed by normative models of decision-making (von Neumann & Morgenstern, 1953), rather decision makers rely on the easily compared common dimension. In addition, not only do the findings show that commensurable and incommensurable attributes are not treated equally, but they also hint at the biasing effect that a contrast between commensurable and incommensurable information can have on decision makers' judgements.

Slovic and MacPhillamy (1974) provide several potential explanations examining why decision makers infer value based on the common dimension with more frequency. One potential cause of the effect offered by the authors (Slovic & MacPhillamy, 1974) is that the unique dimensions assigned to the student creates ambiguity. Decision makers attempt to resolve the ambiguity by focussing their attention on the common dimensions, leading to them being over weighted. Alternatively, it is argued that comparing incommensurable values increases the cognitive strain placed on decision makers. The increased cognitive strain makes trade-offs between the unique dimensions challenging, as a result, it is suggested to promote a reliance on common values (Slovic & MacPhillamy, 1974). The effect of cognitive strain and the reliance on common values was tested by presenting the dimensions given to decision makers either in equal (every dimension had the same mean score of 500, *SD* = 150) or unequal units (the dimensions had different means scores, *M* = 50, *SD* = 20; *M* = 100, *SD* = 20; *M* = 500, *SD* = 150). Presenting the dimensions with unequal units was expected to increase the cognitive strain experienced by decision makers, as they were required to rescale the values which would facilitate direct comparisons between the attributes, increasing reliance on the common dimension. However, increasing the cognitive load of the task did not exaggerate the effect of dimensional incommensurability.

Moreover, a further explanation offered by Tversky (personal communication to Slovic & MacPhillamy cited in Slovic & MacPhillamy, 1968) is the random weight model. This suggests that value is established differently between attributes being considered. For common dimensions a single decision weight is used, capturing the differences between the two dimensions. However, for the unique incommensurable dimension separate decision weights are applied. These weights are then combined

to educate the decision maker's judgement. As a result, there is twice the potential for error in the weighting of the unique dimension, as it occurs twice, this error leads to reducing the weighting applied to the dimensions. However, for the common dimension, as there is only one value under consideration, there is half the opportunity for random error. This hypothesis was tested (Slovic & MacPhillamy, 1968) by comparing the evaluation of pseudo choices (the difference between individual ratings of students) and real choices between the stimuli. This tested the random weight explanation; as if the stimuli were judged individually then each attribute would be weighted individually. Therefore, the individual weighting of each attribute be it on a common or unique dimension means that the random error associated with each option should not vary and the common dimension should not be over weighted. However, when this method was tested the overall difference in judgements between the pairs and pseudo pairs was not significant.

An alternative suggestion is that the ease of making comparisons on a single dimension promotes a reliance on the common dimension, leading to an overweighting on the common dimension (Slovic & MacPhillamy, 1974). Specifically, Slovic and Lichtenstein's (1968) present research examining how decision makers utilise cues in the task, which matches or does not match the evaluation type. Due to limited cognitive processing abilities, decision makers are argued not to use all of the information available to them (Slovic & Lichtenstein, 1968). Instead, the perceived relative importance of the attributes anticipates the attention paid to the dimensions. Applied to Slovic and MacPhillamy's research (1974) the commonality of the attributes dictates the perceived relative importance of the attributes; this in turn dictates the level of attention that is paid to the attribute. In other words, commensurability (common or unique dimensions) moderates the perceived

importance placed on task specific information (Slovic & Lichtenstein, 1968). A further suggestion offered, but not tested by the authors (Slovic & MacPhillamy, 1974), is that the overweighting of the value of the common dimension could stem from decision makers' lack of confidence in their own ability to utilise and integrate uncommon dimensions. In other words, incommensurable decision-making information is suggested to increase decision-making uncertainty, and as a result incommensurable information is attended to less.

1.8.4. Qualitative Incommensurability

Vlaev (2011) has proposed the concept of qualitative incommensurability, reiterating Sunstien's (1994) argument that decision makers cannot make absolute judgements between different types of values, contributing to the underlying proposal that decision makers cannot place judgements of absolute magnitude on a single universal scale for assessment. The proposal is based on research examining how decision makers perceive, judge and then compare psychophysical stimuli, such as loudness (Stewart & Chater, 2003). For example, Stewart and Chater (2003) indicate that decision makers do not use unified scales of perceptual magnitude, instead decision makers make relative judgements of loudness between stimuli. These judgements of perceptual magnitude were found to be more accurate when made in relation to similar types of sounds (e.g., two hisses or two tones), than when they were made in relation to two different types of sounds (e.g., a hiss and a tone). These findings highlight that decision makers cannot make consistent and stable trade-offs between different types of stimuli, just as theorists examining the effects of incommensurability have argued that attempts to place incommensurable values on a single scale will damage the representation of both values (Sunstien, 1994).

Moreover, building on evidence revealing that unified scales of perceptual magnitudes do not exist, (Stewart & Chater, 2003), Vlaev (2011) argues that within decision-making or judgement scenarios the qualitative incommensurability of values has to be considered; specifically, due to their potential to act as an influential factor shaping decision-making. This stands in contrast to arguments put forward by opponents of incommensurability who argue that potential side effects of incommensurability, if a reality would be too great (e.g., Kelly, 2008). Within preferential choices, decision makers are frequently required to make judgements based on their comparison of incommensurable values. In addition, even the presentation of the values can affect the perceived incommensurability of the task being considered, and in turn can shape decision maker's judgements.

Establishing the impact of incommensurability, Vlaev (2011) argues the case that qualitative incommensurability undermines the quality of the choice, just as hypothesised previously by Sunstein (1994). Moreover, it is proposed that the information needed to make an accurate decision under normative circumstances (e.g., von Neumann & Morgenstern, 1953) is incommensurable, in turn the qualitative incommensurability of information being considered has the potential to hinder decision maker's judgements. For example, Vlaev (2011) uses qualitative incommensurability to explain trade-off inconsistency, which can be exemplified by the example that "a person may easily judge that eating marginally more calories is preferable to eating slightly fewer; and marginally less risk of diabetes is preferable to more" (Vlaev, 2011, p.1). Within this example, a trade-off is required between two different and incommensurable dimensions, hunger and risk of diabetes. Vlaev (2011) makes the case that affects, such as trade off inconsistency, are not cognitive processing oddities, but rather they arise due to basic underlying properties of the

cognitive systems; a systematic inability to assess and integrate qualitatively incommensurable values.

1.9. Review of Online Data Collection

The forthcoming research uses online data collection methods and as such a brief consideration of the potential advantages and disadvantages of online research is considered. Whilst online research is still a relatively new method of research compared to studies conducted in a laboratory setting, since its initial inception, theorists have been evaluating the efficacy of online research. For example, Krantz and Dalal (2000) identified that by the time of writing in the year 2000 over 20 studies had already been conducted on the internet. Moreover, Krantz and Dalal (2000) present an early reflection of the reliability and validity of online research which remains relevant to this day.

> *Disagreements between Web results and laboratory results do not, ipso facto, demonstrate the lack of validity of Web-Based studies. Just as there are threats to the validity of Web-based studies, there are threats to the validity of laboratory methods (pg.36, Krantz & Dalal, 2000)*

Dandurand, Shultz and Onishi (2008) present a comparison of studies conducted online research compared to the findings of a “real life” study, specifically in relation to problem solving research. Specifically, the authors (2008) found that broadly there was little difference between the online and in person experimental conditions. Participants who watched demonstrations of successful problem-solving tasks outperformed those who read instructions; irrespectively of whether the participants took part in the study online or in real life. However, despite the broad headline that the results of the experimental conditions remained the same whether

conducted in real life or in person, the authors do note some marked differences between the online vs in real life conditions. Respondents in the online conditions, gave less accurate responses; however, the authors attribute this to a lack of interaction (rather than a generic issue associated with online research) - a concern associated with their experimental design.

Whilst the research of Dandurand, Shultz and Onishi (2008) provides support for the effectiveness of online research they do note that the internet-based conditions did suffer from a lack of interaction with the stimuli. Vadillo and Matude (2011) examine the role of interactivity within the stimuli and the controls which can be exerted on the experimental stimuli in the context of associative learning research. Specifically, the authors found that respondents who took part in the study online or in person demonstrated similar levels of associative learning indicating similar levels of interaction with the task and control over the experimental manipulations. However, the authors (Vadilo & Matude, 2011) note that a higher proportion of the online sample did not meet the experimental criteria, compared to those that completed the study in person; specifically, more participants in the internet-based conditions did not pay attention to the study. In light of this the authors note the importance of stringent completion criteria and an inflated sample size to overcome the potential effects of a proportion of respondents not attending to the experimental manipulations.

Moving away from debates surrounding the comparability of online research to lab studies there are some more specific advantages of online research for example the ease of access to a diverse and large population sample (Bohner, Danner, Siebler, & Samson, 2002), the increased generalisability to the general population (Berinsky, Huber & Lenz, 2012; Horswill & Coster, 2001 & Berinsky,

Huber & Lenz 2012), as well as potentially increased generalisability to more situations (Laugwitz, 2001).

One study that demonstrates the potential for online research to easily access a worldwide diverse sample population of participants is by Bohner et al. (2002). The researchers were able to gain a sample of 440 participants over multiple countries in just three months. The potential to collect data from a wide respondent pool leads into the increased generalisability of research conducted online to the wider populations. For example, Berinsky, et al. (2012) discovered that sample populations drawn from online survey panels were, in fact, more representative of the US population than a sample of the population collected in person. Finally, one concern which could be raised regarding online research is the presentation of information and how its modality may change if presented via a screen vs in person on paper. However, Laughwitz (2001) has identified that the main effects of presenting stimuli online do not differ compared to presenting the stimuli in person.

1.10. Summary of Chapter 1 and Outline of Experimental Chapters 2, 3, 4

Early theorists in decision-making have placed an emphasis on the role of computational mechanisms to inform and educate decision-making (Bernoulli, 1954; von Neumann & Morgenstern, 1953). However, evidence has suggested that decision makers do not act in accordance (e.g., Allais, 1953; Ellsberg, 1961) with the stringencies (von Neumann & Morgenstern, 1953) outlined by this approach. Alternative theories have emerged that offer explanations of decision-making behaviour, which adapt computational processes to account more accurately for the variability seen in decision-making; for example, contributions offered by prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) with its explanation of the fourfold pattern of risk preferences. Moreover, theorists who have

also attempted to integrate additional psychological factors into computational decision-making processes (e.g., Quiggin, 1982), have hinted that even if the calculative processes and mechanisms are to be assumed, there remains a need to appreciate and understand the role of alternative processes such as comparisons. For example, in Quiggin's (1982) anticipated utility theory decision makers are suggested to establish the risk of a prospect, by examining it in relation to alternative available risks in a similar decision context, highlighting the role of information external to the current decision task, and in turn the ability to utilise this information to inform decision-making. Loomes and Sugden's (1982, 1987) proposals within regret theory also presents additional evidence of utilitarian based theories accepting the integration of comparisons into computational mechanisms of decision-making. Specifically, Loomes and Sugden's (1982 & 1987) proposal that decision-makers are suggested to establish a choice less utility function, evaluating the outcomes of a decision through comparisons of the outcome of the decision with their anticipation of the outcome. Hence, despite decision makers being suggested to establish, and in part, base their decision on the utility of the options available to them, they also rely on qualitative comparisons comparing their potential to experience, either regret or rejoice upon experiencing the outcomes.

The impact of similarity and dissimilarity within decision-making is not a new phenomenon. For example, research conducted by Slovic and Lichtenstein (1968) has revealed that decision-makers struggle to use and integrate different sources of decision-making information; in other words, decision makers cannot make comparisons on different dimensions to inform their comparisons. Specifically, the inability to compare and integrate different attributes, shapes the strategies used by decision makers, such as focusing on one prominent attribute of the task. Whilst,

Slovic and Lichtenstein (1968) present a case for dissimilarities to lead to suboptimal decision-making, encouraging decision makers to discard and fail to utilise information, which is not easily integrated or comparable.

Furthermore, theorists have presented detailed accounts, which argue for the role of compatibility and comparability in influencing and shaping decision-making. For example, the cue response compatibility hypothesis (Lichtenstein & Slovic, 1973) and the later scale compatibility (Tversky et al., 1988), and structure compatibility hypotheses. The compatibility hypothesis (Lichtenstein & Slovic, 1973) proposes that compatible dimensions in a decision-making task will be over weighted by decision makers. Moreover, this proposal has been upheld with decision-making made across several domains, such as financial instruments (Slovic, Griffin & Tversky, 1990). Furthermore, compatibility has been suggested to play an important role in predicting behaviour, Azjen's (1988, cited in Sutton, 1988) principle of compatibility argues that for decision-making behaviour to be effectively predicted, and in turn anticipated, there must be compatibility i.e. the action, target, and time of both attitudes and behaviour must be similar and comparable.

Researchers have also revealed the implication of decision-making comparisons, not only for guiding and educating decision-making (Gigerenzer & Seletan, 2002; Stewart et al., 2006), but also for biasing decision-making (Kusev & van Schaik, 2011). Heuristic accounts of decision-making, whilst not exclusively comparative, do place an emphasis on comparative over computational processes (Gigerenzer & Seletan, 2002). For example, the tallying heuristic suggests that rather than making decision by calculating decision weights, decision makers make comparisons between prospects on a single dimension (Gigerenzer & Seletan, 2002). Furthermore, one of the prerequisites of heuristic decision-making – domain

specificity, dictates that heuristics are not a one size fits all strategy for decision-making, but rather the heuristic strategy selected by a decision maker needs to be born from a similar situation to the task at hand (Gigerenzer, Todd & ABC Research Group, 1999). In addition, decision by sampling presents an account of decision-making, reliant on comparisons with decision makers deciding by comparing their present options to prior experiences (Stewart et al., 2006). Moreover, research conducted by Kusev and van Schaik (2011) has explicitly emphasised that decision maker's preferences are biased by their ability to compare current decisions against past experiences.

Philosophical debates surrounding the incommensurability of ideas have laid the foundation for future debates surrounding the potential impact or lack thereof of incommensurability. Importantly, whilst theorists have presented opposing accounts of the potential impact of commensurability (Putman cited in Feyerabend, 1987) or incommensurability (Kuhn, 1983) on scientific knowledge, even those who argue that seemingly incommensurable ideas can be compared, concede that comparisons and understanding will occur on a lower less precise level (Sankey,1991). Specifically, Sankey (1991) has suggested that these theories can still be understood and appreciated, however, they cannot be directly mapped with comparisons of the one against the other; they cannot be translated into a single universal language. Hence, even theorists arguing against the impact of incommensurability recognise that incommensurability, whilst not precluding comparisons will change the nature of comparisons.

Theorists presenting accounts of value incommensurability have argued for varying stringencies between incommensurable values. The initial most stringent form of incommensurability offered by Griffin (1986) – incompatibility dictates that

values cannot be ordered in relation to their value. This theme is reiterated by Wiggins (1987) who suggests that incommensurability occurs if there is no true overall ranking of values; values cannot be aligned on a single scale for comparison. Interestingly, these proposals have been argued to be too stringent both by theorists arguing against the notion of value incommensurability (Kelly, 2008), and also theorists in favour of value incommensurability. Griffin (1986) proposes a weaker form of incommensurability - trumping. Trumping allows for the comparability of values; however, only to the extent that one value can be said to trump the other irrespective of magnitude. Griffin (1986) goes further offering a third weaker form of incommensurability – discontinuity, which implies that incommensurability occurs if past a certain point value is considered superior irrespectively of its magnitude. Moreover, Sunstein's (1994) definition of incommensurability reiterates early proposals of incommensurability, suggesting that incommensurable values are those that do not share a common dimension or scale for evaluation. Additionally, attempts to make comparisons between these incommensurable values is argued to do harm to the representation of value (Sunstein, 1994). In contrast to proposals for the incommensurability of ideas, Kelly (2008) suggests that incommensurability between values does not prevent the comparison of values, as the implications of incommensurability would be too great, impeding too many actions. Moreover, in contrast to Sunstein's (1991) proposal that commensurability between values harms comparisons, Kelly (2008) in fact, argues that commensurability between values produces conflict, with the dimensional closeness of commensurable values said to hamper decision-making. Moreover, Kelly (2008) argues that desire can be used as a universal language for values; in essence, as long as a decision maker can

establish how much they desire each option, then options cannot be considered incommensurable.

Several theorists in psychology have offered suggestions regarding the impact of incommensurability. Slovic and MacPhillamy (1974) argue that incommensurable values bias decision makers, with decision makers overweighting commensurable dimensions compared to incommensurable dimensions. As a result of incommensurability, the decision makers effectively made choices based on a single commensurable dimension. Several explanations were offered by the authors, ranging from the commensurability of the values being considered, being used by decision makers as an indicator of importance, to decision makers' perceived inability to assess incommensurable values, resulting in a compensatory overweighting of the incommensurable values. Reiterating the impact of incommensurability in shaping decision maker's judgements, Vlaev (2011) proposes that the commensurability or incommensurability of task specific information in decision-making scenarios should be considered a key factor in shaping decision maker's judgements, specifically as behavioural biases may arise as a direct result of a cognitive inability to compare qualitatively different decision-making information.

Whilst definitions, and even the impact of incommensurability across fields of study has been debated, what remains clear is one common theme. Specifically, theorists (e.g., Griffin, 1986; Vlaev, 2011) arguing for the debilitating effect of incommensurability on comparisons and evaluations, suggest that the struggle to place incommensurable values on a single dimension for comparison, and attempts to convert incommensurable values, so that they can be compared on a single dimension will damage the representation of the value; whereas alternative accounts, which whilst vetoing the extent to which incommensurability will prevent

the comparison of values, still concede that comparison strategies will vary between commensurable and incommensurable values (e.g., Sankey, 1991; Kelly, 2008).

In light of recent proposals in decision-making research that emphasise the integral role of comparisons, such as decision by sampling (Stewart et al., 2006), coupled with previous work emphasising the impact of incommensurability (Slovic & MacPhillamy, 1972) on decision-making, the current research examines the hypothesis that commensurability in decision-making encourages the production of behavioural biases. Specifically, commensurability in the decision-making environment is suggested to allow and encourage decision makers to use comparative strategies, which as discussed, can lead to biases in decision-making. Moreover, it was also hypothesised and proven that preventing comparisons by introducing incommensurability in to the decision-making task, would reduce respondent's susceptibility to behavioural biases.

The forthcoming chapters examine the potential for commensurability to fuel behavioural biases and equally for incommensurability to reduce behavioural biases. Presenting the case that commensurability within decision-making allows decision makers to rely on comparative strategies to educate decision-making, which leads to variances in decision-making. However, by the same token the forthcoming research also highlights the potential for incommensurability to prevent comparative strategies from being used in decision-making, which reduces behavioural biases. The second chapter examines how introducing incommensurability between a decision-making task (a monetary gamble) and judgement can prevent comparisons, which in turn reduces the proportion of participants who exhibit behavioural biases. Chapter three examines the impact of option incommensurability (the ability for the choice options under consideration to be evaluated and compared on a common dimension) on

biases to multi attribute decision-making (the attraction and compromise effects [Huber et al., 1982; Simonson, 1989]), revealing that presenting the decision options as incommensurable reduces both effects. Finally, the fourth experimental chapter examined the impact of both option commensurability and also commensurability between the different stages of the decision-making task, on choice blindness. Incommensurability between both the decision-making task and the decision-making judgement leads to a reduction in the proportion of participants susceptible to choice blindness.

The second chapter tests the effects of task judgement content commensurability on loss aversion. Explanations of loss aversion have explored a range of possible mechanisms. Some accounts of loss aversion have emphasised an ingrained bias in the perception of gains and losses or explanations tied to decision makers' perceptions of winning and losing (e.g., Kermer, Driver-Linn, Wilson & Gilbert, 2006), whilst others have emphasised the role which comparisons play in shaping decision-making preferences (e.g., McGraw, Larsen, Kahneman & Schkade, 2010; Walasek & Stewart, 2010). An early explanation of loss aversion suggested by Kahneman and Tversky (1979, p.279) with the venerable quote "losses loom large than gains" indicates that a greater decision weight is applied to losses compared to gains. Building on this account theorists have suggested that decision makers under anticipate their ability to cope with losses, and as a result display an aversion to outcomes framed as such (Kermer et al., 2006). However, recent research has highlighted the role which comparisons play in driving loss averse preferences. Specifically, evidence coming from decision by sampling has revealed that loss aversion occurs as current decision prospects are compared to previous comparable circumstances to establish a relative rank position of the

current prospect (Walasek & Stewart, 2015). Moreover, since decision makers experience more losses than gains on a day-to-day basis, there are more reference points for a loss to be ranked against; as a result, losses typically receive a higher relative rank position than equivalent gains, leading to loss aversion. In contrast to this outward looking account of loss aversion, McGraw et al. (2010) have argued that the feeling of loss aversion is produced through the contextual comparison of gains and losses. In other words, decision makers only display loss aversion when judgements of feelings towards winning and losing are placed in the same context for comparison. Specifically, in response to the experimental findings of McGraw et al. (2010) the series of experiments in the second chapter reveals that it is not the ability for decision makers to compare their responses to winning and losing which produces, or in turn inhibits loss aversion, rather it is the presence or absence of task judgement content commensurability. Task judgement content commensurability entails that decision makers can compare the decision-making task on the same dimension as the judgement (e.g., monetary task judgement of monetary worth), and it is this ability to compare the two that fuels loss aversion. Furthermore, it is also revealed that preventing decision makers from comparing the decision-making task and judgement by introducing incommensurability can reduce the proportion of respondents who display loss averse preferences. For example, the study by McGraw et al. (2010) used a method lacking task judgement content commensurability, a monetary task judged in terms of intensity of feelings, and it is this incommensurability, which is attributed to the reduction in loss averse preferences, when gains and losses cannot also be compared.

The third chapter examines the impact of option commensurability, the ability to compare decision-making options on a single common dimension in relation to the

attraction (Huber et al., 1982) and compromise effects (Simonson, 1989). Specifically, this was done to examine the proposal that prevent comparisons between the decision options with incommensurability, whilst maintaining commensurability within the decision attributes, would reduce both effects. Theorists examining multi attribute decision-making have offered various explanations, importantly the impact of the perceived relevance of the decision options has been shown to effect decision-making (Doyle, O'Connor, Reynolds & Bottomley, 1999). Additionally, accounts of multi attribute decision-making have presented explanations of both effects founded not in the aggregation of the attributes of each option, but rather within various processes of information sampling, and within attribute comparisons between options (e.g., Ronayne et al., 2017). Building on this previous research, the current studies have revealed that the incommensurability of the options under consideration can be used to moderate the extent to which the options available shape the comparisons, and in turn elicit the attraction and compromise effects.

Finally, the fourth chapter examined the impact of option incommensurability and task incommensurability between the initial elicitation of preferences and the secondary justification of said preferences. Specifically, this was done to examine the proposal that option incommensurability and task incommensurability would lead to a reduction in the proportion of decision makers who display choice blindness. Theorists (e.g., Johansson et al., 2005) examining choice blindness with visual stimuli have presented research, which indicates that the level of similarity between the options under consideration does not affect choice blindness. However, it is important to note that similarity details the closeness of two items or objects on an evaluatory dimension, implying that whilst the two options may be dissimilar, they are

still comparable on a single dimension. In other words, whilst the options being considered may be dissimilar, none the less they are still commensurable. The present research has revealed that using choice options, which are not only dissimilar but also incommensurable, reduces choice blindness. Specifically, it is argued that this occurs as decision makers cannot rely on shared reference points, which allows them to benchmark one alternative against another. Due to this, reaching a decision relies on an individual introspective assessment of both alternatives. This isolated assessment of each incommensurable item was revealed to reduce the decision maker's susceptibility to choice blindness.

Furthermore, chapter four also examines the effect of an increase in task commensurability on choice blindness; this was achieved by asking respondents to initially judge rather than choose between stimuli. The initial judgement of the two options is suggested to be more commensurable to the secondary justification task; specifically, as judging the two stimuli required an individual assessment of each option (Montgomery et al., 1994). The individual judgement of each stimuli is argued to be akin to the individual reappraisal of the "chosen" image in the feedback stage, increasing the commensurability of the task as a whole. Moreover, it was found that increasing commensurability in this manner resulted in an increase in the proportion of respondents who failed to notice the switch of their selected for their least selected option. Specifically, this is argued to have occurred as the commensurability of the task and judgement means that same strategies are used to assess the options in the initial and secondary stages of the task. The individual appraisal of images manifested as a judgement and a secondary individual assessment meant that in the secondary task, when justifying their initial ratings, decision makers could draw on their reasoning for rating an option. This was possible as they had already assessed

it individually; as a result of this, they were less likely to detect the conflict, as they already had positive pro forma for each option available for them to provide as justification for their decision, despite the fact that they were justifying the incorrect option.

Chapter 2: Commensurability: Loss Aversion and Decision-Making

2.1. Introduction

2.1.1. Loss Aversion

Loss aversion describes a behavioural phenomenon where negative (e.g., losses) outcomes are felt more strongly than equivalent positive (e.g., gains) outcomes (Kahneman & Tversky, 1979). Research has suggested that loss aversion may be experienced broadly across negative departures from the status quo (Bateman, Munro, Rhodes, Starmer & Sugden, 1997). Specifically, research has indicated that losses are weighted up to twice as much as equivalent gains (Kahneman, Knetsch & Thaler, 1990).

Furthermore, the impact of loss aversion on decision-making has been well documented in both humans and non-human decision makers (Chen, Lakshminarayanan & Santos, 2006). Moreover, across a range of decision-making domains such as risky decision-making (Tversky & Kahneman, 1992), buying and selling decisions (Novemsky & Kahneman, 2005) and political decision-making (McDermott, 2004). Interestingly, whilst research has suggested that behavioural biases in general may be reduced in professional traders (List, 2003; Haigh & List, 2005), Haigh and List (2005) present evidence that professional traders compared to a student population, in fact, exhibit greater levels of loss aversion.

The initial conceptualisation of loss aversion comes from Kahneman and Tversky's proposal that "losses loom larger than gains" (1979, pg. 279). Kahneman and Tversky (1979) suggest that the prospect of losing is more aggravating than the potential satisfaction experienced from gaining an amount of money. With the initial iteration of prospect theory, loss aversion is encapsulated with the coefficient of loss aversion. However, in the later cumulative prospect theory (Tversky & Kahneman, 1992) loss aversion occurs as the gamble is viewed in terms of the domain of

decision-making, separate decision weights are applied to gain and loss outcomes. With the separate weighting functions, a separate utility function is applied to gains and losses, with a steeper value function for losses than gains.

Tversky and Kahneman (1991) propose that loss aversion in preferences could exist as a constant underlying behavioural trait. However, the coefficient of the constant loss aversion was found to differ depending on the domain or framing of the loss. In other words, loss aversion is argued to always be present, however, the extent to which loss aversion is felt varies as a function of the loss under consideration (Tversky & Kahneman, 1991). Specifically, the extent to which loss aversion was felt across domains was argued to be dependent on the prominence of the domain being considered (Tversky & Kahneman, 1991). For example, this account of loss aversion was supported by research revealing that loss aversion varies greatly across decision contexts. Also, loss aversion has been shown to occur more strongly in safety scenarios compared to financial scenarios (Viscusi, Magat & Huber, 1987).

Researchers examining the endowment effect, a phenomenon typically attributed to loss aversion, have provided further insights into loss averse preferences. Specifically, the sellers of an item demand a higher price for this item compared to the price that buyers are willing to pay for the item (Kahneman et al., 1990). Kahneman et al. (1990) suggest that rather than being an error or a by-product of an experimental manipulation, loss aversion is an underlying facet of human preferences. This is suggested in light of evidence revealing that transaction costs cannot be attributed to the disparity between willingness to buy and willingness to sell prices. Hence, loss averse preferences persist even when there is no reason

for a loss to be perceived as having occurred in the transaction (Kahneman et al., 1990).

Carmon and Ariely (2000) offer an attention-based explanation of loss aversion. Specifically, decision makers are suggested to attend to different aspects of the decision depending on their role in the task (buyer or a seller). Both sellers and buyers are suggested to focus on what they stand to forgo in the transaction, leading to a disparity between the willingness to pay and willingness to accept prices. The different positions in the transaction are suggested to emphasise different perspectives in the transaction. Framing a person as either a buyer or seller is said to invoke different levels of information processing. Specifically, the benefits of the item being sold are suggested to be more evident to sellers than buyers. This is supported by evidence, indicating that when the potential benefits of the item being sold were highlighted to decision makers, buying prices were affected more than selling prices, whereas when the benefits of money were emphasised, selling prices were affected more than buying prices (Carmon & Ariely, 2000). Whilst attention-based accounts utilise similar processes to the attribute-based accounts presented earlier (Tversky & Kahneman, 1991), there are some distinct differences. The results provided by Carmon and Ariely (2000) indicate that it is not the attributes being considered that affects decision makers, as proposed in the attribute-based account, rather it is the information that decision makers attend to, dictated by their position as a buyer or a seller that fuels loss aversion.

Novemsky and Kahneman (2005) argue that intentions towards items in a transaction dictates whether the selling of an item is or is not judged as a loss. Transactions falling within a decision maker's budgetary intention are not perceived as losses, whereas transactions that are not planned falling outside of budgetary

intentions are viewed as losses, and in turn, produce loss aversion. This account of loss aversion is underpinned by three propositions about the nature of loss aversion. Firstly “The value attached to a consumption good that is given up in an exchange reflects loss aversion.” (Novemsky & Kahneman, 2005, p.123). Secondly, “Goods that are exchanged as intended are not evaluated as losses.” (Novemsky & Kahneman, 2005, p.124). Finally, “There is no risk aversion beyond loss aversion in balanced risks.” (Novemsky & Kahneman, 2005, p.125). The first proposition implies that decision makers display a reluctance to exchange goods; however, this is not expected to occur if the benefits of the item to be received in the transaction are equal to that which is being exchanged, indicating that decision makers when evaluating a transaction do not consider the equivocacy of the attributes under consideration, but instead equate these attributes to potential benefits (Novemsky & Kahneman, 2005). The second proposition emphasises that loss aversion does not occur following every negative departure from a reference point, rather, the decision makers intended purpose for an item shapes their response to the transaction. For example, a market trader will not exhibit loss aversion when selling a mug, as they own it with the intent to sell it. However, an individual will exhibit loss aversion when selling it, if they acquired the mug with the intention of using it for themselves. Therefore, the opportunity to sell the mug rather than being seen as such, is perceived as depriving them of being able to follow through with their intentions (Novemsky & Kahneman, 2005). The final proposition entails that goods given up in a trade are evaluated in the same manner as a loss from a mixed gamble. However, there are two circumstances where this does not occur. Firstly, due to income effects, such as relatively large high value exchanges, such as selling a car or a house, where the outcome influences future spending behaviour. Secondly, loss

aversion is reduced if the evaluation of giving up an item, and in turn the money received from it is not separate. That is to say a person's intentions to give up an item is connected to their intention for the money. For example, selling a car may be perceived as a loss; however, selling a car with the explicit intention of using the money to purchase another car will not be perceived as a loss, and in turn will not produce loss aversion.

Several theorists suggested that loss aversion occurs in effect as decision makers overestimate the negative impact a potential loss will have on them. Camerer (2005) hypothesises that loss aversion can be typified as the emotional fear reaction towards the potential to experience a loss. Specifically, Camerer's (2005) proposal is based on Lowenstein et al.'s (2001) risk-as-feelings hypothesis. The risk-as-feelings hypothesis suggests that the anticipated emotional response to a decision influences the decisions and judgements made. This hypothesis is supported by research, indicating that decisions making is shaped by the decision makers anticipated reaction to the task (Gilbert, Morewedge, Risen & Wilson, 2004). For example, Gilbert et al. (2004) reveal that decisions makers are influenced by their anticipated feelings of regret. However, when decision makers dealt with the situation associated with the loss, rather than being hampered by the negative effect of losing, instead they utilised strategies to mitigate or reduce their feelings of regret and loss aversion.

Building on the explanation of loss aversion as an anticipatory bias Kermer et al. (2006) argue that loss aversion occurs as decision makers underestimate their ability to cope with losses. Specifically, loss aversion occurs in anticipation of an event, but not the actual experience. The authors (Kermer et al., 2006) suggest that when negative outcomes are experienced, the decision maker's reaction does not

fall in line with their anticipations, instead, decision makers employ a range of strategies, designed to negate the negative effect of losing. For example, research has indicated that negative events are more likely to initiate reasoning strategies than positive events; this process of reasoning minimises the experience of the negative effects (Taylor, 1991). The findings of Kermer et al. (2006) reveal that decision makers anticipated that losing would have a greater negative impact on their happiness than an equivalent win; whereas, in contrast, when the gambles were played and experienced by decision makers, the emotional impact was less than anticipated. This is suggested to occur as decision makers did not anticipate that they will be able to rationalise losing and not dwell on the loss (Kermer et al., 2006).

Building on the proposal made by Camerer (2005), loss aversion has been argued to occur as facing a potential loss triggers a different emotional response compared to facing a potential gain. Researchers have identified that the emotional response to winning and losing is reflected in neurological activation (Tom, Fox, Trepel & Poldrack, 2007). Tom et al. (2007) discovered that a range of brain areas, such as the mid brain dopaminergic system, had increased activation as the potential for gains increased; whereas, facing a potential loss resulted in decreased activation in many of the same areas of the decision maker's brain. Furthermore, research has shown that the extent to which individuals display loss averse preferences is associated with a diminishing neurological sensitivity to losses (Tom et al., 2007). The findings indicate that the extent to which individuals display loss averse preferences in their judgements may partially be accounted for by individual differences.

Moreover, additional research has highlighted further the neurological nature of loss-averse behaviour - Canessa et al. (2013) identified that the anticipation of losses reflected activation of both appetitive and aversive brain functions with a larger neural response for losses than gains. There was also found to be a link between individual differences and the structural properties of the activated brain areas, directly linked to loss aversion and low income earning. A case for individual differences in loss aversion is supported by research (Gächter, Johnson & Herrmann, 2007) revealing that the extent to which individuals display loss aversion is shaped by the decision-making context and a participant's level of experience. For example, women were found to be more loss averse than men; in addition, age and household income were all found to be positively associated with increased levels of loss aversion. Additionally, the level of a participant's educational attainment was found to decrease the extent to which the individual displayed loss aversion. Furthermore, the extent to which individuals were loss averse was associated with occupation type. For example, unemployed and blue-collar workers displayed greater levels of loss aversion compared to those in white collar or managerial occupations (Gächter et al., 2007). Further evidence of individual differences comes from Boyce, Wood and Ferguson (2016) examining levels of loss aversion displayed as a result of income and satisfaction. Specifically, the effect of an individual's satisfaction following a loss of income was not uniform, instead, an individual's level of conscientiousness was shown to be associated with the extent to which they were impacted by losses. Highly conscientious individuals displayed stronger reactions to a loss of income, compared to moderate or low conscientious individuals. Boyce et al. (2016) suggest that conscientious individuals may be more susceptible to loss aversion. As identified by Mueller and Plug (2006) conscientiousness was positively

associated with income and outcome orientation, indicating that conscientious individuals may be more vulnerable to changes to income leading to an increased aversion to losses. Whilst individual differences highlight the fluctuation in loss aversion between respondents, none the less, loss aversion was still evident across all the demographic groups.

An alternative account of loss aversion stems from decision by sampling, embedding loss aversion in the structure, nature and distribution of every day positive and negative experiences. This is supported by evidence that decision makers typically experience financial losses with a far greater frequency than they do financial gains (Stewart et al., 2006). Stewart and colleagues (2006) established that the distribution of credits made to current accounts follows a power law function; with a negative correlation between the frequency and size of credits. The same pattern is followed when examining debits from current accounts, however, the frequency of debits decreases as the value increases. Furthermore, more small debits were found to have been experienced compared to credits (Stewart et al., 2006). Decision by sampling suggests that the relative value of a decision prospect is not established in isolation, rather it is constructed with binary ordinal comparisons (e.g., more or less than). The outcome being considered is compared against a sample of similar experiences. Experiences drawn from memory are used to establish a rank position of the current outcome against the number of attributes drawn from memory that the outcome being considered is better or worse than. When considered in relation to the number of debits and credits made to current accounts, the authors (Stewart et al., 2006) found that there was a greater number of small credits or debits, compared to larger credits or debits. As a result of this distribution the same change in value at either end of the spectrum does not produce the same change in rank position. For

example, a unit change to the value of a smaller amount of money will result in a larger increase in relative rank position, compared to the same change in value if it occurred to a higher value. This is suggested to occur as decision makers have less experiences dealing with large values, so the number of potential comparisons is less, which reduces the potential increase in relative rank position. Applied to loss aversion, the evidence that (Stewart et al., 2006) more small debits (losses) than credits (gains) was exhibited is essential in explaining the increased aversion to losses compared to attraction to gains. Specifically, the relative rank position of the same sum of money is greater when framed as a loss compared to a gain; as there are more debits for a loss to be compared against than credits for a gain to be compared against. As a result, the greater relative rank position for losses than gains, resulted in loss averse preferences. The decision by sampling account of loss aversion is supported by experimental evidence from Walasek and Stewart (2015). Walasek and Stewart (2015) reveal that manipulating the range of gains and losses experienced by a decision maker could produce loss averse preferences, loss neutral preferences, and a reversal of loss averse preferences. Specifically, when decision makers experienced a sample of gambles, where the range of losses was greater than the range of gains, participants displayed loss averse preferences. In contrast, when more gains were experienced than losses, loss aversion was reversed. Finally, when the range of possible gains and losses was equal there was minimal evidence of loss averse preferences – respondents displayed loss neutrality. The results support the assumption that decision makers do not poses underlying preferences. For example, a stable aversion to losses, rather preferences occur as a function of the decision task, indicating that the ability to compare the decision-making task to external information influences decision maker's judgements.

2.1.2. Loss Aversion in Judged Feelings

Whilst loss aversion is exemplified by a disparity in how decision makers evaluate positive and negative outcomes, the preferences have principally been established with the monetary evaluation of gains and losses. Research examining loss aversion in relation to judged feelings towards winning or losing has provided mixed results. Some researchers have provided evidence suggesting that loss aversion does not occur when measuring judged feelings (Mellers, Schwartz, Ho & Ritov, 1997), whilst others have argued that loss aversion does occur with judged feelings (Hanrick, Van Dijk, van Beest, & Mersmann, 2007).

Mellers et al. (1997) suggest that the emotional response to an outcome, be it positive or negative, whilst connected to the utility of an outcome, is independent of the outcome itself. For example, the emotional response to an outcome is suggested to be contingent on the anticipated expectation of the outcome's occurrence. For example, winning £100 when you had a 1% chance of winning is welcomed more than receiving the same amount of money when you had a 99% chance of winning; whereas losing £100 pounds when you had a 1% chance of losing is more aggravating, due to the unexpected nature of the outcome, in contrast to losing the same amount of money when presented with a 99% chance of losing. These findings, and those of Mellers, Schwartz and Ritov (1999), indicate that when judging scenarios, or in fact, the outcome of a scenarios, the domain of decision-making is not the key factor in shaping the magnitude of feelings; rather, it is the decision maker's preparedness to deal with the outcome, which moderates a decision maker's judgement. Furthermore, when examining this proposal, the authors (Mellers et al., 1999) revealed that participants did not exhibit loss averse preferences when judging a mixed gamble, placing their feelings on a bipolar scale.

Hanrick et al. (2007) provide evidence indicating that loss aversion with judged feelings does not occur universally. Instead of loss aversion occurring for all monetary amounts, the authors found that judged feelings of loss aversion occurred only for large losses (e.g., €50), but not for smaller losses (e.g., €0.10); in fact, for smaller monetary amounts gains appeared to loom larger than losses. Specifically, the authors asked participants to judge how they felt in response to winning and losing a gamble, placing judgements on a bipolar scale, ranging from very unpleasant to very pleasant. Hanrick et al. (2007) propose that loss aversion is not felt for small losses, as decision makers happily accept a small gain, but equally are willing to discount small losses but not large losses. The authors (Hanrick et al., 2007) suggest that loss aversion is not present for smaller amounts of money for two reasons - decision makers are argued to be aware that small negative circumstances will have less of an impact than large negative events (as proposed by Wilson & Gilbert, 2005). Secondly, based on research coming from decision by sampling (Stewart et al., 2006), it is suggested that as decision makers have more experiences with smaller losses than larger losses, they are aware that smaller losses have less of an impact on their wellbeing. However, this explanation is in fact contradictory to the decision by sampling explanation of loss aversion. Specifically, as the decision by sampling account of loss aversion relies on the greater frequency of experienced losses than gains (Walasek & Stewart, 2015).

An alternative account of loss aversion with judged feelings is presented by McGraw et al. (2010). McGraw and colleagues (2010), argue that decision makers only display loss aversion, if the positive and negative feelings can be compared against each other. The proposal is made in light of theoretical accounts arguing for the separation of positive and negative affective states (Cacioppo & Bernston, 1994;

Larsen, McGraw & Cacioppo, 2001). Specifically, how a judgement is elicited can shape decision makers judgements, whether intensity-of-feelings judgement are placed on unipolar (see Figure 2) or bipolar scales (see Figure 3). The authors (McGraw et al., 2010) suggest that when a person considers the outcomes of their decision, typically they consider the impact within the same domain; for example, how a current loss compares against prior experiences of losing. As a result, decision makers are not predisposed to compare intensity of feelings judgements towards winning and losing, unless a comparison between positive and negative states is encouraged or facilitated. For example, loss aversion occurs with judgements made on unipolar scales, encouraging comparisons, whereas bipolar scales do not. Specifically, judgements made on unipolar scales are said to encourage comparisons as the scale is neutral, not framed in terms of a positive or negative outcome. Due to the neutrality of unipolar scales, gain and loss evaluations are placed in the same context for comparison. However, judgements made on bipolar scales provide specific halves for gain and loss judgements (negative and positive halves); judgements are not placed in the same context for comparison. Moreover, as judgements are not placed in the same context for comparison, gains and losses are not compared, and loss aversion is not experienced.

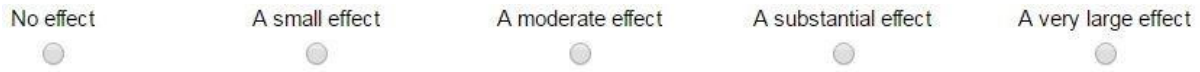


Figure 2. Unipolar intensity-of-feelings scale.

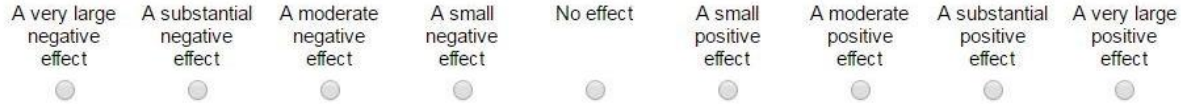


Figure 3. Bipolar intensity-of-feelings scale.

The account for the comparison of positive and negative affective experiences is informed by the evaluative space model (ESM; Cacioppo & Bernston, 1994; Larsen, et al., 2001). The ESM proposes that positive and negative affective experiences are distinct and separate, as a result, positive and negative affective experiences are not automatically compared against each other. In other words, the experience of a positive affective state cannot be characterised as the absence of a negative affective state (Cacioppo & Bernston, 1994). This argument is supported by further research revealing that positive and negative affective states can be experienced simultaneously (Larsen et al., 2001).

Early research examining loss aversion with judged feelings has typically relied on bipolar scales to elicit judgements (e.g., Mellers et al., 1997) indicating that loss aversion does not occur with intensity of feelings judgements. However, in light of the proposed nature of loss aversion (driven by the comparison of gains against losses) and the proposed nature of affective experiences, McGraw and colleagues (2010) have argued that past research (Mellers et al., 1997) does not indicate an absence of loss averse preferences with judged feelings, rather for loss aversion to be displayed with judged feelings, the judgement of feelings towards winning and losing have to be placed in the same context for comparison. In support of this argument, McGraw et al. (2010) show that judgements of feelings can produce loss averse preferences. However, this only occurs when gain and loss judgements are placed in the same context for comparison (e.g., unipolar scales; see Figure 2). The use of unipolar scales with neutral scale points (not specific to either winning or losing) means that judgements of feelings towards winning and losing are placed on the same positions on the scale. Placing feelings of winning and losing on the same points on the scale, encouraging a comparison between the two giving rise to loss

averse preferences; whereas, with bipolar scales, as gain and loss judgements of feelings are separated (on the positive and negative halves of the scale), no comparison between the intensity of feelings towards winning and losing occurs. Accordingly, as comparisons cannot occur, participants do not display loss aversion.

Moreover, Mukherjee, Sahay, Pammi and Srinivasan (2017) have replicated the findings of McGraw et al. (2010), reiterating that loss averse judgements of feelings occur with judgements made on unipolar scales. However, loss aversion with judged feelings was shown not only to be contingent on the ability of decision makers to compare gains and losses, but rather, the magnitude of the outcomes being considered was also found to shape loss aversion in line with the findings of Hanrick et al. (2007). Moreover, the results revealed in contrast to the patterns of loss aversion, that for smaller amounts gains loomed larger than losses. Additionally, the authors (Hanrick et al., 2007) suggest that the relative magnitude of losses or gains plays an important role in shaping responses. Specifically, when a loss was anchored against a larger value presented as a relatively small change from a larger reference point, decision makers did not display loss aversion, irrespectively of the magnitude of the loss they were considering (Mukherjee et al., 2017). The findings indicate that the presence of loss aversion is also dependent on comparisons between the decision or task and the judgements, in addition to the comparison between gains and losses.

In summary, McGraw and colleagues (2010) suggest that loss aversion is fuelled by the ability of decision makers to compare their feelings of winning and losing. The potential to compare feelings of winning and losing accounts for the variance in preferences between unipolar and bipolar scales. However, experimental evidence supporting this proposal, utilised an incommensurable experimental

method (see Figure 4); specifically, employing intensity of feelings judgements to evaluate a monetary task. In contrast, alternative explanations of loss aversion emphasise the importance of decision makers being able to make comparisons of the task against their previous experiences (Stewart et al., 2006). Equally, research has emphasised the potential of commensurable content to bias behaviour (Slovic & MacPhillamy, 1974).

Based on past research it is hypothesised that the commensurability between the decision-making task and judgement content will fuel behavioural biases in this instance loss aversion. Specifically, research has emphasised that (Stewart et al., 2006) the occurrence of loss aversion is dependent on decision makers ability to compare the current task to past experiences i.e. loss aversion is dependent on comparability. In addition, Slovic and MacPhillamy's (1974) work emphasising the role which commensurability plays in encouraging behavioural biases. Commensurability is anticipated to allow decision makers to compare the decision-making task and judgement with commensurable content, producing loss averse preferences. Commensurability is expected to encourage loss averse preferences as it will allow decision makers to make comparisons both within the task and externally, as it has been emphasised previously as a principle driving force of loss aversion (Stewart et al., 2006). Moreover, this proposal is expected to occur irrespectively of decision maker's ability to compare their feelings towards winning and losing. This prediction stands in contrast to McGraw and colleagues' arguments for the role of contextual comparisons between gains and losses as the impetus for loss averse preferences (2010). With commensurable task and judgement content (CTJC), loss aversion is expected to occur independently of whether judgements are placed on unipolar or bipolar scales for comparison. An example of decision-making

scenario with commensurable task and judgement content and an alternative with incommensurable task and judgement content is outlined below in figure 4. On the left hand side of figure 4 you can see the incommensurable task and judgment – a monetary gamble evaluated on an incommensurable dimension intensity of feelings. Whereas on the right hand side you there is a commensurable task, a monetary task– a monetary gamble evaluated in terms of monetary worth.

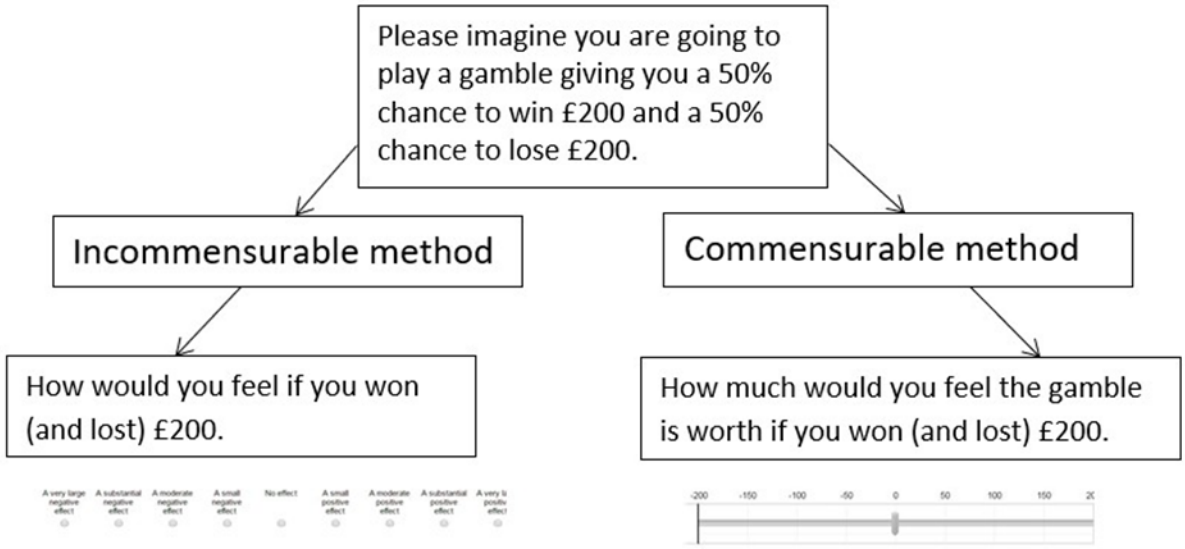


Figure 4. Commensurability mapping.

2.2. Experiment 1: The Effect of Commensurable and Incommensurable Task Judgement Content on Loss Aversion across Unipolar and Bipolar Scales.

2.2.1. Method

2.2.1.1. Participants

A research company with over 20 years experience recruiting participants for academic research was used to recruit the participants. There was no specific recruitment criteria, aside from that the participants were over 18 years of age. The only exclusion criteria used was that respondents completed the study or the batch

of studies in the block. Participants were recruited within a two-week block and the number of participants recruited was dictated by the time constraints.

Participants were treated in accordance with the ethical standards of the British Psychological Society (2013). Participants were recruited with online recruitment panels and rewarded for their participation (£1). A two-week window was set to collect the data; after the 14 days, 183 participants (99 female) had been recruited with a mean age of 47 (*SD* = 13.34).

2.2.1.2. Design and Materials

An independent-measures 2 x 2 design was used with the independent variables scale type (unipolar or bipolar) task and judgement content commensurability (commensurable: monetary task and monetary worth judgements, or incommensurable: monetary task and intensity-of-feelings judgements), with the dependent variable loss aversion.

Participants' responses were coded with the method developed by McGraw et al. (2010); judgements were coded as loss-averse (loss judgement > gain judgement), loss-averse neutral (loss judgement = gain judgement) and non-loss-averse (loss judgement < gain judgement).

A mixed (gain/loss) gamble was used, giving participants a 50% chance of winning £200 and a 50% chance of losing £200:

Please imagine you are going to play a single gamble in which you have a 50% chance of winning £200 and a 50% chance of losing £200.

In the commensurable (task-judgement) conditions participants were asked how much they felt the gamble would be worth if they won £200 and if they lost £200, whereas in the incommensurable (task-judgement) conditions participants were asked how they would feel if they won £200 and if they lost £200.

In contrast, to McGraw et al.'s (2010) methodological approach, both commensurable monetary worth unipolar and bipolar scales were used, as well as incommensurable intensity of feelings unipolar and bipolar scales. The incommensurable unipolar scale (see Figure 2) ranged from no effect to a very large effect, and the incommensurable bipolar scale (see Figure 3) ranged from a very large negative effect to a very large positive effect. The commensurable unipolar-scale condition (see Figures 5a and 5b) used monetary-worth adjectives (neither positive or negative values) and the commensurable bipolar-scale condition employed numerical values and ranged from -£200 to £200 (see Figures 6a and 6b).

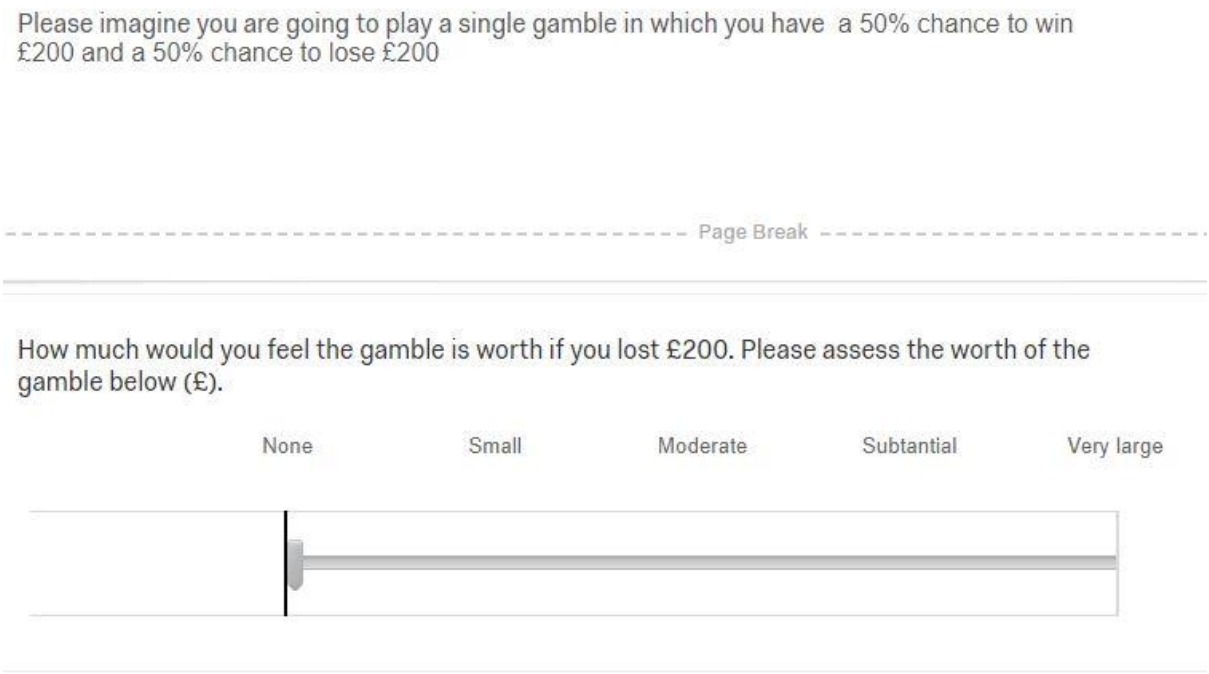


Figure 5a. CTJC unipolar scales (negative gamble outcome).

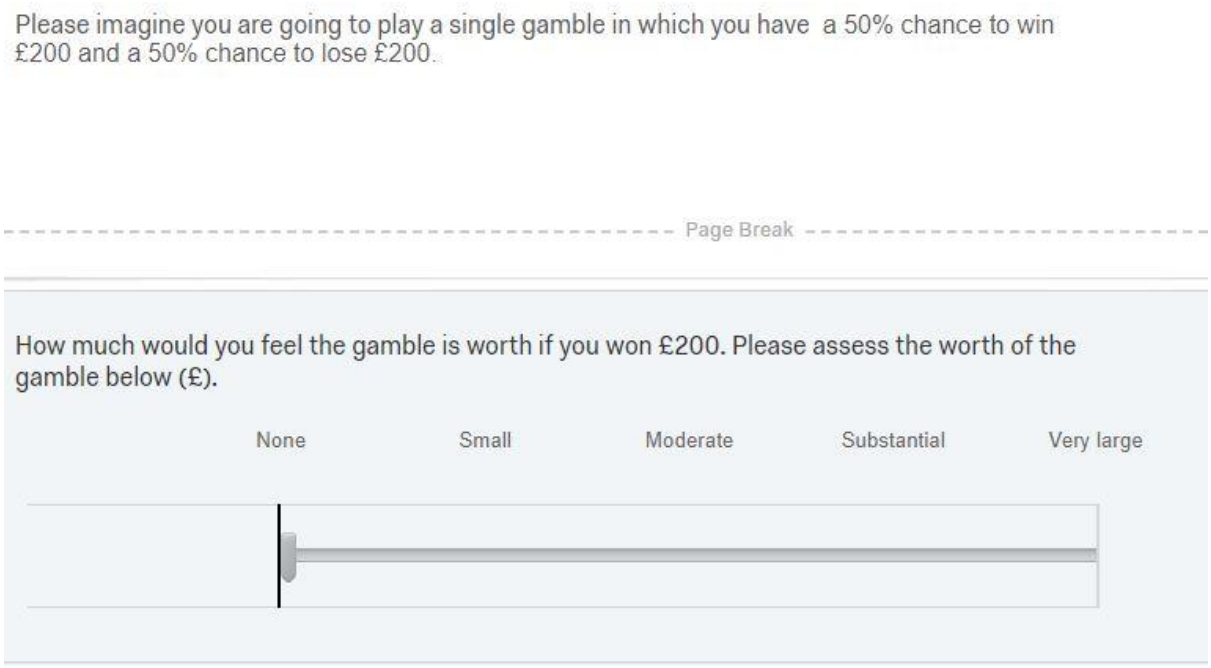


Figure 5b. CTJC unipolar scales (positive gamble outcome).

Figure 6a. CTJC bipolar scale (negative gamble outcome).

Figure 6b. CTJC bipolar scale (positive gamble outcome).

2.2.1.3. Procedure

Once participants had been provided with ethics information, informed consent was obtained, and demographic information was collected. Participants were first introduced to the hypothetical gamble. Participants were introduced to the hypothetical monetary gamble task and asked to judge the gamble in response to both winning and losing. In the commensurable (task-judgement) unipolar and bipolar conditions participants were asked how much they felt the gamble would be worth if they won £200 and if they lost £200, whereas in the incommensurable (task-judgement) unipolar and bipolar conditions participants were asked how they would feel if they won £200 and how they would feel if they lost £200. Following both judgements participants were thanked for their participation and presented with debriefing information.

2.2.2. Results and Discussion

Mann Whitney U tests were used to analyse the statistical significance of the results. Specifically, this form of analysis was chosen due to the non-parametric and ordinal nature of the dependent variable, was the respondent (loss-averse, loss-averse neutral or non-loss-averse responses).

There was no significant difference found in the proportion of non-loss-averse (unipolar = 31.2%, bipolar = 43.3%), loss-averse neutral (unipolar = 25.8%, bipolar = 23.3%) and loss-averse (unipolar = 43.0%, bipolar = 33.3%) judgements made on either unipolar or bipolar scales, U = 3616.50, p = .090, z = -1.69, r = -.13. Additionally, there was also no significant difference in the proportion of non-loss-averse (commensurable = 36.8%, incommensurable = 37.5%), loss-averse neutral (commensurable = 13.7%, incommensurable = 36.4%) and loss-averse (commensurable = 49.5%, incommensurable = 26.1%) judgements made on either the commensurable or incommensurable conditions, U = 3550.00, p = .060, z = -1.88, r = -.14.

Follow-up, pairwise comparisons were conducted to test the effect of task and judgement content commensurability within each scale type. No significant difference was found between judgements made on unipolar scales with CTJC (non-loss-averse = 41.7%, loss-averse neutral = 6.3% and loss-averse = 52.1%) and on unipolar scales with incommensurable task and judgement content (non-loss-averse = 20.0%, loss-averse neutral = 46.7% and loss-averse = 33.3%), U = 1074.00, p = .961, z = -0.49, r = -.01. However, a significant difference between judgements made on bipolar scales with CTJC (non-loss-averse 31.9%, loss-averse neutral 21.3% and loss-averse 46.8%) and without CTJC was found (non-loss-averse 55.8%, loss-

averse neutral 25.6% and loss-averse 18.6%), U = 688.00, p = .005, z = -2.80, r = -.30.

As predicted, the results reveal an increase in the proportion of loss-averse judgements made on bipolar scales with CTJC, compared to a decrease in the proportion of loss-averse judgements made on bipolar scales with incommensurable task judgement content (see Figure 7).

Furthermore, as expected, there was no significant difference between judgements made on bipolar and unipolar scales with CTJC, U = 1110.00, p = .883, z = -0.15, r = -.02. However (see McGraw et al., 2010), there was a significant difference between judgements made on bipolar and unipolar scales with incommensurable task and judgement content, U = 622.50, p = .002, z = -3.07, r = -.33, with a greater proportion of loss-averse judgements made on unipolar scales (see Figure 7).

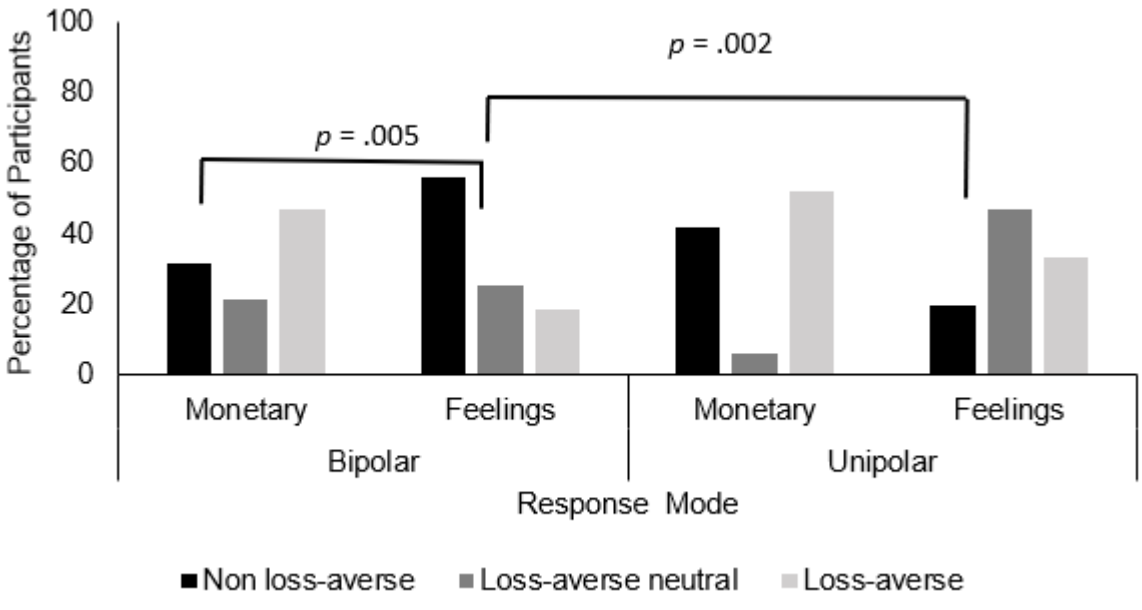


Figure 7. Non-loss-averse, loss-averse neutral and loss-averse judgements made on unipolar and bipolar scales with commensurable or incommensurable task and judgement content (Experiment 1).

In support of the hypothesis that commensurability would increase the proportion of loss aversion, judgements made on bipolar scales with CTJC encouraged loss-averse responses. Specifically, the results revealed that respondents' loss-averse judgements were not influenced by the type of scale (unipolar/bipolar) the judgement was made on, when the task and judgement content was commensurable; whereas, when the task and judgement content was incommensurable, the effect of contextual comparability reported by McGraw et al. (2010) was confirmed. Specifically, the proportion of loss-averse judgements made on unipolar scales was significantly greater than respondents' loss-averse judgements on bipolar scales.

2.3. Experiment 2: The Effect of Low, Medium and High Commensurable Task Judgement Content on Loss Aversion

With the results of experiment, one revealing an effect of task-judgement content commensurability (commensurable: money and money; incommensurable: money and feelings) on the proportion of loss-averse judgements. The second experiment utilised monetary task and judgements; however, the level of commensurability between the task and judgement was manipulated. The high commensurability condition used bipolar scales with CTJC from experiment one and made judgements in response to both winning and losing. The medium CTJC condition required participants to make two judgements on polarity-specific unipolar scales, however (specific to positive or negative outcome; see Figures 8a and 8b), these were incommensurable to the bipolar nature of the gamble (encompassing both positive and negative outcomes). The low CTJC condition was further expected to reduce commensurability between the task and judgement. CTJC was reduced in the low condition by offering one monetary judgement of the total worth of the

gamble, in contrast to the incommensurable bipolar nature of the gamble reflecting opportunities to win and lose. It was hypothesised that reducing the commensurability between the decision-making task and judgement would lead to a reduction of loss averse behaviours – preventing comparisons between the decision-making task and judgement. Specifically, preventing these comparisons will also prevent decision makers from viewing the current task as a whole (task and judgement), and in turn, viewing the task in the context of their past experiences, and as discussed, comparisons between current and past decisions have been attributed to promote loss averse behaviour.

Figure 8a. Medium commensurability: negative half of the split polarity scale.

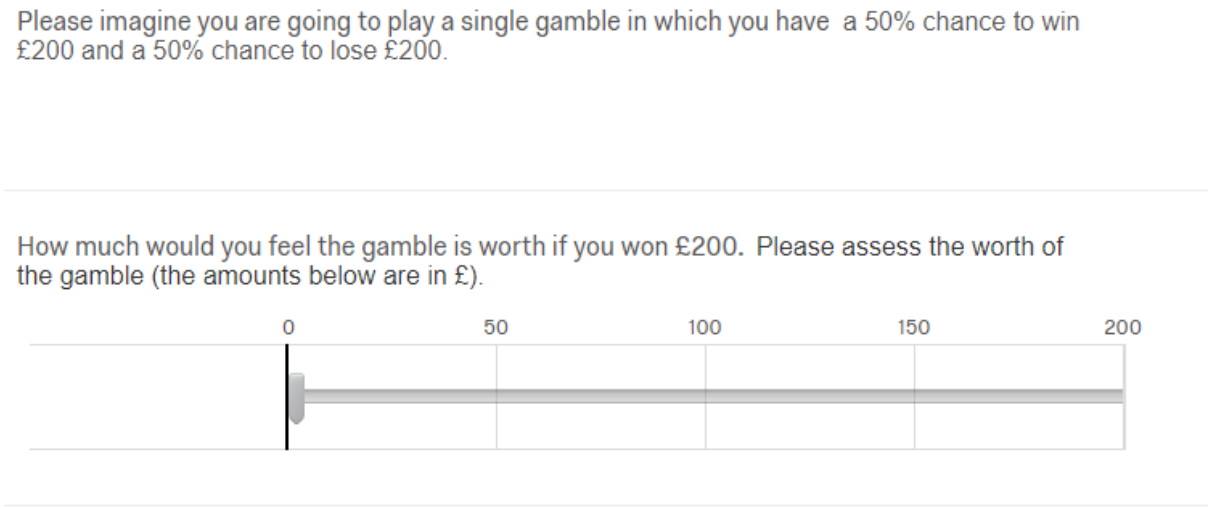


Figure 8b. Medium commensurability: positive half of the split polarity scale.

2.3.1. Method

2.3.1.1. Participants

A research company with over 20 years experience recruiting participants for academic research was used to recruit the participants. There were no specific recruitment criteria, aside from that the participants were over 18 years of age. The only exclusion criteria used was that respondents completed the study or the batch of studies in the block. Participants were recruited within a two week block and the number of participants recruited was dictated by the time constraints.

Participants were recruited with online recruitment panels and rewarded for their participation (£1). A two-week window was set for data collection; after 14 days, 107 participants had been recruited (48 females) with a mean age of 50 (*SD* = 13.96).

2.3.1.2. Design and Materials

An independent-measures one-factor design was used with the independent variable level of CTJC (low, medium and high), and the dependent variable loss

aversion. A mixed gamble was used which offered a 50% chance of winning £200 and a 50% chance of losing £200. In the medium and high CTJC conditions responses were coded following the method outlined in experiment one. However, in the low CTJC condition, as only one judgement was made, judgements falling within the range of -£200 to £-1 were coded as loss-averse, judgements of £0 were coded as loss-averse neutral and judgements ranging £1 to £200 were coded as non-loss-averse.

In the low CTJC condition participants made one judgement of the gamble's total worth, encompassing the potential to both win and lose. In the medium and high CTJC conditions participants were asked how much they felt the gamble was worth if they won £200 and if they lost £200. In the low and high CTJC conditions, bipolar monetary worth scales were used (see Figures 6a and 6b). However, in the medium-CTJC condition two different unipolar scales were used (see Figures 8a and 8b) specific to losing (-£200 to £0) and winning (£0 to £200).

2.3.1.3. Procedure

Once the participants had been provided with ethics information, informed consent was obtained, and demographic information was collected. Participants were then introduced to the hypothetical gamble. In the low CTJC condition participants were asked to evaluate how much they felt the gamble was worth as a whole, placing a judgement on a single bipolar monetary worth scale. In the medium and high CTJC conditions participants made two judgements in response to winning and losing. In the medium CTJC condition participants made judgements on two different polarity-specific unipolar scales (specific to positive or negative outcomes), these were incommensurable to the bipolar nature of the gamble (see Figures 8a and 8b). Finally, in the high CTJC condition participants made judgements on bipolar

monetary worth scales (see Figures 8a and 8b). Following both judgements participants were thanked for their participation and presented with debriefing information.

2.3.2. Results and Discussion

A Chi square test was chosen due to the type of data (ordinal) being analysed and the design of the experiment. Specifically, a Chi square test was chosen as the dependent variable was ordinal and collated into frequency counts. Secondly a Chi square test was chosen as the experiment only had one independent variable making it suitable to analyse with one Chi square test and to further compare the results with a simple frequency table.

A significant difference was found in the proportion of loss-averse judgements made across the three levels of CTJC, $\chi^2(2) = 14.50$, $w = .37$, $p = .001$ (see Figure 9). Additional analysis identified that there was no significant difference between the low (non-loss-averse = 77.1%, loss-averse neutral = 11.4% and loss-averse = 11.4%) and medium (non-loss-averse = 60.5%, loss-averse neutral = 26.3% and loss-averse = 13.2%) CTJC conditions, $U = 564.50$, $p = .175$, $z = -1.36$, $r = -.16$. There was however, a significant difference between the low and high (non-loss-averse = 32.4%, loss-averse neutral = 32.4% and loss-averse = 35.3%) CTJC conditions ($U = 326.50$, $p < .001$, $z = -3.58$, $r = -.43$), a greater proportion of loss-averse judgements were made in the high CTJC condition. Moreover, there was also a significant difference between the medium and the high CTJC conditions ($U = 431.50$, $p = .009$, $z = -2.61$, $r = -.31$), revealing a greater proportion of loss-averse judgements were made in the high CTJC condition.

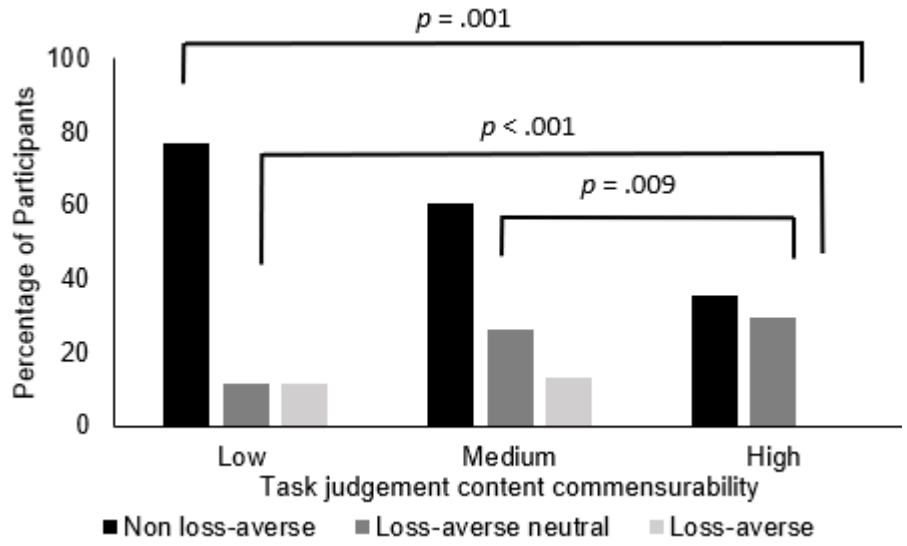


Figure 9. Non-loss-averse, loss-averse neutral and loss-averse judgements made in with low, medium and high commensurability between the task and judgement content.

In the second experiment, the implications of the CTJC, established in Experiment 1, have been reiterated. Accordingly, it was found that the respondents' loss-averse judgements in the high CTJC condition were significantly greater than respondents' loss-averse judgements in the low and medium CTJC conditions.

2.4. Experiment 3: Impeding Task Judgement Content Commensurability

In contrast to the first and second experiments, in the third experiment the commensurability of the monetary task and judgement content was impeded. Specifically, impeding commensurability implies not that the two options being compared are incommensurable per se in a traditional sense, but rather that a task of barrier is placed between the stages of the task, preventing comparisons making the task as a whole incommensurable. Respondents were given distraction tasks between a commensurable monetary task and judgement. It was anticipated that impeding commensurability between task and judgement content would lead to a

reduction in the proportion of loss-averse judgements made on bipolar scales, whereas judgements made on unipolar scales, as in experiment one, were not anticipated to be impacted by impeding commensurability between the task and judgement as contextual unipolar comparisons could still occur (McGraw et al., 2010).

2.4.1. Method

2.4.1.1. Participants

A research company with over 20 years experience recruiting participants for academic research was used to recruit the participants. There were no specific recruitment criteria, aside from that the participants were over 18 years of age. The only exclusion criteria used was that respondents completed the study or the batch of studies in the block. Participants were recruited within a two-week block and the number of participants recruited was dictated by the time constraints.

Participants were recruited with online recruitment panels and rewarded for their participation (£1). A two-week window was set for data collection; after the 14 days, 223 participants had been recruited (126 females) with a mean age of 52 (*SD* = 13.02).

2.4.1.2. Design and Materials

A 2 x 2 independent-measures design was used with the independent variables, access to CTJC (impeded or unimpeded) and scale type (bipolar or unipolar) with loss aversion as a dependent variable. Responses were coded following the method outlined in experiment 1. A mixed gamble was used with a 50% chance of winning £200 and a 50% chance of losing £200.

Following the hypothetical gamble, participants placed their judgements on monetary unipolar or bipolar scales, specifically, how much they felt the gamble was

worth if they won £200 and if they lost £200. However, in the impeded conditions, prior to making judgements, participants completed 10 captcha tasks (see Figure 10) presented individually. The captcha tasks required participants to read, then enter the combination of letters and numbers into a text entry box. Participants could not continue to the judgement of the gamble without first entering the information correctly for all 10 captcha tasks. The unipolar scales with CTJC (see Figures 5a and 5b) employed monetary worth adjectives and the bipolar scales with CTJC employed numerical values and ranged from -£200 to £200 (see Figure 6).

Figure 10. Captcha task.

2.4.1.3. Procedure

Once participants had been provided with ethics information, informed consent was obtained, and demographic information was collected, participants were then introduced to the hypothetical gamble. In the impeded condition participants then completed 10 captcha tasks. Participants were then asked to evaluate the gamble in response to both winning and losing. Following this, participants were presented with debriefing information and thanked for their participation.

2.4.2. Results and Discussion

Mann Whitney U tests were used to analyse the statistical significance of the results. Specifically, this form of analysis was chosen due to the non-parametric and ordinal nature of the dependent variable (loss-averse, loss-averse neutral or non-loss-averse responses).

No significant difference in the proportion of loss-averse judgements was found between the unipolar (non-loss-averse = 40.6%, loss-averse neutral = 3.8% and loss-averse = 55.7%) and bipolar (non-loss-averse = 36.8%, loss-averse neutral = 29.1% and loss-averse = 34.2%) scales was found, $U = 5514.50$, $p = .122$, $z = -1.547$, $r = -.10$. Additionally, impeding commensurability between task and judgement content did not influence the proportion of respondents who displayed loss averse judgements, $U = 5656.50$, $p = .208$, $z = -1.26$, $r = -.08$ (impeded non-loss-averse = 41.4%, loss-averse neutral = 18.9% and loss-averse = 39.6% and unimpeded non-loss-averse = 35.7%, loss-averse neutral = 15.2% and loss-averse = 49.1%).

It is argued that the effect of impeding commensurability between the task and judgement content is dependent on the scale type; to test this effect, pairwise comparisons were conducted. Consistent with the findings of experiment one, when commensurability between task and judgement content was not impeded, there was no difference in the proportion of loss-averse judgements made on unipolar (non-loss-averse = 41.8%, loss-averse neutral = 3.6% and loss-averse = 54.5%) or bipolar scales (non-loss-averse = 29.8%, loss-averse neutral = 26.3% and loss-averse = 43.9%) scales, $U = 1555.50$, $p = .939$, $z = -0.08$, $r = -.01$ (see Figure 8); whereas, when commensurability between the task and judgement content was impeded respondents made significantly more loss-averse judgements on unipolar scales

(non-loss-averse = 39.2%, loss-averse neutral = 3.9% and loss-averse = 56.9%) compared to judgements made on bipolar scales (non-loss-averse = 43.3%, loss-averse neutral = 31.7% and loss-averse = 25.0%), U = 1206.50, p = .039, z = -2.06, r = -.20 (see Figure 8). Furthermore, there was no significant difference between judgements made on unipolar scales irrespectively of whether commensurability was impeded or unimpeded, U = 1367.00, p = .797, z = -0.257, r = -.03 (see Figure 11). In contrast, with judgements made on bipolar scales, significantly more loss-averse judgements were made when commensurability between the task and judgement content was not impeded compared to when it was impeded, U = 1354.00, p = .039, z = -2.06, r = -.20 (see Figure 11).

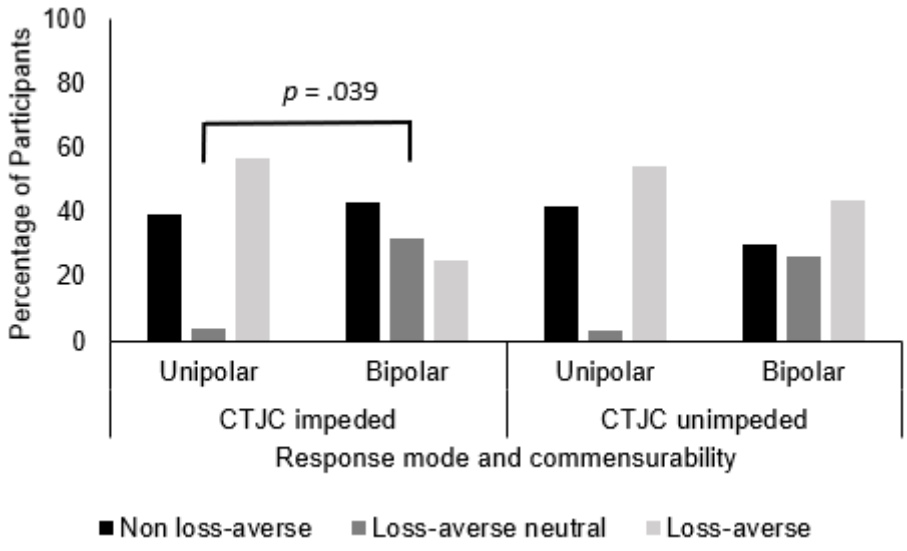


Figure 11. Non-loss-averse, loss-averse neutral and loss-averse judgements made on unipolar and bipolar monetary worth scales with commensurability between the task and judgement content impeded and unimpeded.

As anticipated, impeding CTJC on the bipolar scales led to a significant decline in the proportion of loss-averse judgements. In contrast with unipolar scales,

when CTJC between the task and judgement content was impeded, there was no reduction in the proportion of respondents' loss-averse judgements.

2.5. Experiment 4: The Effect of Incommensurable Task and Judgement Languages on Loss Aversion

To further examine the effect of commensurability between the decision-making task and judgement on respondents' rates of loss aversion, commensurability was manipulated by presenting the task and judgement in two different languages. The gamble task was presented in Bulgarian, incommensurable to the judgement questions presented in English (none of the recruited participants had experience or knowledge of the Cyrillic alphabet and Slavic languages). This created incommensurability, as the task and gamble where presented in different formats not directly comparable, as the participants who were recruited did have the ability to compare between the tasks. It was anticipated that incommensurability between the gamble task (in Bulgarian) and monetary-judgement (in English) would result in a reduction of respondents' rates of loss aversion on bipolar scales but not on unipolar scales. Specifically, as with unipolar scales gain and loss judgements could still be contextually compared producing loss-averse judgements leading to loss aversion.

2.5.1. Method

2.5.1.1. Participants

A research company with over 20 years experience recruiting participants for academic research was used to recruit the participants. There were no specific recruitment criteria, aside from that the participants were over 18 years of age and that they did not have experience with Cyrillic alphabet and Slavic languages. The only exclusion criteria used was that respondents completed the study or the batch

of studies in the block. Participants were recruited within a two-week block and the number of participants recruited was dictated by the time constraints.

Participants were recruited using online recruitment panels and were rewarded for their participation (£1). A two-week window was set to collect the data; after the 14 days, 121 participants (78 females) with a mean age of 50 (*SD* = 12.05) were recruited.

2.5.1.2. Design and Materials

An independent-measures 2 × 2 design was used in the experiment (scale type: unipolar or bipolar and commensurability between the task and judgement language: commensurable gamble task [in English] and judgement questions [in English] or incommensurable gamble task [in Bulgarian] and judgement questions [in English]). The dependent variable was the respondents' rates of loss aversion. The responses were coded following the method outlined in experiment one.

A mixed (gain/loss) gamble task was used giving participants a 50% chance to win £200 and a 50% chance to lose £200, which was presented either in English (commensurable gamble task and judgement language) or Bulgarian languages (incommensurable gamble task and judgement language). Participants were then asked to make two judgements (loss and gain domains) – judging the worth of the gamble (how much they felt the gamble was worth if they won/lost £200 presented in the English language for both commensurable and incommensurable tasks). The judgements were made on either unipolar (see Figure 2) or bipolar monetary worth scales (see Figure 3).

2.5.1.3. Procedure

All participants were introduced to a hypothetical gamble task and asked to judge the gamble in response to winning and losing. A mixed (gain/loss) gamble task

was used giving participants a 50% chance of winning £200 and a 50% chance of losing £200, which was presented in either the English language (commensurable gamble task and judgement language) or the Bulgarian language (incommensurable gamble task and judgement language [Please imagine you are going to play a single gamble in which you have a петдесет процента шанс да спечелиш двеста лири и петдесет процента шанс да загубиш двеста лири]). Participants where then asked two judgement questions (loss and gain domains) – to judge the worth of the gamble (how much they felt the gamble was worth if they won/lost £200 in the English language for both commensurable and incommensurable tasks). Judgements were made on either unipolar (see Figure 2) or bipolar scales with CTJC.

2.5.2. Results and Discussion

Mann Whitney U tests were used to analyse the statistical significance of the results. Specifically, this form of analysis was chosen due to the non-parametric and ordinal nature of the dependent variable (loss-averse, loss-averse neutral or non-loss-averse responses).

No significant difference between the rate of loss-averse judgements made on unipolar (non-loss-averse = 44.1%, loss-averse neutral = 1.7% and loss-averse = 54.2%) and bipolar (non-loss-averse = 43.5%, loss-averse neutral = 14.5% and loss-averse = 41.9%) scales, $U = 1707.50$, $p = .483$, $z = -0.70$, $r = -.06$ was identified. However, there was a significant effect of commensurability between the task and judgement languages (commensurable - English [non-loss-averse = 34.4%, loss-averse neutral = 7.8% and loss-averse = 57.8%] or incommensurable - Bulgarian [non-loss-averse = 54.4%, loss-averse neutral = 8.8% and loss-averse = 36.8%]) on the proportion of loss-averse judgements, $U = 1419.00$, $p = .019$, $z = -2.34$, $r = -.21$.

As it was hypothesised that the effect of commensurability between the task and judgement language would differ between scale types unipolar or bipolar, pairwise comparisons were conducted as a follow-up. No significant difference in the rate of loss-averse judgements made between the commensurable English task (non-loss-averse = 37.5%, loss-averse neutral = 0.0% and loss-averse = 62.5%) and the incommensurable Bulgarian task (non-loss-averse = 51.9%, loss-averse neutral = 3.7% and loss-averse = 44.4%) judged on unipolar scales, $U = 360.00$, $p = .207$, $z = -1.26$, $r = -.16$ (see Figure 12) was found. However, there was a significant difference in the rate of loss-averse judgements made between the commensurable English task (non-loss-averse = 31.3%, loss-averse neutral = 15.6% and loss-averse = 53.1%) and the incommensurable Bulgarian task (non-loss-averse = 56.7%, loss-averse neutral = 13.3% and loss-averse = 30.0%) judged on bipolar scales: more loss-averse judgements were made in response to gambles presented in English, $U = 346.50$, $p = .040$, $z = -2.05$, $r = -.26$ (see Figure 12). Furthermore, consistent with the results of the first experiment, there was found to be a significant difference between unipolar and bipolar judgements made in response to the commensurable English task, $U = 494.00$, $p = .782$, $z = -0.28$, $r = -.04$ (see Figure 12). Specifically, the difference between unipolar and bipolar judgements made in response to the incommensurable Bulgarian task was not significant, $U = 366.00$, $p = .483$, $z = -0.70$, $r = -.09$ gambles (see Figure 12).

The results revealed that respondents' judgements made on bipolar scales with incommensurable task and judgement languages were less loss-averse than judgements made with commensurable task and judgement languages. Moreover, in line with earlier experiments, it was discovered that with unipolar scales, the

commensurability between the task and judgement languages did not impact respondents' rates of loss aversion.

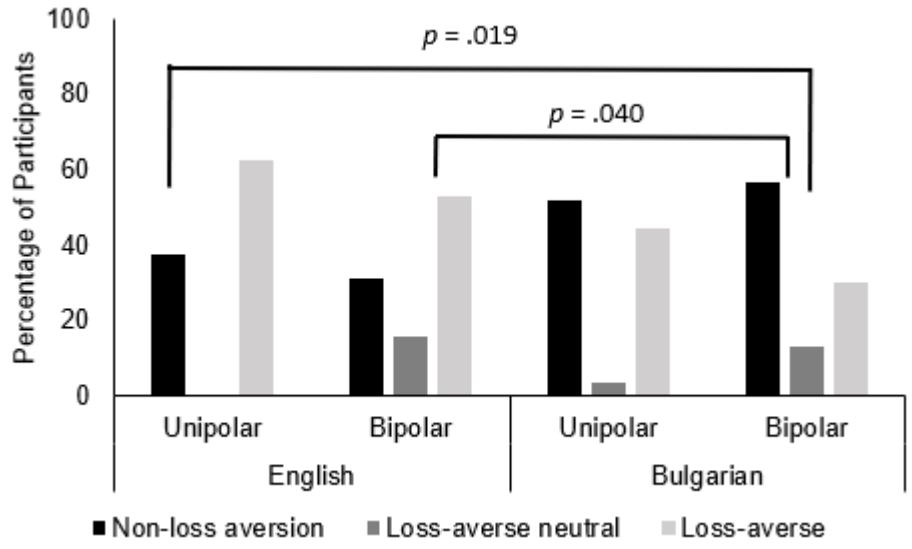


Figure 12. Non-loss-averse, loss-averse neutral and loss-averse judgements made in with low, medium and high commensurability between the task and judgement content.

2.6. General Discussion

The four experiments examined the theoretical proposal that loss-averse behaviour is facilitated by commensurability between the decision-making task and judgement content. The experimental findings have shown that CTJC can produce loss aversion. Specifically, CTJC increased respondents' propensity for loss-averse judgements. Whilst theoretical proposals on commensurability have already been made (e.g., Vlaev, 2011; Vlaev, et al., 2011), these have not examined the validity of commensurability as a predictor of decision-making behaviour, specifically, loss aversion. In addition, past research has emphasised that decision makers are unable to make comparisons between different (e.g., incommensurable) stimuli and decision options (Kusev et al., 2009; Stewart et al., 2005; Vlaev et al., 2011; Vlaev et al.,

2011). Moreover, in contrast to McGraw et al. (2010), it has been shown that incommensurable task and judgement content (and not the absence of contextual unipolar comparisons) produces a reduction in loss-averse judgements. McGraw et al.'s (2010) results revealed an increase in loss-averse judgements (intensity-of-feelings). However, this only occurred when gain/loss judgements could be contextually compared on unipolar scales; with the first unipolar judgement creating the context for the second unipolar judgement. This explanation is supported by the evaluative space model (Cacioppo & Bernston, 1994), as judgements of affective experiences are suggested to be made on separate unipolar scales, as both judgements are made on neutral unipolar scales. However, the evaluative space model (Cacioppo & Bernston, 1994) claims that judgements of affective experiences made on bipolar scales prevent comparisons. Comparisons are suggested to be prevented by judgements made on bipolar scales, as judgements are made on opposing sides of the bipolar scale, isolating positive and negative experiences. Yet, the incommensurable task and judgement method used by McGraw et al. (2010) (monetary gamble task that is judged with intensity of feelings scales) was, in fact, found to prevent participants from comparing the content of the gamble task and the judgement.

Chapter 3: Commensurability and Context with Non-risky Decision-Making

3.1. Introduction

Multi attribute decision-making refers to decisions that require a decision maker to distinguish between options each represented by more than one attribute. For example, an orange assigned two attribute values - price and taste. Research examining multi attribute decision-making has been applied to examine context effects; specifically, how preferences change or are altered by the addition of a third option to the choice set (for example, the attraction and compromise effects; Simonson & Tversky, 1992; Simonson, 1989). The compromise effect is a phenomenon, where a third (compromise) option (which falls on both attributes between the two initial options under consideration) added to a choice set is chosen with a disproportionately high frequency, compared to the two initial options under consideration (Simonson, 1989). The attraction effect is a phenomenon where the addition of a decoy option to a choice set leads to the selection of the target option over the competitor. Specifically, the decoy option is asymmetrically dominated by the target option and produces a change in selection preferences for the target option over the competitor with the distribution of selection changing from 50/50 for the target and competitor; to with the presence of the decoy option, an overwhelming preference for the target option (Huber et al., 1982; Huber & Puto, 1983).

3.1.1. Normative Assumptions in Multi Attribute Choice

The independence axiom, whilst stemming from risky utilitarian decision-making theory, is still relevant and readily applicable to theories of multi attribute decision-making. For example, the addition of an option to a choice set that is irrelevant (not offering any additional benefit over the two initial options under consideration) should not alter a decision maker's preferences. The premise behind the independence axiom is that a choice should be made independently of whether

an irrelevant alternative option is or is not present in the choice set (von Neumann & Morgenstern, 1953). Another consideration proposed by McFadden (1973) is the assumption of proportionality. The assumption of proportionality proposes that when an additional alternative is added to the choice set, the decline in market share of the original options should become the market share of the new alternative under consideration. In other words, if the options under consideration each had an initial 50% share, reduced to a combined 50% share, then the new option should possess a 50% share (McFadden, 1973). Furthermore, the assumption of regularity builds on the assumption of proportionality (Tversky, 1972; Luce, 1977). Specifically, the introduction of an additional alternative to a choice set should not lead to an increase in the proportion of decision makers selecting one of the initial alternatives. In other words, adding an additional item to a choice set should produce a uniform decline in the market share of the initial items in the set, or preferences should remain stable, not changing if the additional option is not chosen.

In contrast to normative assumptions, proposing that the utility of the options in the task being considered as the only factor that should influence decision-making, the similarity hypothesis takes into consideration how the similarity of the attributes being considered shapes decision-making behaviour (Tversky & Russo, 1969; Tversky, 1972). Specifically, the similarity hypothesis suggests that adding an additional option to the choice set which is similar to one of the alternatives already under consideration will take a greater market share from the initial option it is similar to, violating the of assumption of proportionality (Tversky, 1972; Luce, 1977). In other words, an additional option is predicted to detract from the perceived favourability of an option which it is similar to, more than an option which it is dissimilar to.

3.1.2. Psychological Theories of Multi Attribute Choice

Simonson and Tversky (1992) propose trade-off contrast explanation of multi-attribute choice which focusses on whether decision makers can make favourable or unfavourable comparisons within the choice set. The trade-off contrast describes a tendency for decision makers to prefer an alternative based on whether a trade-off within the choice set is favourable or unfavourable. Specifically, it is suggested that an item will be perceived as more favourable if it is presented amongst other less favourable stimuli. Equally, an item will appear less favourable if it is presented amongst more favourable stimuli. The authors (Simonson & Tversky, 1992) suggest that the same trade-off contrast also applies to comparisons between attributes. For example, with a choice between two options if neither is superior to the other, each being superior on one attribute and inferior on another attribute, the choice between the two options is contingent on the trade-off between the values of the two options under consideration. This approach suggests that the individual assessment of stimuli does not occur in isolation (e.g., the options are not initially judged independently but are compared directly).

Multi alternative decision field theory provides an alternative account of multi attribute decision-making. Decision makers' preferences are suggested to develop over time through deliberation, combining a series of options across each of their attributes over time (Roe et al., 2001). For example, when comparing between options based on a single attribute, respondent's preferences for either of the options changes depending on the attribute being evaluated. Preferences for an option move up or down depending on whether the option under consideration has either an advantage or disadvantage over the other options. Decision makers initially attend to the principle attribute, then go onto attend to less important attributes with the

comparisons occurring which are added to the previous preferences. Decision makers then may return to the initial attribute under consideration and based on this evaluation update their preferences. The decision process - switching between attributes then continues until either time constraints are reached, or the decision maker reaches a satisfactory threshold and makes their choice.

Brown and Heathcote (2008) propose an alternative model of multi attribute decision-making, the linear ballistic accumulator model. With the linear ballistic accumulator model comparisons are suggested to occur first across attributes with information accumulated independently for each of the options under consideration. Information about each of the options increases independently over time as the decision maker assesses the options (Brown & Heathcote, 2008). The process of information accumulation is non-stochastic; the initial trajectory of accumulation is determined by the continued path of accumulation. The accumulation continues until one of the options under consideration reaches a threshold determining the response (e.g., one option reaches a satisfactory threshold). The first item to reach the threshold is used to determine the response. To account for the variance in responses, two random factors are incorporated into the model 1) the starting point of accumulation and 2) drift rates the variation in speed of evidence accumulation for a response which varies between trials. Drift rates account for variations in decision-making behaviour, specifically as they account for the time it will take a decision-maker to reach the satisfactory threshold of information needed to educate their selection.

The leaky competing accumulator model seeks to recognise the potential for errors in the accumulation of information (Usher & McClelland, 2001) to shape decision-making; multi attribute decisions are said to be informed by the gradual

accumulation of noisy sources of information. Due to the noise, the integration of information is suggested to not occur perfectly or ideally, but rather information is damaged in the accumulation process. Specifically, when information is accumulated, some is lost due to factors such as leakage or differences between the attributes may be amplified. The amplification of the differences is said to occur when decision makers repeatedly attend to competing accumulators (Usher & McClelland, 2001). The accumulation of information is said to occur with an initial level indexing the inputs of information which represents external sources of information; accordingly, for each of the alternatives the inputs are indexed and accumulated. Initial activation is tied to the population being considered and the output that corresponds to the frequency of occurrence within the population. Specifically, the activation of each accumulator determines a given response, just as in multi alternative decision field theory time constraints dictate choice selection. Within the time constraints of the task, the response that is chosen is the one which is most activated when the time allocated for the task has run out. However, in the absence of time constraints, an option that surpasses a pre-set threshold of activation is chosen (Usher & McClelland, 2001).

Multi attribute decision by sampling proposes that an option's value is established based on its relative rank position, within the sample under consideration, established using within attribute comparisons between the options (Ronayne & Brown, 2017). Specifically, the value of an option is established based on the number of sampled comparisons that the option under consideration dominates, compared to the other options in the choice set (Ronayne & Brown, 2017), e.g. with a choice between two options, each depicted by several attributes, decision makers will compare between each of the options multiple times, once for

each of the attributes; for each of these comparisons decision makers will record which option is superior and this record then will be used to establish the relative rank position – how many times an option was superior across all the comparisons. This sample of comparisons is shaped by the available options and values within the choice set, and the selection of an option is suggested to be governed by binary comparisons. This decision-making process is founded on three assumptions. Decision makers do not conduct an exhaustive search and comparison of all options, rather, decision makers conduct a limited search of the information available to them, and as a result make comparisons against a limited sample of information. Secondly, the sampling process does not occur in isolation, instead, the sampling of the information is systematically shaped by the choice in question. For example, the distribution of the options in the choice set shapes how decision makers infer the presence of unobserved options, which then informs comparisons. Finally, participants preferences can be predicted by the dominance relationships of the items in a decision maker's mental sample, established through the binary ordinal comparisons between the pairs of the options being considered. Moreover, the proposal that these decision-making processes occur within multi attribute comparisons is supported by prior research from Naguchi and Stewart (2014). Naguchi and Stewart (2014) established, based on eye tracking data, that decision makers when comparing the options, do not combine and aggregate both attributes of an option under consideration, instead they compare between the options with single attribute comparisons.

3.1.2. Compromise Effect

The compromise effect describes a decision-making phenomenon where the addition of an option (a compromise option) to a choice set of two options is selected

with a disproportionately high frequency, compared to the two initial options under consideration (Simonson, 1989). On both attributes the compromise option is positioned between the initial options under consideration. For example, the compromise option may be superior on attribute A to one option and inferior to the second option on the same attribute, and vice versa for attribute B, whereas the two alternative options are superior on one of their attributes and inferior on their second attribute. The compromise effect has been demonstrated with a diverse range of scenarios, from purchasing cameras (Tversky & Simonson, 1992) to the selection of food from a menu in a restaurant (Pinger, Ruhmer, Krell & Schumacher, 2016).

When examining the compromise effect, Simonson (1989) suggests that under uncertainty (such as establishing value between different attributes) decision makers select the option they believe is best supported by their reasoning - the option most easily justified to others. The compromise option with its central position on both attributes is proposed to reduce the conflict associated with sacrificing one attribute in favour of another. In the case of justifying the decision to others the compromise option is suggested to be perceived as a safe choice, minimising potential errors due to the central position on both attributes. This account is supported by evidence from think aloud protocols, revealing that decision makers who selected the compromise option commonly cited anticipating that selecting the compromise was the action least likely to be criticised (Simonson, 1989). Furthermore, participants revealed feeling that choosing the compromise option demonstrated consideration of all three alternatives (Simonson, 1989). In addition, the compromise effect was found to be stronger for participants who knew that they would have to justify their preferences (Simonson, 1989). Moreover, the compromise effect has been suggested by theorists to lead to violations of both the assumptions

of proportionality (Dhar & Simonson, 2003) and regularity (Tversky, 1972). For example, rather than adding a compromise option to the binary choice set but adding an option framing one of the initial options as a compromise option, also led respondents to select the newly framed compromise option (Huber & Puto, 1983).

The extremeness aversion explanation suggests that disadvantages loom larger than advantages (Simonson & Tversky, 1992). This explanation has its foundations in loss aversion - the proposal that losses have a greater impact than gains on decision makers (Kahneman & Tversky, 1979), as a result, decision makers are more averse to a loss than they are attracted to a gain. Specifically, with the compromise effect both alternative options possess a large advantage on one attribute and a large disadvantage on the other attribute, whereas when compared to the compromise option the two alternative options each have a small advantage and a small disadvantage on each attribute. In contrast, when considering the compromise option, it possesses a small advantage and a small disadvantage when compared against the alternatives. As a result, when the options are considered in terms of the advantages and disadvantages, they offer the compromise option which only possesses a small disadvantage is evaluated more favourably.

To explain the compromise effect with multi alternative decision theory, theorists (Roe et al., 2001) have drawn on the suggestion that the negative position of each inferior option in a comparison reinforces the position of the superior option creating a positive bolstering effect. In essence, the inferior position of both alternatives compared to the compromise option on one of their attributes bolsters the superior position of the compromise option. As a result, the difference between one alternative and the compromise is positively correlated with the differences between itself and the second alternative. This positive correlation gives the

compromise option an advantage over the competitors being considered, leading to it being preferred by decision makers (Roe et al., 2001).

The Leaky competing accumulator (Usher & McClelland, 2001) differs in its explanation of how information is accumulated and condensed, compared to multi alternative decision field theory (Roe et al., 2001), and in turn, how the compromise effect occurs. Rather than establishing the position of an option based on how it matches up against the other options in the comparison, advantages and disadvantages between options are established with a value function. The value function is suggested to be asymmetrical, with losses weighted more heavily than gains. The heightened aversion to losses compared to attraction to gains is used to explain the compromise effect (Usher & McClelland, 2004). The greater disadvantage of both alternatives is over weighted, making them appear less favourable when compared to the compromise option.

Research has indicated that the compromise effect may occur as decision makers struggle to compare between the two attributes. Specifically, when the option to opt out of making a choice between the initial three options was provided, this was chosen frequently detracting from the proportion of respondents who selected the compromise option (Dhar & Simonson, 2003). In the first instance it is suggested that the compromise option is most likely to be chosen by those who are challenged by comparing between different attributes. As a result, when the option to opt out of choosing between the three options is available, justifying the selection of the compromise option, which is not superior on any dimension is a challenge. As a result, a preference for the compromise option is replaced by a preference for the decision maker to absolve themselves from the decision task (Dhar & Simonson, 2003). The findings suggest that the compromise effect is symptomatic of a conflict

relief strategy. The selection of the compromise option helps to overcome the challenge of comparing incomparable attributes. However, when a superior conflict resolving option is available, this resolution is preferred over selecting the compromise option (Dhar & Simonson, 2003). Moreover, this argument is supported by research highlighting that a forced choice combined with uncertainty leads to psychological discomfort, encouraging decision makers to choose the option which negates the need to make a difficult decision (Luce, 1998). This argument is also supported by prior evidence from Simonson (1989), indicating that decision makers were more likely to select the compromise option when they knew that they would have to justify their choice. Interestingly, when choices were framed as real or binding, the compromise effect was also reduced (Müller, Kroll & Vogt, 2012). Whilst in line with standard economic theory (Beattie & Loomes, 1997), the findings indicate that the compromise option is not, in fact, the option decision makers may perceive as their best potential option, but rather the easiest option to justify. The ease of justification explanation is also supported by Chuang, Cheng, Chang and Chaing (2013), who identified that individuals with low self-confidence coupled with high decision uncertainty were more likely to display the compromise effect.

Whilst evidence indicates that the challenge in comparing attributes coupled with decision uncertainty provides a viable explanation of the compromise effect, Trueblood et al. (2014) suggest an explanation embedded in the explanations of multi attribute decision-making, proposed within the linear ballistic accumulator model (Brown & Heathcote, 2008). The linear ballistic accumulator model (Brown & Heathcote, 2008) accounts for the initial sampling of information in the choice set. Building on the linear ballistic accumulator model (Brown & Heathcote, 2008), the multi attribute linear ballistic accumulator accounts for how the final choice is

reached. As with the initial model, (Brown & Heathcote, 2008) selection is determined in part by the drift rates (the average speed of information accumulation), which determines the option a decision maker will be fixed on when time limits expire, as well as factors such as the effect of extreme or intermediate values, the starting point and the satisfactory threshold. The effect of extreme or intermediate values is accounted for by a transformation of objective to subjective values through a curve; if the curve is convex, then extreme values are favoured. However, if the curve is concave, then intermediate values are favoured. Secondly, attention weights define how much attention is placed on comparing the option, more attention is payed to similar rather than dissimilar options, due to the increased effort required to differentiate between them. The attention weights inform the psychological weighting assigned to the target. As well as the initial starting point, the threshold defines the stopping point and drift rate. In the case of the compromise effect, two elements of the model are drawn on, decision makers are proposed to favour intermediate options over extreme options. Moreover, as the competitors are easily differentiated between due to their asymmetrical superiority/inferiority across both attributes, minimum attention weights are needed to discriminate between the two options. However, as the compromise option is closer to both competitors on both attributes (than the competitors are to each other), more attention is needed to discriminate between it and the competitors, the increased attention paid to the compromise option adds to its perceived value, hence it is selected.

Multi attribute decision by sampling proposes that, the value of an option is established based on its relative rank position, constructed via binary ordinal comparisons, and offers an explanation of the compromise effect (Ronayne & Brown, 2017). Applied to the compromise effect, the addition of the compromise

option to the choice set is suggested to produce a shift in the sampling distribution of the options. The shift favours the compromise option, due to its central position on both attributes in the choice set (Roynaye & Brown, 2017). This is suggested to occur as the compromise option on each attribute dominates one of the competitors. In contrast, each alternative, whilst dominant over the compromise and the other alternative on one attribute, are also dominated on the second attribute by the other alternative and compromise option. Therefore, comparing the options with binary ordinal comparisons to educate decision-making makes the compromise option appear more favourable, as it dominates the single attribute binary comparisons (and is also not inferior to the same extent as the alternatives).

3.1.4. Attraction Effect

The attraction effect describes a phenomenon where adding an inferior option (decoy) to a pre-existing choice set composed of two equivalent (when considered across both attributes) but different options (target and competitor) produces a shift in preferences. This change in preferences is not anticipated by the independence of irrelevant alternatives axiom (von Neumann & Morgenstern, 1953), and the assumptions of proportionality (McFadden, 1973) and regularity (Tversky, 1972). Specifically, one of the initial options is superior on one attribute, but inferior on the second attribute; however, the second alternative is also superior on the second attribute. The additional decoy option is asymmetrically dominated by the target option; the attribute the target is superior on - the decoy option is marginally inferior, and on the second attribute, the target and competitor are equal. The pattern of asymmetrical dominance produces a change in selection preferences between the target and competitor; when presented in a choice set containing the decoy option,

the majority of participants prefer the target option over the competitor (Huber et al., 1982; Huber & Puto, 1983).

Utilising Parducci's (1965) range frequency theory, Huber et al. (1982) suggest that the asymmetrically dominated decoy increases the psychological range (the distance between the lowest and highest values which forms the psychological context for the judgement) of the target on the attribute it is inferior on, whilst also increasing the frequency on the dimension it is superior on, making the target option appear favourable compared to the competitor. Later work by Huber and Puto (1983) indicates that the decoy option extends the range of the attribute the target is inferior on, more than the superior attribute, detracting from the value of the target. However, Huber et al. (1982) provide an alternative account suggesting that selection of the target option over the competitor occurs as decision makers do not assess the value of the prospects being considered, but examine the costs and benefits associated with switching by establishing the costs and benefits of switching on each attribute. The relative superiority of the target as a result of the decoy's closeness on the superior attribute leads to a change in preferences and the widespread adoption of the target option.

Evidence presented by Simonson (1989) suggests that the ease of justifying a preference fuels its selection. The asymmetrical dominance relationship between the target and competitor provides a reason for choosing the target over the competitor. The effect occurs as the decision maker is not cognizant of the preferences of the person, they anticipate justifying their decision to. Moreover, this explanation follows proposals that even decision makers who are not anticipating justifying their preferences, still rely on the dominance relationship. Specifically, the dominance relationship between the target and decoy helps to break the tie between the target

and competitor, leading to the selection of the target option. The ease of justification explanation of the attraction effect is supported by later, research indicating that the attraction effect is reduced when judgements are made instead of choices (Aaker, 1991). However, when participants were asked to judge the stimuli, but were informed that they would have to justify their decision, the attraction effect was not reduced. The return of the attraction effect, when justification was required, is suggested by Aaker (1991) to make the judgements a de facto choice. This argument is in line with literature examining the difference between judgements and choices. Beach and Mitchel (1978) suggest that making a choice involves a commitment to a path or course of action (in the case of Aaker's [1999] research the justification), whereas, judgements remain detached from a course of action; however, requiring justification for a judgement creates a commitment to a course of action making the judgement akin to making a choice. The difference between the judgement and pseudo choice condition regarding the prevalence of the decoy effect highlights the potential for the attraction effect to be driven by single attribute comparisons across the choice set, rather than an integrated comparison of the option's combined attributes.

The trade-off contrast (Simonson & Tversky, 1992) explanation suggests that the trade-off between options is enhanced, if the choice set contains an option such as the decoy, which makes the trade-off between attributes unequal, in turn making one attribute appear more important. For example, in the case of the attraction effect, if one of the two competitors has a quality score of 8 and a taste score of 2, and the second has a quality score of 2 and a taste score of 8 (considered in isolation) the trade-off between quality and taste is equal. However, if a decoy option is introduced to the choice set with a quality score of 6 and a taste score of 2, it will

increase the trade-off between quality and taste. For example, decision makers choose the target option, as the addition of the decoy option implies that the trade-off between quality and taste is greater than indicated by the initial comparison between the competitors in the absence of the decoy option (Simonson & Tversky, 1992).

The value shift explanation of the attraction affect proposes that a change in preferences occurs as the inclusion of the decoy option results in a shift in the subjective weights of the stimuli on the attributes the judgement is contingent on (Wedell, 1991; Wedell & Pettibone, 1996). The subjective value of the stimuli is suggested to be shaped by its position, in relation to both the minimum and maximum values being considered, as well as the range and frequency of stimuli with which it is being considered against that it is better or worse than. The inclusion of the decoy option is suggested to increase the subjective value of the target option on its inferior attribute. However, with the competitor the decoy does little to change its subjective value, as it is already near the maximum value on the attribute it is dominant on. Moreover, the addition of the decoy option also increases the number of options which the target is superior to, increasing the subjective value of the target option, whereas the competitor's subjective value is reduced, as it is inferior to both the target and decoy options on that attribute. Furthermore, the value-added model presents an account of multi attribute decision-making not founded in decision weights and added value, but instead focussing on the relative context in which the choice is made for producing the context effects (Wedell & Pettibone, 1996). Specifically, the closeness of the decoy option to the target is proposed to add value to the target option under consideration. This value-added process is exemplified in the justifications given by participants in Simonson's (1989) research, such as the dominance of the target over the decoy adds to its perceived worth, helping to break

the tie between the decoy and the target. Theoretical proposals by Pettibone and Wedell (2000) indicate that both the value shift and value-added processes may work simultaneously complementing each other. This perspective is supported by Pechtl (2009) who suggests that the value shift does not inflate the value of the target, but rather the value shift is proposed to reduce attractiveness in relation to the target. However, the attraction effect is suggested to still occur, specifically as the value-added process is stronger than the negative effect of the value shift process (Pechtl, 2009).

Doyle et al. (1999) emphasise with multi alternative decision field theory the comparative effect at play driving the attraction effect. For example, even an unavailable decoy still shapes comparisons, producing a shift towards the target option. This is suggested to occur not only when the decoy is present in the choice set, but also when participants are told post hoc that it is unavailable (Doyle et al., 1999). However, when the decoy is unavailable, and its inclusion in the choice set is presented as a mistake - preventing it from being integrated into the choice set, it does not result in a shift to the target option. The findings indicate that the perceived relevance of the decoy option to the choice set is essential for the production of the attraction effect. Specifically, when decision makers consider the decoy relevant, it is used to inform the comparison between the options and attributes, and the attraction effect occurs; whereas, when the decoy is not considered relevant by decision makers, it is not used to inform the comparison between options and attributes, in turn it does not elicit a shift towards the target option.

Multi alternative decision field theory is used by Roe et al. (2001) to explain the attraction effect with the following process. The dominated decoy is judged negatively, compared to the two alternatives under consideration which produces a

negative preference for the decoy option. The negative preference for the decoy option produces a negative inhibitory association to the closely positioned target, framing it in a positive light. In contrast, the competitor does not benefit from this positive bolstering effect, due to its distance from the decoy option on both attributes.

Whilst evidence previously discussed in relation to the compromise effect revealed that the addition of an option allowing the decision maker to opt out of making a choice between the compromise and the competitor weakened the compromise effect (Dhar & Simonson, 2003), the same cannot be said for the attraction effect. The introduction of an option to opt out of choosing between the target, competitor and decoy options, in fact, strengthened the attraction effect. Whereas, when an option to opt out was presented in the initial choice set (without the decoy option), it was chosen with a greater frequency than when presented as part of a choice containing the decoy option (Dhar & Simonson, 2003). The findings are taken to suggest that the mechanisms underlying the attraction effect are more perceptual in nature, with decision makers actively preferring the target, due to its asymmetrical dominance over the decoy option. In contrast, in the case of the compromise effect, the compromise option helps to break the tie between the options, but it is not seen as a preferable option in itself.

The multi attribute Linear Ballistic Accumulator model accounts for the attraction effect with attention weights (Trueblood et al., 2014). Specifically, the difference between the decoy option and the target option is smaller than between the decoy and the competitor options; as a result, the attention placed on the decoy and target comparison is greater than the attention placed on alternative comparisons (decoy vs competitor & competitor vs target). Due to the increased attention paid to the difference between the competitor and the target, the subjective

value assigned to the target is over weighted. In essence, the target and competitor present the hardest comparison to differentiate between; as a result, more attention is payed to those two options, which inflates the worth of the superior target option. However, as on both attributes the competitor is distant from the target and decoy it does not benefit from increased attention weights.

Research conducted by Fasolo, Miscura, McCelland and Cardaci (2006) indicates that the occurrence of the attraction affect is moderated by the presentation format of the options under consideration. For example, if the images of both the target and competitor are animated rather than static, then the attraction effect was reduced. This occurred irrespectively of whether the decoy was presented in either an animated or static format. However, the attraction effect increased when the image of the target was animated, and the image of the competitor was static, irrespectively of whether the decoy was or was not animated. Fasolo et al. (2006) propose that the novelty of an animated target compared to that of a static competitor may grab a decision maker's attention more, directing their decision-making. Alternatively, it's suggested that an animated target could be more tangible, and as such, grab the decision maker's attention.

Finally, multi attribute decision by sampling (Roynaye & Brown, 2017) presents an account of the attraction effect reliant on binary ordinal attribute comparisons. Specifically, with the attraction effect, the addition of a decoy option close to the target provides more positive comparisons on the dominant dimension of the target option, in turn, increasing the likelihood that comparisons will occur which favour the target, based on its dominant attribute. As a result of this, comparisons are predisposed to favour the target leading to its selection (Roynaye & Brown, 2017).

Theorists have offered varying explanations of the attraction effect; one element that appears in several of the explanations is the similarity or comparability of the decoy to the target, and in turn, the ability to compare the decoy and the target options to produce the attraction effect. For example, Simonson's (1989) proposal that the selection of the target is easy to justify, due to the comparable but inferior position of the decoy. This is reiterated by Tversky and Simonson's (1992) proposal, with the trade-off contrast explanation, where the closeness between the decoy and target options enhances the importance of the trade-off between the decoy and the target option where the target is dominant, leading to the selection of the target option. Moreover Doyle et al. (1999) emphasise with multi alternative decision field theory the comparative effect at play driving the attraction effect. Specifically, an unavailable but relevant decoy still produced the attraction effect, whereas an unavailable decoy that was irrelevant, and so not compared to the options in the choice set, did not produce the attraction effect. In addition, the multi attribute linear ballistic accumulator model accounts for the attraction effect with attention weights (Trueblood et al., 2014). The increased similarity of the decoy and target options (compared to decoy between the decoy and competitor, as well as the competitor and compromise), requires increased attention to differentiate between them which increases the subjective weighting assigned to the target option. Finally, multi attribute decision by sampling (Roynaye & Brown, 2017) places an emphasis on decision makers comparing the options using binary ordinal comparisons. Hence, with this explanation of the attraction effect the decision options must be comparable, facilitating binary ordinal comparisons.

It was suggested that the commensurability of the choice options is key to the production of both the compromise and attraction effects. Commensurability between

choice options implies that the options can be directly compared on a single common dimension. Proposals regarding the nature of the compromise and attraction effects have both relied on a variety of factors, such as loss aversion (Usher & McClelland, 2004) or the effect of extreme values, however, multiple theories (e.g. Simonson, 1989; Trueblood et al., 2014; Roynaye & Brown, 2017) have placed an emphasis on the role of comparisons and comparability on the production of both effects. When examining the compromise effect, Simonson (1989) has proposed that decision makers struggle to compare between the different attributes of the choice options, so do not rely on computational processes, instead they select the option which they believe is most justifiable to others - the compromise option. Moreover, Dhar and Simonson (2003) reiterate Simonson's (1989) earlier proposal, that the compromise option is most likely to be chosen by decision makers who struggle or are unable to compare between attributes on different dimensions, suggesting that the selection of the compromise option is a conflict relief strategy; its selection negates the need to compare and equate value across the different attributes. Moreover, Trueblood et al. (2014), with the multi attribute linear ballistic accumulator, suggest that the compromise effect occurs due to attention weights; specifically, the similarity of the compromise option to both competitors means that it attracts a greater attention weight, adding to its value prompting its selection. Finally, Ronayne and Brown (2017), with multi attribute decision by sampling, propose that decision-making between choice options occurs with binary ordinal comparisons, and as a result – the effect can be said to be contingent on the comparability of the decision-making content.

3.2. Experiment 5: The Commensurability Attraction Effect

Theorists have provided multiple explanations of the attraction effect; however, one element appearing in several of the explanations is the similarity or comparability of the decoy option to the target option, in turn, the ability for decision makers to compare the decoy and the target options for the production of the attraction effect. Simonson (1989) has proposed that the selection of the target option is easy to justify, due to the comparable yet inferior position of the decoy option. This is reiterated by Tversky and Simonson's (1992) suggestion with the trade-off contrast explanation, where the closeness between the decoy and target options enhances the importance of the trade-off between the decoy and the target option, where the target is dominant, in turn leading to the selection of the target. Moreover Doyle et al. (1999) suggest in multi alternative decision field theory the comparative effect producing the attraction effect. Specifically, an unavailable but still relevant decoy to the target in the choice set, also produced the attraction effect, however, an unavailable irrelevant decoy was not compared to the options in the choice set and did not produce the attraction effect. Moreover, the multi attribute linear ballistic accumulator model accounts for the attraction effect with attention weights (Trueblood et al., 2014). The increased similarity of the decoy and target options (compared to between the decoy and competitor, as well as the target and competitor), requires increased attention to differentiate between them, which increases the subjective weighting assigned to the target option. Finally, multi attribute decision by sampling (Roynaye & Brown, 2017) places an emphasis on decision makers, comparing the options using binary ordinal comparisons. Hence, for this explanation of the attraction effect the decision options must be comparable, facilitating binary ordinal comparisons.

Comparability between choice options or values only implies similarity (e.g., whether items are matching or not matching; similar or dissimilar), whereas commensurability implies whether items can or cannot be compared. Research (Slovic & MacPhillamy, 1974) has emphasised the biasing effect of commensurable decision content on decision-making, with decision makers relying only on commensurable attributes (and not the incommensurable attributes) to educate their decision-making, in turn, shaping decision-making behaviour. The forth coming fifth study examines the proposal that the commensurability of the choice options will dictate whether the options are compared, and in turn, whether the attraction or affects will occur. Introducing an incommensurable decoy option is anticipated to reduce the effects, specifically as introducing incommensurability will prevent the options from being entered into the comparisons.

3.2.1. Method

3.2.1.1. Participants

A research company with over 20 years experience recruiting participants for academic research was used to recruit the participants. There was no specific recruitment criteria, aside from that the participants were over 18 years of age. The only exclusion criteria used was that respondents completed the study or the batch of studies in the block. Participants were recruited within a two-week block and the number of participants recruited was dictated by the time constraints.

A two-week window was set to collect the data; after 14 days, 213 participants (110 females) had been recruited with a mean age of 52.92 (*SD* = 13.85). Participants were recruited with online recruitment panels and rewarded for their participation (£1) and treated in accordance with the ethical standards of the British

Psychological Society, and in accordance with their guidelines for internet-based research (British Psychological Society, 2013).

3.2.1.2. Design and Materials

A 2 x 2 independent measures design was used with the independent variable target type (apple or orange) and decoy commensurability (commensurable or incommensurable). The price (£0.50) and quality and taste (rated 80 out of 100) of the target and competitor was fixed. For the decoy option the price (£0.50) remained the same, however, quality and taste was reduced (rated 60 out of 100). Participants were presented with the three options and asked to choose the option they would most like to purchase. Accordingly, the dependent variable was participants option selection – did they choose the target, the decoy or the competitor.

Participants took part in the study, online using Qualtrics. In total 6 different images were used. Across all the conditions the attribute values of the options were fixed (£0.50 & 80/100 quality and taste).

The commensurable condition featured a choice between an apple, orange and the decoy option either an apple sliced in two (see Figure 13), or an orange sliced in two (see Figure 14), depending on whether the apple or orange was the target. The incommensurable condition featured a choice between an apple, orange and the decoy option either a puree of an apple (see Figure 15) or an orange (see Figure 16), depending on whether the apple or orange was the target.

Figure 13. Commensurable condition with apple as a decoy and a target.

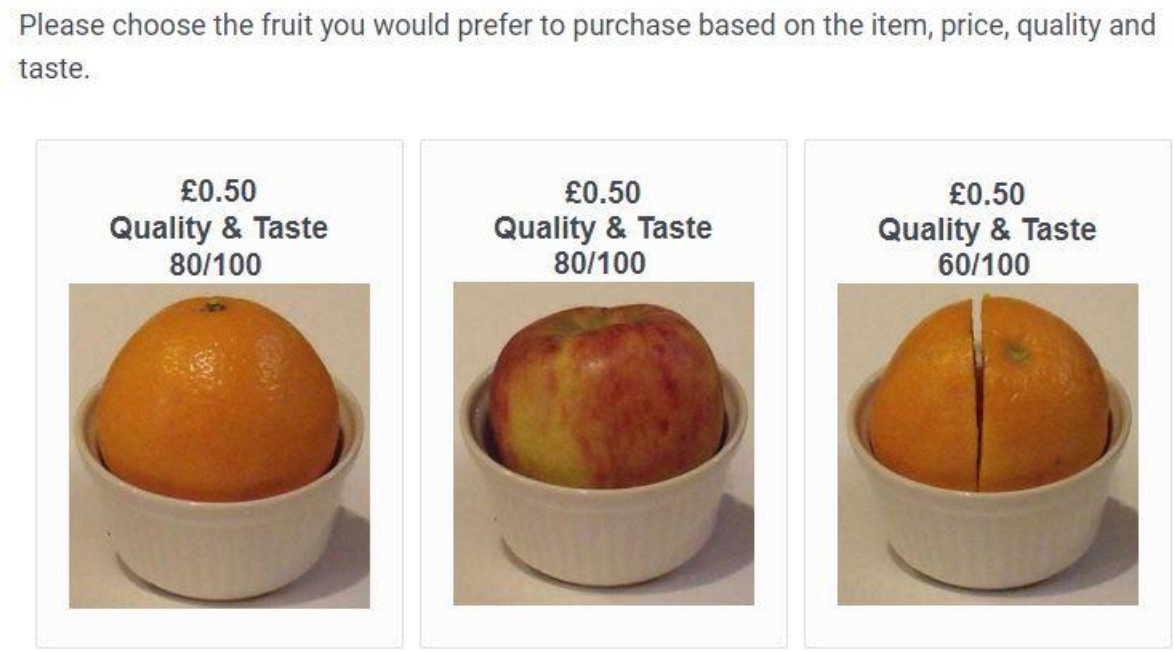


Figure 14. Commensurable condition with orange as a decoy and target.

Figure 15. Incommensurable condition with apple as a decoy and target.

Figure 16. Incommensurable condition with orange as a decoy and target.

3.2.1.3. Procedure

Once participants had been explained the nature of the experiment and had their rights as participants explained to them, demographic information was collected (age & gender). Participants were then introduced to the task and the stimuli and were asked to “Please choose the fruit you would prefer to purchase based on the items, price, quality and taste”. Once participants had made their selection, they were thanked and provided with debriefing information.

3.2.2. Results and Discussion

A Chi square test was chosen due to the type of data (nominal) being analysed, specifically the frequency count of respondents selecting each of their preferred options. Moreover, as the main effect being examined was the commensurability of the decoy option a Chi square test was deemed suitable as it was an appropriate non-parametric test to test the effect of a single independent variable.

The results revealed that there was an effect of decision option commensurability on the attraction effect (x^2 [6] = 15.57, *p* = .016). To distinguish the potential effect of the target stimuli on the compromise effect. When the target stimulus was an apple, there no significant effect of decoy commensurability (x^2 [2] = 0.40, *p* = .820). However, when the target stimulus was an orange there was an effect of decoy commensurability on target selection (x^2 [2] = 9.55, *p* = .008); specifically, there was a 20% increase in the selection of the target option when they decoy option was commensurable (see Figure 17).

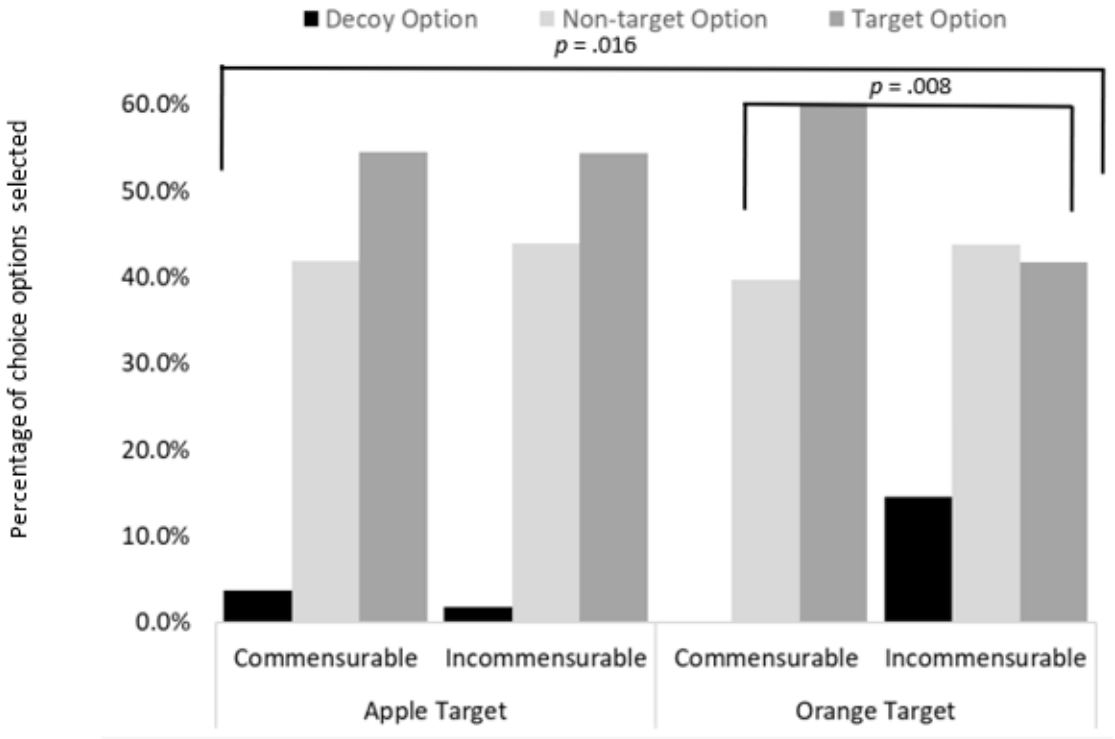


Figure 17. Proportion of decoy, competitor and target selection with commensurable and incommensurable apple and orange decoy and target.

The experimental findings partially support the proposal that decreasing the commensurability of the decoy option would produce a decline in the selection of the decoy option was partially supported. Specifically, when the decoy and target options were oranges, there was an effect of decoy commensurability. When the decoy orange was incommensurable there was a decline in the selection of the target option. However, there was no effect of decoy commensurability when the decoy and target options were apples. It is anticipated that there was no effect decoy commensurability when the decoy option was an apple, potentially due to a general underlying preference for the apple stimuli, potential evidence of this underlying effect can also be observed in the findings of experiment 6. Moreover, it is argued that the addition of a commensurable orange decoy overcame the underlying

preference for the apple stimuli, allowing for the effect of decoy commensurability to occur. Moreover, an incommensurable orange decoy, was not comparable to the target and competitor, and in turn, was not compared against the two options and so did not frame the target option as preferable over the competitor.

3.3. Experiment 6: The Commensurability Compromise Effect

Whilst theorists have offered varying explanations of the compromise effect, one element running throughout the explanations, is the importance of the ability and ease by which decision makers can compare the compromise option to the alternatives. For example, Simonson's (1989) explanation that the compromise option is the most easily justified, as it is most easily compared to the competitors. Furthermore, Dhar and Simonson (2003) propose that decision makers struggle to compare between the two different attributes; as a result, decision makers prefer the compromise, as it can easily be compared against each competitor without having to establish which attribute to base their decision on, as they would, if selecting either of the competitors with the asymmetrical superiority and inferiority across the two attributes. Moreover, the multi attribute linear ballistic accumulator model (Brown & Heathcote, 2008) places an emphasis on the heightened comparability of the compromise option to the alternatives, requiring more attention to distinguish between the options. Specifically, increased attention weighting is placed on the compromise option over the competitors. The increased attention weights lead to a favourable assessment of the compromise option, as in total decision makers spend the most time in summation evaluating it. Finally, multi attribute decision by sampling (Roynaye & Brown, 2017) places an emphasis on decision makers comparing the options, using binary ordinal comparisons. Hence, with this explanation of the compromise effect, the decision options must be comparable to facilitate binary

ordinal comparisons producing the compromise effect. These explanations of the compromise effect place great emphasis on the comparability of the compromise option to both of the alternative options, which then produces the compromise effect. The current study, as discussed previously, will further examine the role of comparability of the compromise option on the compromise effect; testing the proposal that the commensurability of the compromise option will dictate whether the compromise effect is displayed. The sixth experiment examines the proposal that the compromise effect will occur dependent on whether the compromise option is commensurable or incommensurable to the other options in the choice set. Specifically, reducing the commensurability of the compromise option was proposed to prevent the compromise effect, as an incommensurable compromise option will not be compared to the two alternative options when decision makers are evaluating the options, and in turn, will not be chosen.

3.3.1. Method

3.3.1.1. Participants

A research company with over 20 years' experience recruiting participants for academic research was used to recruit the participants. There was no specific recruitment criteria, aside from that the participants were over 18 years of age. The only exclusion criteria used was that respondents completed the study or the batch of studies in the block. Participants were recruited within a two-week block and the number of participants recruited was dictated by the time constraints.

A two-week window was set to collect the data; after the 14 days, 789 participants (385 female) had been recruited with a mean age of 53.60 (*SD* = 13.63). Participants were recruited with online recruitment panels and rewarded for their

participation (£1) and treated in accordance with the ethical standards of the British Psychological Society, in accordance with their guidelines for internet-based research (British Psychological Society, 2013).

3.3.1.2. Design and Materials

An independent measures design was used with the independent variable compromise commensurability (incommensurable compromise & commensurable compromise) with the dependent variable choice selection (see Figure 18). The commensurable condition offered a choice between a whole apple, whole orange and the compromise option half an apple and half an orange (see Figure 19). Finally, in the incommensurable condition participants had a choice between a whole apple, whole orange (see Figure 20), and the compromise - a puree consisting of half an apple and half an orange.

Figure 18. Control condition featuring a whole apple and orange.

Figure 19. Commensurable compromise featuring a whole apple and orange and the compromise option featuring half an apple and half an orange.

Figure 20. Incommensurable compromise featuring a whole apple and orange and the compromise option featuring half an apple and half an orange.

Participants took part in the study, online using Qualtrics. In total 6 different images were used to represent the fruits. Across all conditions the attribute values of the options were fixed (£0.50 & 80/100 quality and taste).

3.3.1.3. Procedure

Once participants had been explained the nature of the experiment and had their rights as participants explained (following APA guidelines) to them, demographic information was collected (age & gender). Participants were introduced to the task and were asked to “Please choose the fruit you would prefer to purchase based on the items, price, quality and taste”. Once participants had made their selection, they were thanked and provided with debriefing information.

3.3.2. Results and Discussion

A Chi square test was chosen due to the type of data (nominal) being analysed, specifically the frequency count of respondents selecting each of their preferred options. Moreover, as the main effect being examined was the commensurability of the compromise option a Chi square test was deemed suitable, as it was an appropriate non-parametric test to test the effect of a single independent variable.

The results revealed that there was a significant difference in the proportion of options selected x^2 (4) = 85.35, $p < .001$. Following this further analysis was conducted without the control condition with standardized z scores to examine further the effects of incommensurability. Specifically, the findings revealed that there was a significant difference in the proportion of each alternative selected between the commensurable condition and the incommensurable condition x^2 (2) = 15.98, $p < .001$. A Z-test with a Bonferroni correction was conducted to compare the proportion

of compromise selection between the commensurable and incommensurable conditions. The Z-test revealed that there was a significant decline ($p < .05$) in the selection of the compromise option in the incommensurable condition (13.1%), compared to the commensurable condition (26.1%) (see Figure 21).

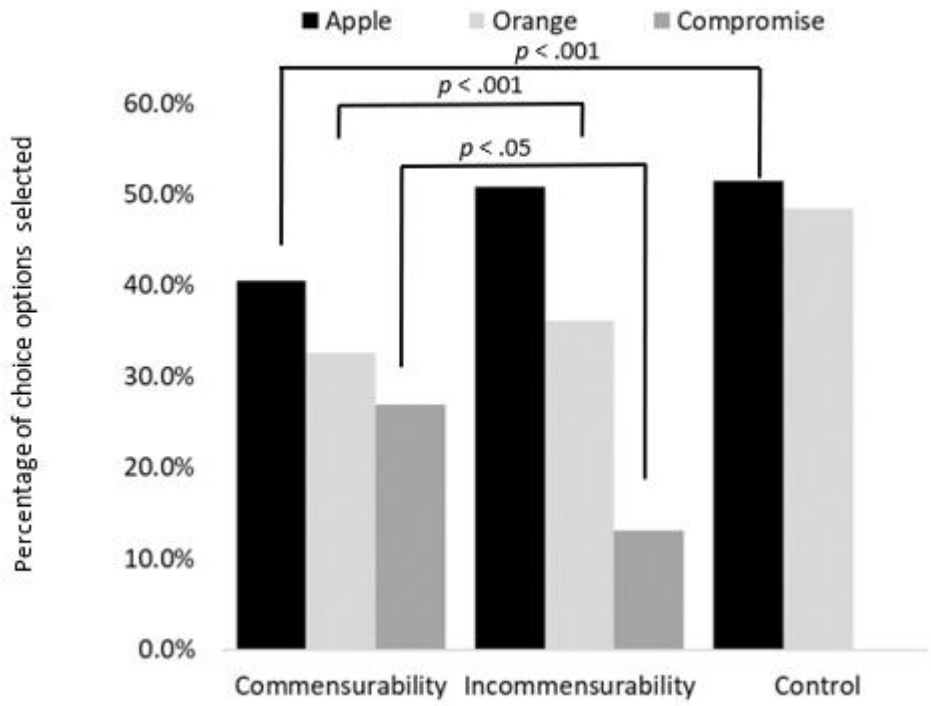


Figure 21. Effect of Compromise Commensurability on the Compromise Effect.

As proposed initially, decreasing the commensurability of the compromise option decreased the proportion of respondents who selected the compromise option. Equally, decreasing the commensurability of the compromise option decreased the proportion of respondents who selected the compromise option. However, it should be noted that even in the commensurable condition, whilst the proportion of respondents who selected the compromise option increased compared to the incommensurable condition, there was not an overwhelming preference for the compromise option. Moreover, in the commensurable, incommensurable and control conditions there appears to be an underlying preference for the apple stimuli over

the orange stimuli with a greater proportion of respondents selecting the apple stimuli over the orange stimuli. This unexpected pattern of behaviour was similar to the underlying preference for apples, over oranges identified in the fifth experiment. The increased selection of the compromise option with a commensurable compromise (compared to an incommensurable compromise) option builds on past research highlighting the effect of commensurability on behavioural biases. Specifically, the work of Slovic and MacPhillamy's (1974), which has shown that commensurable decision attributes are over weighted by decision makers biasing their decisions.

3.4. General Discussion

The effect of commensurability was examined on the compromise and attraction effects. The research discovered that the commensurability of the choice options dictated whether the options were compared, and in turn, whether the attraction and compromise effects occurred.

With the attraction effect, the findings partially supported the proposal that incommensurability between decision options would reduce the attraction effect; however, the pattern of behaviour was affected by the stimuli used for the manipulation. When the decoy and target options were oranges there was an effect of decoy commensurability, an incommensurable decoy led to a decline in selection of the target option. However, there was no effect of decoy commensurability when the decoy and target options were apples.

The sixth experiment examining option commensurability on the compromise effect found that decreasing the commensurability of the compromise option, making the compromise option incommensurable, decreased the proportion of respondents

who selected the compromise option. However, it should be noted that whilst the proportion of respondents who selected the compromise option in the commensurable condition increased, compared to the incommensurable condition, there was not an overwhelming preference for the compromise option. Moreover, in the commensurable, incommensurable and control conditions there appeared to be an underlying preference for the apple stimuli over the orange stimuli illustrated by a greater proportion of respondents selecting the apple stimuli over the orange stimuli. This unexpected pattern of behaviour is similar to the underlying preference for apples, over oranges identified in experiment five.

Chapter 4: Commensurability and Decision-Making Blindness

4.1. Introduction

Normative accounts of decision making imply that decision makers possess a certain level of awareness, regarding the nature of choices and actions (von Neumann & Morgenstern, 1953). In contrast, early psychological research has suggested that decision makers lack awareness of the processes used in their decision-making (Nisbett & Wilson, 1977). Specifically, Nisbett and Wilson (1977) have indicated that, in some instances, decision makers are either unaware of a stimulus that has shaped their decision or are unaware of the influence of the stimuli. Moreover, Nisbett and Wilson (1977) detail that in some instances decision makers can be unaware of a response they gave in the first instance. The findings highlight that decision makers' decisions do not reflect or recall their actions, instead, decision makers may reconstruct events based on what they believe to be plausible, given the information available to them (Nisbett & Wilson, 1977).

The current chapter explores two examples of violations of procedural invariance, choice blindness (Johansson et al., 2005) and the reversal of preferences elicited between judgements and choices (Lichtenstein & Slovic, 1971). Specifically, choice blindness may reflect a process of decision-making akin to that proposed by Nisbett and Wilson (1977), which details a pattern of behaviour, where decision makers do not detect a switch between their preferred chosen option and the alternative, instead decision makers go onto explain their reasoning for selecting the option they did not choose (Johansson et al., 2005). Additionally, Lichtenstein and Slovic (1971) have revealed that preferences change depending on how outcomes are assessed or evaluated. Specifically, preferences were found to vary depending on how participants evaluated decision prospects, making either judgements or choices.

4.1.1. Choice Blindness

Choice blindness (CB) describes a phenomenon where decision makers do not detect that when asked to provide feedback on their chosen option, the option they are presented with, and in turn are evaluating, is the option which they did not choose. Strikingly, decision makers then go onto justify their choice. Specifically, they provide details not specific to their chosen option, but instead construct reasons based on the features of their least preferred option - the one they were presented with (Johansson et al., 2005; Hall et al., 2010). The pattern of behaviour is not anticipated from a normative account of decision-making, when considering the axiomatic logic of decision-making put forward by von Neumann and Morgenstern (1953), or indeed theories of adaptive behaviour with the emphasis on evaluating the outcome of decisions, whilst considering current behavioural intentions. For example, the completeness axiom suggests that decision makers have well defined preferences, so should make consistent choices (von Neumann & Morgenstern, 1953). Theorists (Ridderinkhof, van Den Wildenberg & Segalowitz, 2004) offering adaptive models of behaviour suggest that the ability for a decision maker to monitor, then evaluate the outcome of a task; taking into consideration the intentions and outcomes of their behaviour is essential for behaviour optimisation. Decision makers and learners are suggested to monitor their choices and decisions, then consider the outcome in light of choices they have made (Ridderinkhof et al., 2004). Neurological research has indicated that actions and outcomes form a loop directing future behaviours. General performance monitoring is suggested to continue throughout a task, signalling when behaviour needs adjustment. However, as evidence from choice blindness indicates, preferences may not be complete and stable (Johansson et al., 2005; Hall et al., 2010). Choice blindness also offers questions for proposals

made regarding the adaptive nature of behaviour. Specifically, as decision makers should be able to inform, then evaluate their current situation in light of the outcomes of the decisions they have made (Ridderinkhof et al., 2004).

Choice blindness was initially demonstrated with a preferential choice, assessing the attractiveness of two monochrome images of female faces (Johansson et al., 2005). Decision makers were asked to choose the face they found most attractive, following this they were presented with their unchosen option presented in the guise of their chosen option and asked to explain their selection (Johansson et al., 2005). In the majority of cases participants did not notice that a switch had occurred, but instead provided justification of their selection. Moreover, the justification given by decision makers was found to not be based on the features of their chosen image, but rather, based on the image they had not chosen but were presented with in the feedback stage (Johansson et al., 2005). Choice blindness has been established with a variety of stimuli and assessment methods ranging from attractiveness (Johansson et al., 2005), political and moral opinions (Hall, Strandberg, Pärnamets, Lind, Tärning & Johansson, 2013; Hall, Johansson & Strandberg, 2012) to taste (Hall et al., 2010) and touch (Steenfeldt-Kristensen & Thornton, 2013). Across a range of studies examining choice blindness, switch detection has been found to be as low as 12% for choices between female faces (Johansson, Hall & Sikström, 2008) to 70% for pairs of dissimilar objects experienced via haptic touch with detection rates ranging from 22% to 79.4% when video stimuli were used (Sagana, Sauerland & Merckelback, 2014).

The range of stimuli choice blindness has been demonstrated with highlights the generalisability of the effect, and also the potential for the effects to damage real world decision-making in light of the fallibility of decision maker's perceptual and

discriminatory processing as highlighted by Kusev et al. (2017). Decisions assessing the of attractiveness of monochrome female faces conducted both in person and via a computer has produced overall detection rates as low as 12% (Johansson et al., 2008) and as high as 43% (Sagana et al., 2014). Manipulations reversing decision makers' judgements regarding their political (Hall et al., 2013) opinions and moral principles (Hall et al., 2010) have been examined with detection rates ranging from between 22% to 50%. Studies examining choice blindness have used visual stimuli with choices made between images or written stimuli. For example, images of monochrome female faces or written statements. However, other senses have also been used to differentiate between stimuli such as taste, hearing and touch which produced varying levels of detection. Despite variations in detection, overwhelmingly participants continued to adopt and justify the "selection" of the unchosen option. Eliciting preferences with taste (Hall et al., 2013) led to detection rates of between 32.2% and 33.3%. With auditory stimuli detection rates for voice recordings resulted in relatively low detection rates of 29% (Sauerland, Sagana & Otgaar, 2013). However, the combination of auditory and visual stimuli in the form of videos produced the highest detection rates documented of 79.4% (Sagana et al., 2014).

Whilst most studies examining choice blindness have examined the phenomenon by establishing preferences with choices (e.g., Johansson et al., 2005), several studies have relied on judgements (e.g., Johansson et al., 2008; Hall et al., 2010; Hall et al., 2012; Hall et al., 2013) for the assessment of the stimuli; however, the studies did not rely purely on judgements to elicit preferences for an opinion or stimuli. Johansson et al. (2008) asked participants to judge the attractiveness of female faces; however, this occurred following a preferential choice between the stimuli. The rating of the stimuli was used as a confirmatory process, following an

initial choice between the stimuli, hence, judgements were not the sole method of eliciting preferences. Making a judgement following a choice led to a significant increase in detection, compared to simply making a choice between the stimuli. Whilst the authors (Johansson et al., 2008) refer to this manipulation as a rating condition, it is evident that the judgement served to reinforce the choice. Therefore, it could be argued that the increased detection is just as likely to have occurred due to the increased exposure to the stimuli. Specifically, as with the procedure (Johansson et al., 2008) the chosen image stayed on screen once selected for rating. Moreover, once the ratings had been given, the non-chosen image reappeared, and participants rated the option, doubling their exposure to both stimuli, serving to reinforcing the initial decision.

Hall et al. (2010) measured respondents' judgements in the form of an initial preference of the stimuli, with participants sequentially rating how much they liked each of the stimuli. However, following these assessments participants were shown the images again and asked to choose the stimuli they preferred, before the switch and justification occurred. Whilst the task relied heavily on the use of judgements, the judgement did not motivate or inform the manipulation. Specifically, whilst the judgement occurred before the choice it did not inform the manipulation, as the manipulation could be made in contrast to the pattern of preferences revealed from the judgement. For example, participants who judged the stimuli as equivalent were not removed from the study, but instead were prompted to make a definitive choice between the two options, despite having already stated an equal preference for the two stimuli, and this choice was then used to dictate the direction of the switch.

Additionally, Hall, Johansson and Strandberg (2012), when examining choice blindness in relation to moral positions, collected ratings for each of the options

which informed the switch manipulation. Participants were asked to state the extent they either agreed or disagreed with a series of statements about their moral positions and based on these ratings their moral position was switched. With this method 69% of participants failed to notice the switch and went onto construct arguments supporting the reversed moral position. Whilst the study demonstrates susceptibility and the ability for the manipulation to produce moral flexibility, the impact of the judgements compared to choices cannot be established as there was not an equivalent experimental manipulation reliant on making choices. Furthermore, the same methodological constraints can be seen in Hall et al.'s (2013) study examining voting intentions. Participants were asked to place their judgements in response to political statements on a scale for assessment. The statements were then aggregated to form a voting intention based on the political orientation of their combined responses to the questions. The experimental manipulation occurred with participants making judgements in response to each of the statements illustrating again that judgements can be used to induce choice blindness; however, no measure was available to compare the effect of elicitation method on susceptibility to choice blindness.

Several factors have been identified as moderating and limiting choice blindness, ranging from similarity (Johansson et al., 2005; Hall et al., 2010; Sauerland et al., 2013; Steenfeldt-Kristensen & Thornton, 2013), self-relevance (Sauerland, Sagana, Otgaar & Broers, 2014) and outcome relevance (Somerville & McGowan, 2016) to memory (Johansson et al., 2008; Sauerland et al., 2013; McLaughlin & Somerville, 2013; Sagana et al., 2014). The impact of these factors on choice blindness is mixed across studies. Some studies have indicated the potential for factors such as similarity to impact choice blindness (Hall et al., 2010) whereas

other studies suggest that stimuli similarity does not impact choice blindness (Johansson et al., 2005). However, due to the breadth of senses tested when examining the effect of similarity, it is challenging to distinguish the potential effect or lack thereof of similarity on choice blindness.

When examining stimuli similarity, switch detection rates have been found to vary as a function of stimuli similarity, as well as the senses being utilised. With visual perception and the choice between images of female faces, the similarity of the images being used was controlled with low and high similarity pairs. Johansson et al. (2005) identified that the similarity of the images did not produce significant differences in switch detection, supporting the proposal that choice blindness occurs irrespectively of stimuli similarity (Johansson et al., 2005). However, when other senses were tested, such as taste and hearing, the impact of similarity on the choice blindness is apparent. With taste there was an increase in the detection of dissimilar pairs of stimuli compared to similar pairs of stimuli (Hall et al., 2010). One consideration with the experimental methodology is that prior to making the judgement participants were asked to rate the stimuli, compounding their exposure to the stimuli in the choice task.

Hall et al. (2010) provide two potential explanations of the effect of stimuli similarity on switch detection. One explanation is that the marked dissimilarity between dissimilar stimuli enhances feature matching, contrasting the key flavours of the different jams or teas. Alternatively, it could be suggested that the flavours are more easily labelled and therefore can be categorised, this process of categorisation enables and facilitates switch detection. In other words, with taste the difference in similarity entails that the two stimuli are placed in different categories, enabling the stimuli to be placed into distinct separate categories, e.g., sweet or sour; whereas

the difference in similarity for visual stimuli, such as images of female faces, may entail distance on the same category scale (Johansson et al., 2005). For example, a big and small nose, which whilst different are only placed on different positions on the same category.

The sampling of the stimuli with haptic touch has been identified by Steenfeldt-Kristensen and Thornton (2013) to result in a failure to detect the switching of the stimuli; however, the similarity of the stimuli has also been shown to affect switch detection. Similar stimuli pairs produced an average detection rate of 22%, whereas dissimilar pairs produced an average detection rate of 70%. One example of similar stimuli used by the authors was a pair of different mobile phones both with a keypad, alternatively the dissimilar pair was one mobile phone with a key pad, and the second mobile phone with a touch screen. The similar pair had an average similarity rating of $M = 7$ ($SD = .05$), whereas dissimilar pairs had an average similarity rating of $M = 3.2$ ($SD = .03$). The findings could indicate the different discriminability abilities of the senses used (e.g., touch vs. sight). However, as an experimental condition asking participants to only experience and evaluate the stimuli visually was not conducted, this is only speculative. The findings do offer an insight into the two explanations offered previously - the dissimilarity between stimuli enhances feature matching and secondly, the ability to categorise the stimuli, placing them into discrete groups aids and improves feature matching. The case for categorisation and feature matching could be viewed as a plausible explanation, for example, items in the high similarity group belonged to the same sub category (e.g., key pad mobile phones), whereas items in the low similarity group belonged to distinctly different sub categories (e.g., a key pad mobile phone & a touch screen mobile phone). This explanation however, coincides with the feature matching

hypothesis, as in the low similarity group the features of the objects had discernible identifiable tactile features i.e. the presence or absence of a physical keypad. Evidence for (Steenfeldt-Kristensen & Thornton, 2013) and against the effect of similarity on switch detection indicates that whilst a dissimilar item in itself may not be enough to produce a rise in detection rates, if the lack of similarity is marked enough to result in the stimuli being identified as belonging to distinct separate categories, or the difference between the two stimuli is distinct enough to allow the features to be matched and contrasted, then detection is increased.

Furthermore, Sauerland et al. (2013) discovered similarity effects for auditory sounds - similarity was found to effect switch detection rates. Although the effect was present only with concurrent detection (detecting the switch when asked to justify preferences), but not retrospective detection (detection occurring later at the end of the task). Interestingly, the authors (Sauerland et al., 2013) found evidence indicating the potential for memory to effect choice blindness. There was an increase in detection rates for participants who chose the audio clip second; in other words, the clip closest to the justification task. Post hoc tests revealed that the pair of low similarity voices, as well as being dissimilar, were also judged as being distinctive in contrast to the similar pair of voices. Supporting the argument that whilst similarity may not be enough to lead to an increase in detection rates, the manner in which the stimuli are dissimilar can have an effect on detection i.e. distinctiveness enhances the decision maker's ability to distinguish between stimuli, increasing detection.

The length of time participants spent deliberating on their selection has been revealed to impact detection rates. Johansson et al. (2005) found that the length of time respondents spent deliberating on their choice led to a significant increase in the proportion of participants who detected the switch. No difference in detection was

found between participants who spent one or two seconds examining the images. However, free deliberation led to significantly higher detection rates. Moreover, although participants who were given just two seconds to examine the images, reported feeling that they had enough time to examine the images. Johansson and colleagues (2005) suggest that the results indicate that for effective and accurate choices it is essential to let decision makers govern and regulate their own decision-making by not setting time limits.

Research has shown that information relevant to the self is encoded differently; more effectively than information not related to the self, in turn, when the information being recalled is of high self-relevance, recall is improved (Rogers, Kuiper & Kirker, 1977). In relation to choice blindness, theorists have hypothesised that the self-relevance of the stimuli may be implicated in the rate of switch detection (Sauerland et al., 2014). Several researchers have partially examined self-relevance using stimuli of a high self-relevance, such as voting intentions (Hall et al., 2013) and moral opinions (Hall et al., 2012). In both studies however, participants still readily accepted the switch, indicating that even when the stimuli are of a high-self relevance participants still displayed choice blindness. In addition, Hall et al. (2013) also discovered that neither a respondent's level of political engagement nor the certainty of their voting intentions was associated with switch detection.

Sauerland et al. (2014) present further evidence indicating that self-relevance does not impact switch detection. When assessing children's changes to their school environment, there was no significant difference in detection between the low and high self-relevant conditions. In the high self-relevant condition, participants made choices which directly affected them, for example, a choice regarding potential changes affecting their own school environment; whereas, in the low self-relevant

condition the same changes where assessed, but not framed in relation to the participants' own school environment. Whilst the authors (Sauerland et al. 2014) present a case that self-relevance does not affect detection rates, Sauerland et al. (2014) suggest that detection may be facilitated by highly self-relevant stimuli, such as the stimuli participants themselves designate as being of a high self-relevance. The implication of this proposal is that to evaluate the effect of self-relevant stimuli on choice blindness, rather than assessing this effect with a relative difference between self-relevant stimuli (e.g. low & high); instead a highly self-relevant stimuli which surpasses a specific threshold should be used. Moreover, research by Somerville and McGowan (2016) has suggested that the self-relevance of the stimuli does not affect switch detection rates. Specifically, when a choice was made between pairs of chocolates, the authors found that whether participants were making the choice regarding their favourite chocolate did not affect detection rates.

One factor that has been suggested to impact choice blindness is the extent to which a decision maker attends to the stimuli in the initial selection task. Johansson, Hall, Tärning, Sikström and Chater (2014) suggest that inattention does not explain choice blindness. Specifically, as respondents did attend to the stimuli when explaining their reasoning by providing justification, which is specific to their choices. However, evidence does indicate that whilst participants may attend to the stimuli when giving their feedback, the effect of attention or exposure may be implicated in the initial presentation task. Johansson et al., (2005) found that free deliberation improved switch detection, compared to when deliberation time was constrained (one or two seconds). Furthermore, Somerville and McGowan (2016) whose study examined choice blindness with chocolates as stimuli (both real chocolate and images of chocolate) resulted in high detection rates (over 50%)

compared to past research pointing towards the role of attention as a moderating factor in choice blindness. Somerville and McGowan (2016) argue that attention is not binary (on and off), specifically, irrespectively of whether the participants were choosing between female faces, or choosing between the chocolate, both appeared engaged. However, it is suggested, based on qualitative measures, that participants' engagement was greater when the stimuli was chocolate, compared to when the task stimuli consisted of images of female faces (Somerville & McGowan, 2016).

Mixed results have been presented for the role of memory on choice blindness, some evidence points towards memory effects (Johansson et al., 2008), whereas other research has indicated an absence of memory effects (McLaughlin & Somerville, 2013). Research conducted by Johansson et al. (2008) revealed that increasing exposure to the stimuli produced increased switch detection. Asking participants to rate the images after choosing their preferred option, resulted in a reduction in choice blindness, indicating that increasing exposure to the stimuli produced a decline in choice blindness. Johansson et al. (2008) discovered with a secondary memory test (presenting participants with the same set of stimuli and asking them to choose the option they had originally selected) that participants' correct recall of their selected option was impacted by whether they were in the manipulated or non-manipulated conditions. A significant reduction in correct recall was found for participants in the switched condition, indicating that the manipulation had a long-term effect on participants recall of events, supporting the argument that participants memory of events (and in turn preferences) was reconstructive not recollective.

However, in contrast McLaughlin and Somerville (2013) did not find memory effects on detection rates with a test designed to test participants' recollection of the

initial task and attention. However, there was found to be a positive association between participant's financial sophistication and detection rates. Given the nature of the stimuli participants were tasked with choosing between financial products indicating a familiarity effect. Research has (Johansson et al., 2008) revealed that increasing attenuated exposure impacted detection rates, supporting the proposal that familiarity with the stimuli is pivotal in shaping detection. Furthermore, research by Sagana et al. (2014) has indicated that the switch manipulation did not result in a change to long term preferences, in contrast to the suggestions made by Johansson et al. (2008). However, both pieces of research relied on different procedures. Johansson et al. (2008) asked participant to recall which stimuli they selected, whereas Sagana et al. (2014) informed participants, after a short interval, that for some of them the image they had been presented with in the feedback stage had been switched. After being informed participants were asked to then reselect their chosen option, with this measure only 3% of participants selected the switched alternative. Furthermore, the authors (Sagana et al., 2014) discovered there was no significant difference in detection accuracy for the participants in the manipulated and non-manipulated conditions.

Pärnamets, Hall and Johansson (2015) examined two post hoc measures of memory revealing no difference in recognition (asking participants if they recalled seeing one of the images previously) between the manipulated and non-manipulated trials. In other words, there was no difference in a participant's ability to recall seeing images, depending on whether the switch had occurred. Furthermore, in the manipulated conditions there was no difference in recognition depending on whether participants did or did not detect the manipulation. However, Pärnamets et al. (2015) discovered that participants who initially failed to detect the switch, later confirmed

that the non-chosen image was their preferred option, in line with past research indicating that the choice blindness manipulation led to a long-lasting change in respondent's memory of events (Johansson et al., 2008).

One explanation that contrasts the proposals that participants' memory of events is altered by the presentation of the unselected image, is that the justification of the initial decision is confabulatory (Johansson, Hall, Sikström, Tärning & Lind, 2006). Confabulation implies that decision makers in response to an inability to recall their initial selection, create a justification based on the information available to them i.e. their non-chosen image (Johansson et al., 2006). Johansson et al. (2006) provide evidence supporting this account; the authors revealed that between the manipulated and non-manipulated trials there were minimal semantic or qualitative differences between the reasons given by respondents.

Finally, based on findings that participants' memory of their chosen image was not stable following the task, theorists suggest that the manipulation changed participants' long-term memory; participants continued to select their non-chosen image as their chosen image following the task. Pärnamets et al. (2015) argue that the choice blindness manipulation alters respondents' long-term memory of events. Specifically, self-perception theory (Bem, 1967) posits that attitudes, memory and preferences are constructed by decision makers based on external sources of information, constructed by interpreting their own actions, as a result, when decision makers were presented with their non-selected image, rather than being viewed as contradictory to their initial choice, it informed their recollection of events and their continued acceptance of the switched alternative. Evidence of self-perception theory in action with choice blindness also comes from Aucouturier et al. (2016) who revealed that a participants' emotional state altered as a result of listening to the

feedback of their own voices. Participants were asked to read a piece of text out loud which was presented back to them through head phones, the sound of their own voice was manipulated to sound either happy, sad or afraid. Not only did participants not detect the manipulation, their emotional state changed in line with the manipulation of the emotion. The findings reiterate the potential for self-perception to play a role in choice blindness; specifically, participants' own actions or rather their perception of their actions informed their emotions (Aucouturier et al., 2016).

4.1.2. Judgement vs Choice

Whilst in simple terms judgements and choices both establish preferences, they are qualitatively different processes. Choices, as well as ascertaining a preference, embody a commitment to a course of action or an outcome (Beach & Mitchel, 1978). However, judgements only measured preferences but remain detached from future outcomes (Beach & Mitchel, 1978). Theorists have proposed from a psychological standpoint that judgements act as an aid to a choice, and as a result, are not equivalent to a choice (Einhorn & Hogarth, 1981). When considering the difference between judgements and choices the actions required for both assessments are distinct and separate, arguably making them qualitatively incommensurable (Vlaev, 2011) – with both elicitation methods requiring incomparable or incommensurable strategies, leading to different outcomes. Specifically, choices produce a binary outcome, selecting one option over the other born from the comparison of both items being considered (Montgomery, Selart, Garling & Lindberg, 1994). On the other hand, judgements produce a qualitatively rich outcome born from an introspective assessment of the merits of both options when assessed individually (Montgomery et al., 1994). In other words, making a

choice is relative between the options under consideration whereas, judgements require a non-comparative intrinsic assessment of the options available.

Research has shown that preferences do not remain stable between choices and alternative methods of preference elicitation such as ratings, estimations and judgements. This instability results in a reversal of preferences despite the stability of the attributes being considered (Lichtenstein & Slovic, 1971; Lichtenstein & Slovic, 1973, Holt, 1986; Montgomery et al., 1994) leading to violations of procedural invariance. For example, Lichtenstein and Slovic (1971) highlight a disparity in preferences elicited between judgements and choices. The findings reveal that decision makers when making a choice between two gambles, select the option offering them the greatest likelihood of winning. In contrast, when bidding on the items (judging the options) decision makers placed a greater value on the gamble offering a higher reward. Moreover, the findings were not isolated to the lab; a similar study conducted with gambles offering monetary rewards in a casino with gamblers either making a choice between two gambles or stating the price they would be willing to pay to play the gamble produced similar results (Lichtenstein & Slovic, 1973). When participants chose a bet, they selected the option giving them a higher probability of winning the gamble, whereas when bidding on the gambles, decision makers placed bids closer to the value of the high worth gamble.

Lichtenstein and Slovic (1971,1973) have suggested that the reversal in preferences between judgements and choices occurs as different strategies are used by decision makers when making a choice or a judgement. Specifically, when making a choice between options, the attributes can be matched and compared against each other. However, when making a judgement, a natural starting point is provided; for example, in the case of a monetary gamble the amount to win provides

an initial reference point. Slovic and Lichtenstein (1968) suggest that decision makers begin with the amount to win as a reference point, adjusting up or down considering the other aspects of the gamble, such as the risk. However, due to the challenge of combining attributes, it is proposed that integrating the probability of the gamble with the monetary outcome presents a challenge as decision makers cannot easily combine two attributes. The strategies adopted by decision makers to combine the two values is argued to be crude at best, poorly taking into consideration the probabilistic information and are over reliant on monetary outcomes (Lichtenstein & Slovic, 1971). For example, these strategies lead to decision makers placing a higher monetary value on a gamble with a larger but unlikely payoff, compared to a gamble with a lower yet more likely payoff. In other words, Lichtenstein and Slovic (1971) suggest that reversals in preferences occur as different strategies are used for the respective elicitation strategies, with judgements a decision maker's approach is predisposed to be biased by an inability to balance risks and rewards.

The prominence hypothesis proposed by Tversky, Sattath and Slovic (1988) suggests that when making a choice, the attribute considered most important is weighted more heavily receiving more attention than the alternative attributes under consideration. The authors (Tversky et al., 1988) suggest that the effect of prominence occurs differently between judgements and choices based on various processes, used to reach decisions for both judgements and choices. Strategy compatibility influences choices, whereas scale compatibility influences judgements. Both scale and strategy compatibility effects are founded on the compatibility principle which implies that the "weight of any input component is enhanced by its compatibility with the output" (Tversky et al., 1988, p.376).

Whilst the effect of prominence on choices preferences, where one option has a clear advantage, on a prominent dimension it is straightforward to appreciate the manner in which decision makers are suggested to make choices. Decision makers are first suggested to establish supremacy on the prominent dimension to inform their decision. However, Tversky et al. (1988) go onto suggest that when judging or matching, the effect of prominence cannot as easily be understood. Specifically, matching or judging requires a quantitative assessment of the values to reach a judgement. In light of this, it is suggested that when making an evaluation, decision makers pick a value from the task comparable to the scale, then adjust to the value based on the other attributes of the options. However, attempts to adjust values are inefficient, resulting in little change to the decision weights. For example, in the case of estimating the value of a risky prospect, estimations are informed more by the potential reward than the associated risk.

Overreliance by decision makers on the aspect of the decision that is compatible to the dimension used on the scale that the judgement is made on is termed scale compatibility by Tversky et al. (1988). Scale compatibility (Tversky et al., 1988) indicates that the weighting attached to an attribute is increased by its compatibility to the response manner, whereas values that are less compatible to the output are suggested to be given less weighting, due to the challenge associated with transforming values into a compatible format. As mentioned previously, in the case of a monetary gambles judged in terms of monetary worth, the compatibility between the value of the gamble and the estimation of its worth results in an overweighting of the monetary dimension. Slovic, Griffin and Tversky (1990) have found evidence supporting the scale compatibility hypothesis, for example, indicating that judgements are more heavily influenced by comparable information in the

decision-making task than incomparable dissimilar decision information. Moreover, the authors (Slovic et al., 1990) found that when participants were asked to predict a student's rank position on a course, judgements were informed by the rank position on alternative courses, ignoring the student's grades; whereas, when the participants were asked to estimate a student's grades, they were informed by the student's grades on other courses but not their rank position on the course, supporting the proposal that for judgements the attribute that is compatible with the task is over weighted biasing judgements.

Fisher and Hawkins (1993) coined the term strategy compatibility to capture the more general preference reversal between tasks requiring value trades-off strategies (quantitative) to those requiring ordering or elimination strategies (qualitative strategies). Specifically, qualitative tasks are argued to be more likely to lead to the prominence effect. Kahneman et al. (1988) provide an explanation of how the qualitative act of choosing leads to the prominence effect. Initially, decision makers are suggested to assess whether one of the options is dominant, for example, is the option superior across all the attributes being considered. If one option is not dominant, then they are assessed to see whether it has a clear advantage over the options under consideration. If a clear advantage cannot be established, then attempts are made to resolve the conflict. However, translating different attributes onto one dimension to achieve this can be challenging (Tversky et al., 1988). As a result of the challenge presented by comparing incommensurable values, decision makers are suggested to resort to making decisions based on one attribute - that which appears most prominently.

The process behind choices leading to the prominence effect, as described by Tversky et al. (1988), is not questioned by Fischer and Hawkins (1993). However,

Fischer and Hawkins (1993) do suggest that the effect is not isolated to choices, but is applicable to all quantitative tasks (e.g., those that do not lead to a solely computational assessment). For example, a strength of preference ordering task was found to produce the same preferences as those made with choices (Fischer & Hawkins, 1993). The strength of preference judgements in the ordering task is suggested to be qualitative in nature. Decision makers begin by ordering the options to establish which is preferred, then they go onto ascribe a value reflecting the strength of their preferences, in light of the pre-emptive choice they made. Hence, the qualitative outcome will not diverge from the qualitative assessment. Montgomery et al. (1994) support strategy compatibility as the cause of prominence effect. However, they also suggest that the "structure of information required as an output" (Montgomery et al., 1994 p.154) should be compatible with an input. In other words, it is argued that the structure of the evaluations, regardless of whether qualitative or quantitative, shapes the decision makers consistency between tasks. For example, if two judgements are made simultaneously, the outcome is argued to be in line with the preferences made via a choice, not two judgements made sequentially. A simultaneous presentation encourages comparisons between the options, meaning the mechanism for judging items simultaneously is more akin to that of making a choice.

Finally, building on the effects of compatibility in consumer choice, Nowlis and Simonson (1997) suggest that the two aspects of the attributes inform the weighting of the options in judgements and choices. With choices comparable dimensions are over weighted, whereas with judgements prominent attributes which can be interpreted independently, are over weighted, compared to when a separate evaluation of the options is made. Specifically, the difference in behaviour is

suggested to occur as the task type dictates the importance of the information (Nowlis & Simonson, 1997). When making choices, comparable information, such as price, is seen as more meaningful and useful in educating decisions. In contrast with an independent assessment, such as a judgement, the sources of comparable information carry less weight, as they cannot be as easily utilised without an external reference point to compare against. Moreover, prominent attributes are argued to facilitate independent assessments by adding meaning and value without the need for independent comparisons.

The current research is designed to test the proposal that increasing incommensurability will result in a reduction of the proportion of respondents who display choice blindness. Specifically, commensurability is suggested to encourage comparisons facilitating choice blindness, whereas incommensurability will prevent direct comparisons from occurring in the decision-making task, in turn preventing choice blindness.

Two forms of commensurability are proposed and anticipated to shape the proportion of respondents who display choice blindness - option and task commensurability. Option commensurability, decreasing the commensurability of the options under consideration, was hypothesised to decrease the proportion of participants who exhibit choice blindness. This was expected to occur, as the participants would not be able to rely on shared reference points. The suggestion of shared reference points is similar to Steenfeldt-Kristensen and Thornton's (2013) suggestion with the feature matching hypothesis i.e. items which share the same types of features are more likely to produce choice blindness. In contrast items with unique features will not be compared but rather recognised as unique and there for increase choice blindness detection. The shared reference points with

commensurable options was anticipated to allow decision makers to compare one alternative against another. As a result of this, reaching a decision will rely on an individual introspective assessment of both alternatives. The isolated assessment of incommensurable options is expected to prevent susceptibility to choice blindness, whilst previous research has presented mixed results on the effects of stimuli similarity.

Secondly, task commensurability is similar to the task judgement content commensurability highlighted in the first four experiments. The level of commensurability between the initial task and the secondary justification task is expected to impact the proportion of respondents who displayed choice blindness. An increase in task commensurability is expected to increase the proportion of respondents who display choice blindness. This is expected to occur if both stages of the task are commensurable, so decision makers have access to shared reference points between both stages of the task, due to commensurability, and as a result are less likely to detect the change. In contrast, task incommensurability is expected to produce a decline in the proportion of respondents who display choice blindness. An initial judgement of the two options is argued to be more commensurable to the secondary justification task than choosing between the initial two options. Specifically, making a judgement is argued to be commensurable to the second task as making judgements has been argued to require an individual assessment of each option (Montgomery et al., 1994) under consideration. More over making a judgements is akin to the individual reappraisal of the chosen image in the feedback stage, in other words, these processes are commensurable, whereas making a choice initially is a comparative act - comparing the options against each other to decide on a preference for one option or the other, whereas

the secondary evaluation (showing participants their non-chosen option and asking them to justify their decision) involves an individual assessment of one option (e.g. appraising it individually), which is argued to be incommensurable to the choice between the stimuli (a comparative act comparing between the options evaluating them against each other). Specifically, the task commensurability and task incommensurability, is hypothesised to effect whether respondents display choice blindness – as just has been argued by Slovic and MacPhillamy (1974) decision makers struggle to compare between incommensurable values, it is proposed in this study that decision makers struggle to compare between incommensurable tasks. The challenge of comparing between incommensurable tasks is argued to result in decision makers not integrating their past experiences (the initial evaluation) into the secondary reappraisal of the initial task, and in turn leaving them unaware of their initial decision, and as such displaying choice blindness.

4.2. Experiment 7: Commensurability Blindness Preferences for Apples and Peppers

The initial experiment examined the effect of commensurability on choice blindness, specifically testing both option and task commensurability. The commensurability of the options being considered was manipulated to test the effect of option commensurability, as well as the commensurability between the initial decision-making task and the secondary justification task to test the effect of task commensurability. Specifically, decreasing commensurability was predicted to result in a decline in the proportion of participants who will display choice blindness.

4.2.1. Method

4.2.1.1. Participants

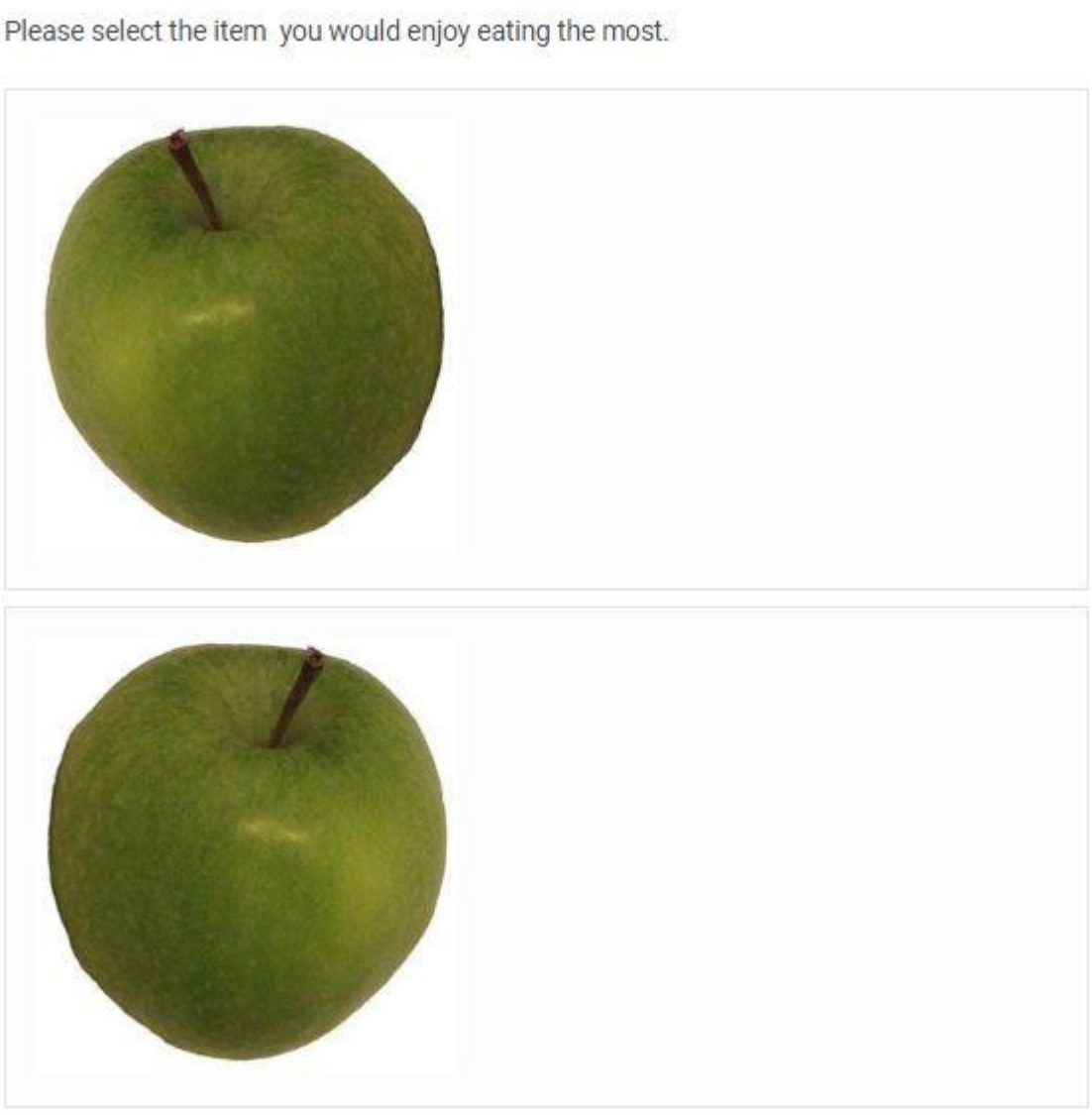
A research company with over 20 years experience recruiting participants for academic research was used to recruit the participants. There was no specific recruitment criteria, aside from that the participants were over 18 years of age. The only exclusion criteria used was that respondents completed the study or the batch of studies in the block. Participants were recruited within a two-week block and the number of participants recruited was dictated by the time constraints.

Participants were recruited with online recruitment panels and rewarded for their participation (£1). A two-week window was set to collect the data; after the 14 days, 617 participants (306 female) had been recruited with a mean age of 53 (*SD* = 13.63).

4.2.1.2. Design and Materials

A 2 x 3 x 3 independent measures design was used with the independent variables - decision type (choice [incommensurable] or judgement [commensurable]) to test task commensurability, stimuli match (apple & apple, pepper & pepper and apple and pepper), colour match (red & red, green & green and red & green) to test option commensurability. This resulted in 20 experimental conditions; the mixed stimuli and mixed colour conditions (judgement and choice) both required all possible combinations of stimuli and stimuli colour to be explored (e.g., green and red reversed for both combinations across judgments and choices). The use of the two independent variables stimuli match and colour match allowed for choices and judgements between both the highly commensurable and incommensurable options in the task. For example, the choice between the same type of stimuli in the same colour, or highly incommensurable options different types of stimuli (e.g., an apple

and pepper) in different colours (e.g., red and green). The dependent variable was whether participants displayed choice blindness - whether they detected the switch, either concurrently, immediately following the manipulation when participants were asked to justify their decision, or retrospectively when they were told that for some participants a switch had occurred, and did they believe this had happened to them.



This was the item you chose.

Please explain your reason for choosing this item.

Did you notice anything unusual?

Yes

No

What did you find unusual?

Figure 22a. Experimental procedure with choices.

Please rate how much you would enjoy eating the two items with 0 being I do not enjoy eating this at all to 10 I enjoy eating this a lot.

0 1 2 3 4 5 6 7 8 9 10

This was the item you rated as enjoying eating the most.

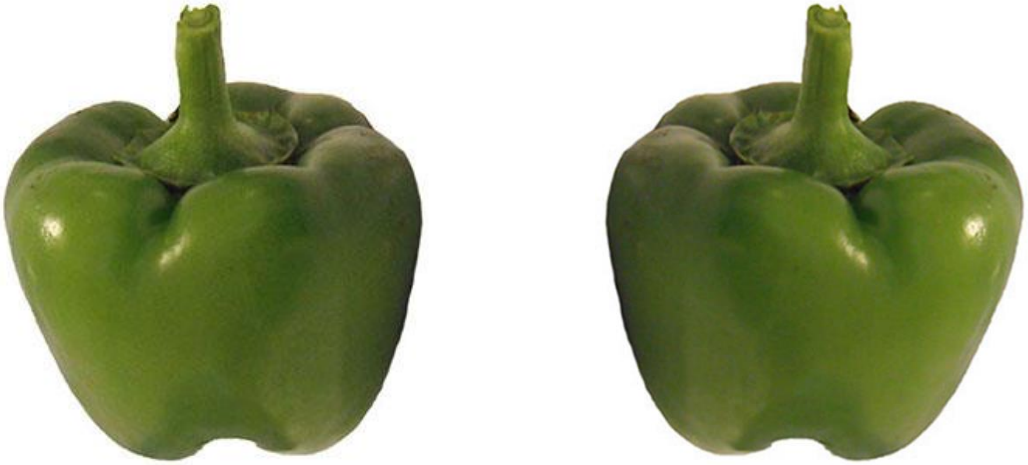
Please explain why you rated this item higher.

Figure 22b. Experimental procedure with judgements.

Green Apple

Red Apple

Green Pepper



Red Pepper

Figure 23. Experimental stimuli (green apple, red apple, green pepper & red apple) each of the stimuli is presented in its standard orientation and the mirror image of the stimuli.

The images of the fruit (red or green apple) or vegetables (red or green pepper) were prepared using Photoshop (2015). The images were initially prepared by removing the shadows from the images to allow all the images to be orientated in the same direction; the images were then rotated so that the stalks of the apples and peppers were facing upwards. Once the images had been orientated in the same direction, in order to create a highly commensurable yet different pairs, each image

was transformed using the horizontal flip feature in Photoshop (2015) transforming the images into a mirror images of themselves (see Figure 23).

The experiment was conducted online using Qualtrics. In the judgement condition participants were asked *"Please rate how much you would enjoy eating the two items with 0 being I do not enjoy eating this at all to 10 I enjoy eating this a lot"*. Participants then rated their enjoyment of both items on a Likert scale ranging from 0 - I do not enjoy eating this, to 10 - I do enjoy eating this (see Figure 22b), whereas in the choice conditions participants were asked *"Please select the item you would enjoy eating the most."*(Figure 22a). After participants had provided their preference for the stimuli either judging them individually or choosing between them, they were shown the option they did not choose and, in the judgement, condition were asked *"Please explain why you rated this option higher",* whereas in the choice condition respondents were asked *"Please explain your reason for choosing this item."* in response to both questions participants placed their responses in a text entry box.

4.2.1.3. Procedure

Once participants had been explained the nature of the study and had their rights as participants explained to them, demographic information was collected. Participants were asked to either rate how much they would enjoy eating both items individually on a likert scales, or participants were asked to select the item they would most enjoy eating. Following an initial assessment in the judgement condition, participants were presented with an image of the option they rated as being least enjoyable to eat, framed as the option they had rated as being most enjoyable to eat, and were asked to explain their judgement. In the choice condition participants were presented with the image of the option which they had not selected, framed as the option they selected, and were asked to explain their choice. Following this

participant were asked several questions to confirm whether they had detected the switch. First participants were asked if they noticed anything unusual, if they indicated they had, they were asked what they had noticed. Participants were told that for some of them their preferred image had been switched, and did they think this had happened to them. After completing this question, participants were presented with debriefing information and thanked for their participation.

4.2.2. Results and Discussion

Due to the binary nature of the outcome (choice blindness or non-choice blindness preferences) binary logistic regressions were used to analyse the results. Whilst the other tests used in the thesis thus far would have been sufficient to cope with this data, a binary logistic regression was chosen in order to examine the extent to which changes between different levels of commensurability would lead to an increase in the likelihood of the respondents displaying or not displaying choice blindness.

Table 1. Percentage of respondents who detected the choice blindness manipulation.

	Decision	Stimuli Match	Colours Match	Concurrent Detection*	Retrospective Detection*
Choice	Different	Different	No	32	7
			Yes	68	93
	Different	Match	No	30	4
			Yes	70	96
	Match	Different	No	36	4
			Yes	64	96
	Match	Match	No	79	78
			Yes	21	22
Judgment	Different	Different	No	65	26
			Yes	35	74
	Different	Match	No	55	16
			Yes	45	84
	Match	Different	No	67	23
			Yes	33	77
	Match	Match	No	85	62
			Yes	15	38

* Percentage of participants who noticed the choice blindness manipualtion

Cox and Snells R^2 indicates that 19% of the variance in detection can be explained by the model. The Hosmer-Lemeshow test indicates that the model is a good fit to the data χ^2 (5) = 0.00, p = 1. The decision type did not significantly contribute to the model (p = .343), however whether the stimuli type matched (p = .007) and whether the colours matched (p = .008) did significantly contribute to the model. The (EXP [B]) for stimuli type indicates that when the stimuli match changes by one unit (going from matched to different), the odds of a participant noticing the switch increase by 3573.44. The (EXP [B]) for colour match indicates, when the colour match changed by one unit (going from matched to different), the odds of a participant noticing the switch increased by 3138.74.

Retrospective detection

Cox and Snells R^2 indicates that 29% of the variance in detection can be explain by the model. Hosmer-Lemeshow test indicates the model is a good fit to the data χ^2 (5) = 0.00, p = 1. Decision type (p = .006), whether the stimuli type matched (p < .001) and whether the colours matched (p < .001) all significantly contributed to the model. The (EXP[B]) for decision type indicates when the stimuli match changes by one unit (going from judgement to choice) the odds of a participant noticing the switch increases by 4448.45. The (EXP [B]) for stimuli type indicates when the stimuli match changes by one unit (going from matched to different) the odds of a participant noticing the switch increases by 1607383.73. The (EXP [B]) for colour match indicates that when the colour match changes by one unit (going from matched to different) the odds of a participant noticing the switch increases by 2539683.80.

The study revealed that whether the stimuli matched and whether the stimuli colour matched (option commensurability) both predicted whether respondents detected the switch. Specifically, as the option's commensurability decreased, changing from matched stimuli in matching colours to unmatched stimuli in unmatched colours, the likelihood of respondents detecting the switch significantly increased. Secondly, with retrospective detection, again both stimuli match and stimuli colour match both significantly contributed to the model, again with a decrease in commensurability, leading to an increase in switch detection. Moreover, a decrease in task commensurability (going from choice to judgement) was also found to lead to an increase in switch detection, participants in the incommensurable choice condition were more likely to detect that a switch had occurred, compared to participants in the commensurable judgement condition.

4.3. Experiment 8: Commensurability Blindness Preferences Between Images of Female Faces

Building on the findings of experiment seven, the eighth experiment sought to examine the effect of commensurability on choice blindness, specifically, using stimuli similar to that used previously in choice blindness research (Johansson et al., 2005). The stimuli used were monochrome images of female faces taken from the Psychological image collection at Stirling (PICS; http://pics.psych.stir.ac.uk/), the same source of images used by Johansson et al. (2005).

As the stimuli used was predetermined by a desire to use stimuli previously used in choice blindness research, option commensurability could not be examined (however, similarity and attractiveness were controlled). Task commensurability was examined, testing the proposal that increasing the incommensurability of the task would result in a decrease in the proportion of respondents who detected the choice blindness manipulation. Individual judgements of the images were commensurable to the latter individual justification of the chosen image. Specifically, this was anticipated to result in an increase in the proportion of respondents displaying choice blindness, compared to when a choice was made between the images incommensurable to the later individual justification of their selection. Whilst the commensurability of the options could not be manipulated, similarity and attractiveness were controlled for. The images used in the study were first evaluated in terms of attractiveness (by independent raters), following this independent raters, then judged the similarity of the pairs (with attractiveness controlled for) to establish high and low similarity pairs, and attractiveness was controlled for.

4.3.1. Method

4.3.1.1. Participants

A research company with over 20 years experience recruiting participants for academic research was used to recruit the participants. There was no specific recruitment criteria, aside from that the participants were over 18 years of age. The only exclusion criteria used was that respondents completed the study or the batch of studies in the block. Participants were recruited within a two-week block and the number of participants recruited was dictated by the time constraints.

Participants were recruited by way of online recruitment panels and rewarded for their participation (£1). A two-week window was set to collect the data; after the 14 days, 134 participants (74 female) had been recruited with a mean age of 48 (*SD* = 12.22).

4.3.1.2. Design and Materials

A 2 x 2 independent measures design with the independent variables stimuli similarity (high or low) and decision type (judgement or choice) to test task commensurability was used. The dependent variable was whether participants displayed choice blindness (whether they detected the switch; concurrently immediately following the manipulation when participants were asked to justify their decision; retrospectively, when they were told that for some participants a switch had occurred, and did they believe this had happened to them.).

The monochrome images of female faces were taken from the Psychological image collection at Stirling (http://pics.psych.stir.ac.uk/); a selection of images was taken from the Nottingham Originals and Stirling image data bases. Two pre-test studies were conducted to establish pairs of similar and dissimilar faces with

attractiveness controlled for. Initially 350 participants were presented with 67 images of female faces from the data base and asked to rate the attractiveness of the images. Participants were asked "*How attractive would you say the face is on a scale of 0 to 10?*" participants then placed their judgement on a sliding scale which ranging 0 to 10, with 0 being least attractive to 10 being most attractive.

Following the collection of attractiveness ratings, the researchers selected 10 faces from the middle of the range in terms of attractiveness, which used the similar coloured backdrops and had similar scaling of the faces in the pictures. The rated attractiveness of the images ranged from *M* = 3.86 (*SD* = 1.78) to *M* = 4.48 (*SD* = 1.72). With these images a selection of 21 similar and dissimilar pairs were established. Following the construction of these pairs, a further 30 raters were recruited from the student population and asked to *"Please rate the similarity of the pair of faces"* ratings were placed on a sliding scale ranging from 0 - 100 to give a percentage similarity with an overlay which ranged from very dissimilar (equivalent to 0% similarity) to very similar (100% similarity). From these ratings two pairs of images were identified a low (*M* = 19% similarity rating, *SD* = 18.28) and high (*M* = 64% similarity rating, *SD* = 25.90 similarity pair) similarity pair (see Figure 24).

For this question please select the face you find most attractive.

This was the face you chose as most attractive.

Please explain your reasons for selecting this face out of the two options provided.

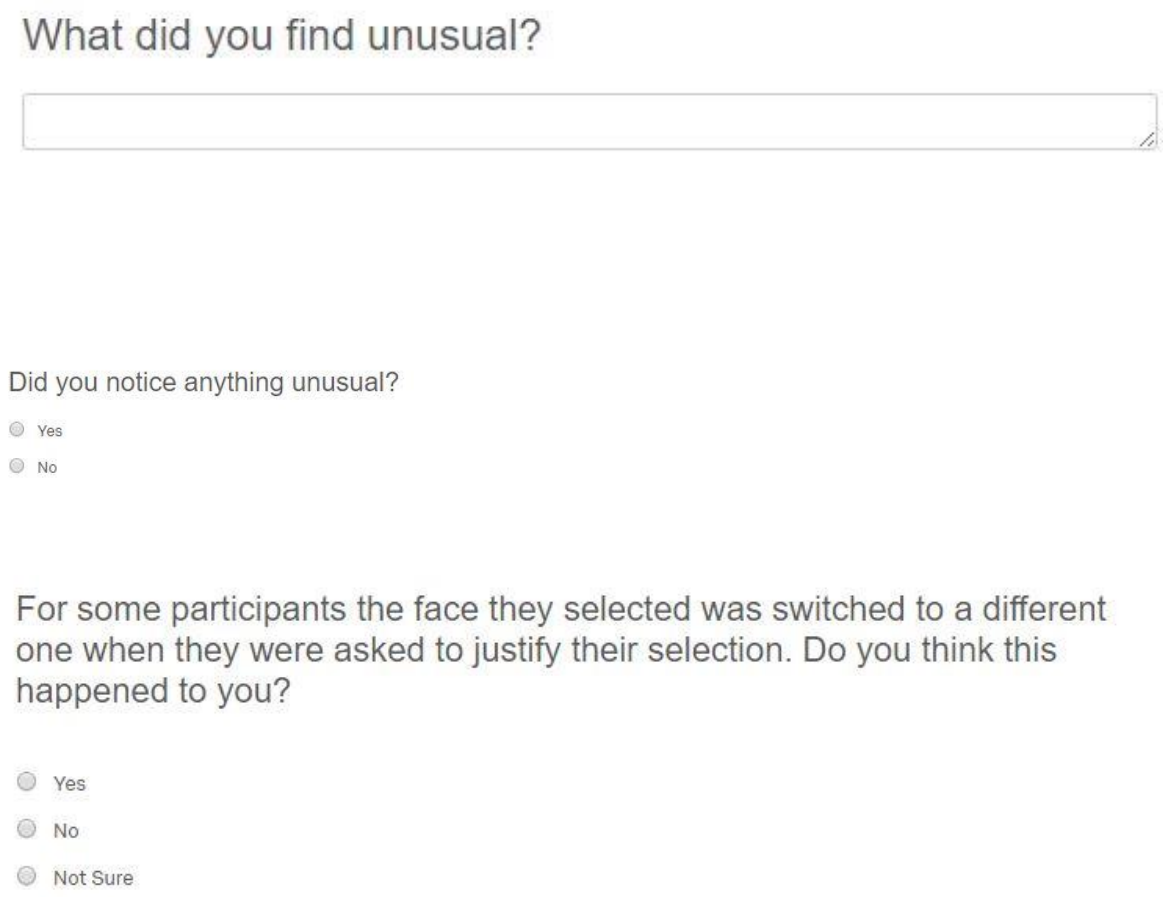


Figure 24a. Example of experimental procedure

Low similarity set

F033

F059

High similarity set

F059

F086

Figure 24b. Pairs of stimuli used in the study (low and high similarity pairs of female faces).

The experiment was conducted online using Qualtrics, in the judgement condition participants rated the attractiveness of both faces, specifically, they were asked *"Please rate the attractiveness of the two faces with 0 being not attractive and 10 being attractive"* (see Figure 25), whereas in the choice conditions participants were asked *"Please select the face you find most attractive."* (see Figure 24a). Following providing their preferences participants were shown the switched option and, in the judgement, condition were asked *"Please explain your reason for rating this face as more attractive out of the two provided.",* whereas in the choice condition participants were asked "*Please explain your reason for selecting this face as most attractive",* and in both conditions respondents placed their responses in a text entry box.

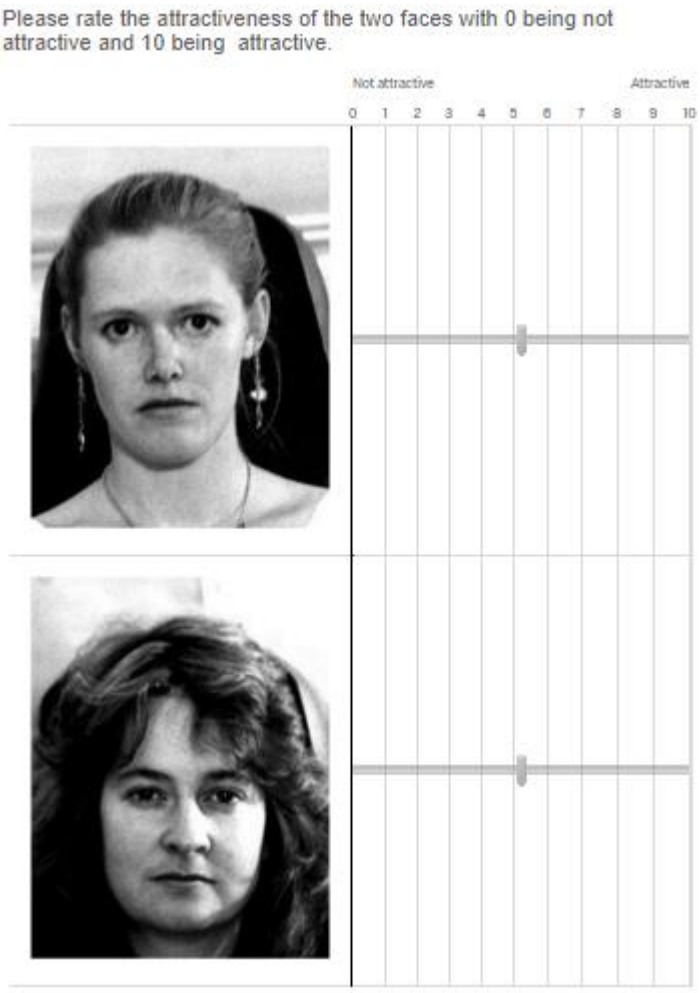


Figure 25. Example of likert scale used for the individual judgement of the choice options.

4.3.1.3. Procedure

Once participants had been explained the nature of the experiment and had their rights as participants explained to them, demographic information was collected. In the judgement condition participants were asked to rate the attractiveness of the faces individually on a likert scale, ranging from not attractive to very attractive (see Figure 25), whereas in the choice condition, participants were asked to select the face they found most attractive. Once participants had provided their preferences for the stimuli, in the judgement conditions participants were presented with the face they rated as least attractive, or in the choice conditions with the image they did not select as most attractive and asked to justify their choice. Participants were asked several questions to confirm whether they had detected the switch; first they were asked if they noticed anything unusual, if they indicated noticing something, they were then asked to state what they had noticed. Participants were then informed that for some of them their preferred image had been switched and did they think this had happened to them.

4.3.2. Results and Discussion

Binary logistic regressions were used to analyse the results, specifically due to the binary nature of the outcome (choice blindness or non-choice blindness preferences). Whilst the other tests used in the thesis thus far would have been sufficient to cope with this data. A binary logistic regression was chosen in order to examine the extent to which changes between different levels of commensurability would lead to an increase in the likelihood of the respondents displaying or not displaying choice blindness.

An initial binary logistic regression examined the potential for stimuli similarity and decision type to predict concurrent detection. The Hosmer-Lemeshow test indicated that the model with both predictors was a good fit to the data χ^2 (2) = 0.03, p = .986, with a Cox and Snells R^2 = .05. Decision type significantly contributed to the model (p = .032); however, stimuli similarity did not significantly contribute to the model (p = .184). The (EXP[B]) for decision type indicated that when the stimuli match changed by one unit (going from choice to judgement) the odds of a participant not noticing the switch increased by 0.442.

Table 2. Percentage of participants who concurrently detected the choice blindness manipulation

Decision Type	Stimuli Stimularity	Concurrent Detection*
Choice	Low	48
Choice	High	35
Judgement	Low	31
Judgement	High	20

*Percentage of participants who noticed the choice blindness manipulation

Secondly, a multiple logistic regression was used to examine whether stimuli similarity and decision type predicted whether retrospectively respondents were aware of the switch; unaware of the switch; or unsure if the switch had occurred to them. The model, however, was not a significant fit to the data χ^2 (2) = 4.97, p = .291, indicating that neither stimuli similarity nor decision type could predict whether respondents retrospectively detected the switch.

The findings of experiment eight have offered further support for the effect of task commensurability operationalised with decision type to predict whether

respondents would detect the switch with concurrent detection. However, no effect of stimuli similarity was found for whether respondents would detect the switch. Moreover, there was no effect of either the manipulations on retrospective detection. The study found that respondents were more likely to notice the switch concurrently when the initial decision was a choice, compared to when the initial decision was a judgement.

The increased switch detection with choices compared to judgements is argued to have occurred, specifically as discussed previously, the initial choice required a comparative assessment comparing the options against each other. In contrast, the secondary task evaluating the image was not comparative, but an isolated assessment of the individual stimuli. As result of the incommensurability in the tasks, decision makers were more likely to notice the switch as establishing their initial preference relative to the other available option, so had already identified pro forma differences between the two options facilitating switch detection. In contrast, the judgement condition had task commensurability, as the act of individually judging the images was akin to individually rating the images. Hence, when presented with the image and asked to explain their selection, participants already had identified favourable points for either of the images, formed when establishing their judgements, so were able to provide these favourable attributes when asked to justify their preferences. Whilst with the independent variable stimuli similarity every care was taken to ensure that the images were as dissimilar as possible, whilst controlling for attractiveness, none the less they were commensurable, simply positioned at either end of the same category. Due to this, it is no surprise that there was no effect of similarity on switch detection, specifically, as the findings reiterate those found previously - that similarity does not have an effect on switch detection

(e.g. Johansson et al., 2005), unless the stimuli are dissimilar enough to belong to distinctly separate categories, in effect making the measure more akin to commensurability and incommensurability than simply similarity or dissimilarity (Steenfeldt-Kristensen & Thornton, 2013).

4.4. General Discussion

The seventh and eighth experiments tested the hypothesis that decreasing commensurability within the choice blindness task would lead to a reduction in the proportion of respondents who display choice blindness. The seventh experiment tested the effect of option and task commensurability on choice blindness. Option commensurability can be defined as the commensurability of the decision options under consideration. Incommensurable decision options compared to commensurable decision options was hypothesised to decrease the proportion of participants who would exhibit choice blindness. This was expected to occur, as with incommensurable decision options participants would not be able to rely on shared reference points between the decision options. As a result of incommensurability reaching a decision would rely on an individual introspective assessment of both alternatives. The isolated assessment of incommensurable items was expected to prevent susceptibility to choice blindness.

Past research has presented mixed results on the effect of stimuli similarity on choice blindness detection rates. Research has identified that the use of dissimilar stimuli can reduce the proportion of respondents who display choice blindness (Steenfeldt-Kristensen & Thornton, 2013). However, this occurs only if the stimuli are not only dissimilar on a dimension, but also if the stimuli belong to two separate categories; for example, not only dissimilar but also incommensurable (e.g., a mobile

phone with a touch screen input compared to a mobile phone with a keypad input; Steenfeldt-Kristensen & Thornton, 2013).

Secondly, task commensurability dictated whether decision makers could compare between their initial decision and the secondary justification of the decision. The level of commensurability between the initial task and the secondary justification task was expected to impact the proportion of respondents who would display choice blindness. An increase in task commensurability was expected to increase the proportion of respondents who display choice blindness. This was expected to occur as if both stages of the task are commensurable, decision makers would have access to shared reference points between both stages of the task due to commensurability and so are less likely to detect the change. In contrast, task incommensurability was expected to result in a decline in the proportion of respondents who display choice blindness.

The findings of experiment seven partially supported the hypothesis that incommensurability would reduce the proportion of respondents who would display choice blindness. Specifically, as the option's commensurability decreased, changing from commensurable to incommensurable, the likelihood of respondents detecting the switch increased. Secondly, with retrospective detection, again both stimuli match and stimuli colour match significantly contributed to the model, again a decrease in commensurability led to an increase in switch detection. However, in contrast to the initial findings, a decrease in task commensurability also led to an increase in in switch detection, with participants taking part in an incommensurable task more likely to detect that a switch had occurred compared to participants who had a commensurable task.

The eighth study sought to examine the effect of task commensurability on choice blindness, using stimuli similar to that used previously in choice blindness research (Johansson et al., 2005), as such option commensurability could not be manipulated. Whilst it was not possible to test the effects of option commensurability, the similarity of the images used was controlled for to provide a similar and dissimilar choice set. The findings of experiment eight offered further support for the effect of task commensurability operationalised with decision type to predict whether respondents would detect the switch with concurrent detection, with an incommensurable task leading to an increase in the switch manipulation compared to the commensurable task. However, no effect of stimuli similarity was found on whether respondents would detect the switch. Moreover, there was no effect of either the manipulations on retrospective detection. The study identified that respondents were more likely to notice the switch concurrently, when the initial decision was a choice compared to when the initial decision was a judgement. Task commensurability was found to effect switch detection, as task commensurability increased the proportion of respondents who displayed choice blindness increased. As result of the incommensurability in the task (with a choice between the options), decision makers were more likely to notice the switch, as they had established their initial preference relative to the other available option; hence, already had identified pro forma differences between the two options, facilitating switch detection. In contrast, the judgement condition had high task commensurability as the act of individually judging the images was akin to individually rating the images. Whilst with the similarity variable every care was taken to ensure that the images were as dissimilar as possible, whilst controlling for attractiveness, none the less they were still commensurable simply positioned at either end of the same category. Due to

this, it is no surprise that there was no effect of similarity on switch detection; specifically, as these finding reiterate those found previously, that similarity does not have an effect on switch detection (e.g. Johansson et al., 2005), unless the stimuli are dissimilar enough to belong to distinctly separate categories, in effect making the measure more akin to commensurability and incommensurability than simply similarity or dissimilarity (Steenfeldt-Kristensen & Thornton, 2013).

Chapter 5: Conclusions and Future Work

5.1. Discussion and Summary of Main Findings

The research has examined the proposal that commensurability in decision-making tasks encourages behavioural biases, and moreover that introducing incommensurability in decision-making tasks discourages behavioural biases. The effect of commensurability on decision-making is supported by experimental and theoretical research, which has highlighted the biasing effect of commensurable decision attributes (Slovic & MacPhillamy, 1974), as well as research detailing the comparative nature of human decision-making processes (e.g., decision by sampling, Stewart et al., 2006). Specifically, decision makers have been shown to over rely on common commensurable attributes (Slovic & MacPhillamy, 1974) to inform their decision making. Commensurability was expected to allow decision makers to compare decision-making information (leading to behavioural biases), whereas incommensurability was expected to prevent decision makers from comparing decision attributes, and in turn reducing behavioural biases.

Theorists in psychology have made suggestions regarding the impact of commensurability and incommensurability on decision-making behaviour. For example, Slovic and MacPhillamy (1974) argue that commensurable values are favoured over incommensurable values by decision makers, and as such are over weighted (biasing decision makers' judgements) compared to incommensurable values. Vlaev (2011) has reiterated the impact of commensurable and incommensurable decision content on shaping decision maker's judgements, proposing that the commensurability (and incommensurability) of task specific information (e.g., attributes) should be considered as a key factor in predicting decision maker's judgements.

The definition and impact of commensurability and incommensurability across fields of study have been heavily debated. However, what remains undisputed by theorists (e.g., Griffin, 1986; Vlaev, 2011) is the proposal that decision makers cannot place incommensurable values on a single common dimension for comparison. Moreover, theorists vetoing the extent to which incommensurability prevents the comparison of values, still concede that comparison strategies vary when comparing either commensurable or incommensurable information (e.g., Sankey, 1991; Kelly, 2008).

In light of theoretical proposals emphasising the integral role of comparisons in educating decision making, such as decision by sampling (Stewart et al., 2006), coupled with research emphasising the impact of incommensurability (Slovic & MacPhillamy, 1972) on decision making, the current research has examined the proposal that commensurability in decision-making encourages behavioural biases. Commensurability, in the decision-making task or scenario was found to encourage decision makers to use comparative strategies, leading to the production of behavioural biases. Equally incommensurability was found to prevent decision makers from using comparative strategies, in turn inhibiting behavioural biases. The effect of commensurability/incommensurability on decision-making behaviour was predicted to occur based on research which emphasizing that decision-makers are unable to make comparisons between different (e.g., incommensurable) stimuli and decision options (Kusev et al., 2009; Stewart et al., 2005; Vlaev et al., 2011; & Vlaev et al., 2012). Hence, when incommensurability is introduced into the decision-making task (e.g. with incommensurable content) decision makers will not attempt to use biased comparative strategies.

The second chapter examined the effect of commensurable task judgement content (the ability to compare the decision-making task and judgement, with the same commensurable content [e.g. a monetary task and a monetary judgement]) on loss aversion. Testing the proposal that it is hypothesised that commensurability between the decision-making task and judgement content will fuel loss averse behaviour. This proposal is based upon research emphasising (Stewart et al., 2006) that the occurrence of loss aversion depends on decision makers' ability to compare the current task to past experiences. Moreover, Slovic and MacPhillamy's (1974) work has emphasised the role which commensurability plays in encouraging behavioural biases. Commensurability is anticipated to allow decision makers to compare decision-making task and judgement with commensurable content, producing loss averse preferences. Commensurability was expected to encourage loss averse preferences by allowing decision makers to make comparisons both within the task and externally, as it has been emphasised previously as a principle driving force of loss aversion (Stewart et al., 2006).

Accounts of loss aversion have explored a range of possible mechanisms. Some accounts of loss aversion have emphasised an ingrained bias in the perception of gains and losses or explanations tied to decision makers' perceptions of winning and losing (e.g., Kermer et al., 2006), whereas others have emphasised the role of comparisons in shaping decision makers preferences (e.g., McGraw et al., 2010; Walasek & Stewart, 2010). Kahneman and Tversky (1979, p.279) offer an early explanation of loss aversion with the proposal that "losses loom larger than gains" which suggests that a greater decision weight is applied to losses than to gains. Theorists have proposed that decision makers under anticipate their ability to cope with losses, so display an aversion to outcomes framed as such (Kermer et al.,

2006). Recent research, however, has highlighted the role of comparisons in driving loss-averse preferences. Evidence coming from decision by sampling has indicated that loss aversion occurs as current decision options are compared against previously experienced comparable decision options; by doing so decision makers establish the relative rank position of the options under their consideration (Walasek & Stewart, 2015). Since decision makers experience more losses than gains on a day-to-day basis, there are more ranks (reference points) for losses to be ranked against; as result, losses typically receive a higher relative rank position than equivalent gains, producing loss averse preferences. McGraw et al. (2010) provide an alternative account, arguing that loss aversion is produced through the contextual comparison of gains and losses. In other words, decision makers only display loss aversion when judgements of feelings towards winning and losing are placed in the same context for comparison. In response to the experimental findings of McGraw et al. (2010), the series of experiments in the second chapter has revealed that the presence or absence of task judgement content commensurability determines (inhibiting or inducing) loss-averse behaviour.

The initial study found that CTJC increased respondents' propensity for loss-averse judgements. Whilst theoretical proposals on commensurability have already been made (e.g., Vlaev et al., 2011), they have not examined the validity of commensurability as a predictor of decision-making behaviour, specifically, loss aversion. Additionally, past research has emphasised that decision makers are unable to make comparisons between different (e.g., incommensurable) stimuli and decision options (Kusev et al., 2009; Stewart et al., 2005; Vlaev et al., 2011).

The first experiment found in support of the hypothesis that commensurability increased the proportion of loss-averse judgements. Specifically, the proportion of

loss-averse judgements made was not influenced by the type of scale (unipolar/bipolar) the judgement was made on, when the task and judgement content was commensurable. In contrast, when the task and judgement content was incommensurable, the effect of contextual comparability reported by McGraw et al. (2010) was confirmed.

The second examined and supported the hypothesis that manipulating commensurability between the decision task and judgement would reduce loss averse behaviours – preventing comparisons between the decision-making task and judgement. Specifically, preventing these comparisons will also prevent decision makers from viewing the current task as a whole (task and judgement), and in turn viewing the task in the context of their past experiences, and as discussed comparisons between current and past decisions have been attributed to promote loss averse behaviour. The study found further support for the effect of incommensurable/commensurable task judgement content on loss aversion across low, medium and high levels of task judgement content commensurability. Specifically, the proportion of respondents who displayed loss aversion, as commensurability went from low to high, increased.

The third study examined the effect of impeding commensurability to reduce the proportion of loss-averse judgements. It was hypothesised that impeding commensurability between task and judgement content would reduce the proportion of loss-averse judgements made on bipolar scales. Whereas judgements made on unipolar scales, as in experiment one, were not expected to be impacted by whether commensurability was impeded between the task and judgement as contextual unipolar comparisons could still occur (McGraw et al., 2010). Impeding commensurability between the decision-making task and judgement with bipolar

scales was found to lead to a decline in the proportion of loss-averse judgements. However, with unipolar scales when commensurability between the task and judgement content was impeded, there was not a reduction in the proportion of respondents' who displayed loss-averse judgements. The fourth study further examined the effect of commensurability between the decision-making task and judgement content on respondents' rates of loss aversion. Specifically, the study examined the hypothesis that incommensurability between the gamble task (in Bulgarian) and monetary-judgement (in English) would reduce respondents' rates of loss aversion on bipolar scales but not on unipolar scales. Commensurability was manipulated by presenting the task and judgement in two different languages. The gamble was presented in Bulgarian - incommensurable to the judgement question presented in English. As anticipated the findings revealed that participants who made judgements on bipolar scales with incommensurable task and judgement languages displayed less loss aversion than judgements made with commensurable task and judgement languages. Moreover, in line with earlier research when judgements were made on unipolar scales the commensurability between the task and judgement language did not impact respondents' rates of loss aversion. The findings identified that judgements made on bipolar scales with incommensurable task and judgement languages were less loss-averse than judgements made with commensurable task and judgement languages. Moreover, it was found that with unipolar scales, the commensurability between the task and judgement languages did not impact the proportion of respondents who displayed loss aversion, as the decision makers could still make contextual comparisons between gains and losses.

The third chapter examined the impact of option commensurability - the ability for decision makers to compare choice options on a single common dimension. The

effect of option commensurability was examined on the compromise and attraction effects. The compromise effect describes a phenomenon where the addition of a third (compromise) option to the choice set, which falls on both attributes between the two initial options under consideration, is chosen with a disproportionately high frequency, compared to the two initial options under consideration (Simonson, 1989). The attraction effect describes a pattern of behaviour where adding a decoy option to a choice prompts the selection of the target option (Huber et al., 1982). The decoy option is asymmetrically dominated by the target option and produces a change in preferences between the target and competitor with the distribution of selection changing from 50/50 for the target and competitor (without the decoy), to an overwhelming preference for the target option (Huber et al., 1982; Huber & Puto, 1983). Accounts of multi-attribute decision-making have presented explanations of both effects founded not in the aggregation of the attributes of each option, but instead, based on the various processes of information sampling and within attribute comparisons between the options (e.g., Ronayne et al., 2017). The current research has revealed that the commensurability of the options under consideration moderates the extent to which the options are compared, and in turn whether the attraction and compromise effects occur.

The fifth study examined the hypothesis that commensurability of the choice options would dictate whether the options are compared and whether the attraction effect would occur. Introducing an incommensurable decoy option was anticipated to reduce the effect, specifically incommensurability will prevent the options from being entered into the comparisons, and in turn, preventing the attraction effect. Examining the attraction effect, the findings partially supported the hypothesis that incommensurability between the decision options would reduce the attraction effect,

specifically, the pattern of behaviour was affected by the stimuli used for the manipulation. When the decoy and target options were oranges, there was an effect of decoy commensurability with an incommensurable decoy producing a decline in selection of the target option, compared to when the decoy was commensurable. However, there was no effect of decoy commensurability when the decoy and target options were both apples. This disparity in decision making behaviour depending on whether the decoy option was either an apple or an orange occurred potentially due to a general underlying preference for apples over oranges. Moreover, evidence of the underlying preference for the apple stimuli over the orange stimuli was also observed in the findings of the sixth experiment examining the compromise effect. It is argued that there was an effect of commensurability with the orange stimuli, as the addition of an orange decoy overcame the underlying preference for the apple stimuli, allowing for the effect of decoy commensurability to be observed.

The sixth experiment examined the proposal that the occurrence of the compromise effect will depend on whether the compromise option is commensurable or incommensurable to the other options in the choice set. Reducing the commensurability of the compromise option was expected to prevent the compromise effect, as an incommensurable compromise option will not be compared to the two alternative options when decision makers are evaluating the options, and in turn, will not be chosen. The sixth study found that increasing the commensurability of the compromise option led to an increase in the proportion of respondents who selected the compromise option. Moreover, decreasing the commensurability of the compromise option, making the compromise option incommensurable, led to a reduction in the proportion of respondents who selected the compromise option. However, it should be noted that whilst the proportion of

respondents who selected the compromise option in the commensurable condition increased, compared to the incommensurable condition, there was not an overwhelming preference for the compromise option. Moreover, in the commensurable, incommensurable and control conditions there again appeared to be an underlying preference for the apple stimuli over the orange stimuli, illustrated by a greater proportion of respondents selecting the apple stimuli over the orange stimuli. This unexpected pattern of behaviour is similar to the underlying preference for apples, over oranges identified in experiment five.

The final experimental chapter examined the proposal that decreasing commensurability in the choice blindness task would reduce the proportion of respondents who display choice blindness. Choice blindness describes a pattern of behaviour where decision makers, after making an initial selection between two options, fail to notice that their chosen option has been switched for the option they did not choose (Johansson et al., 2005). Two forms of commensurability were manipulated, task commensurability the commensurability of the initial decision making task to the secondary task (the decision makers justification of their decision) and option commensurability, the commensurability of the options under consideration either commensurable or incommensurable choice options.

Past research has shown that the use of dissimilar stimuli reduces the proportion of respondents who display choice blindness, however, this only occurs if the stimuli is not only dissimilar on a single dimension, but also if the stimuli belong to two separate categories (Steenfeldt-Kristensen & Thornton, 2013). Whereas option commensurability dictates not only whether the stimuli used in the task are similar or dissimilar, but rather, whether the options can be placed on a single scale for comparison e.g. can the options be compared. Introducing option

incommensurability (the opposite of task commensurability) was expected to reduce the proportion of participants who display loss aversion, as the participants would not be able to rely on shared reference points. The suggestion of shared reference points is similar to Steenfeldt-Kristensen and Thornton's (2013) proposal with the feature matching hypothesis i.e. items sharing the same types of features are more likely to produce choice blindness. Whereas, contrasting items with unique features will not be compared, but rather recognised as unique and therefore any switching of these options was expected to be detected. Task commensurability dictates whether the decision makers could compare between their initial decision and their secondary justification of the decision. The level of commensurability between the initial task and the secondary justification task was expected to impact the proportion of respondents who display choice blindness. Increasing task commensurability was expected to increase the proportion of respondents who display choice blindness. This was expected to occur, as when both stages of the task are commensurable decision makers will have access to shared reference points between both stages of the task due to commensurability and so identifying discrepancies is less likely and decision makers are more likely to display choice blindness.

The findings of experiment seven partially supported the hypothesis that incommensurability would reduce the proportion of respondents who display choice blindness. Specifically, as option commensurability decreased, changing from commensurable to incommensurable, the likelihood of respondents detecting the switch increased. Secondly, with retrospective detection both variables were designed to assess option commensurability; stimuli match and stimuli colour match both contributed to the model with a decrease in commensurability, leading to an increase in switch detection. In contrast with concurrent detection, a decrease in task

commensurability led to an increase in switch detection, with participants in the incommensurable choice condition being more likely to detect that a switch had occurred, compared to participants in the judgement condition.

The eighth study sought to further examine the effect of task commensurability on choice blindness using stimuli similar to those used previously in choice blindness research (Johansson et al., 2005), as such option commensurability could not be manipulated. Whilst it was not possible to test the effect of option commensurability, the similarity of the images was controlled to provide a similar and dissimilar choice set. The incommensurable choice blindness task produced an increase in detection of the switch manipulation, compared to the commensurable choice blindness task. Respondents were more likely to detect the switch concurrently when the initial task involved an incommensurable choice, compared to when the initial task was a commensurable judgement. However, no effect of stimuli similarity was found on whether respondents detected the switch; whilst every effort was taken to ensure the marked dissimilarity of the dissimilar stimuli, none the less they were still commensurable, simply positioned at either end of the same category. Due to this it is of no surprise that there was no effect of stimuli similarity on switch detection. Specifically, as the finding reiterate those found previously that stimuli similarity does not have an effect on switch detection (e.g. Johansson et al., 2005), unless the stimuli are dissimilar enough to belong to distinctly separate categories (Steenfeldt-Kristensen & Thornton, 2013), in effect making the measure more akin to commensurability and incommensurability than simply similarity or dissimilarity. Moreover, there was no effect of either the manipulations on retrospective detection.

5.2. Strengths and Limitations

The first four studies examined the impact of task judgement content commensurability on loss aversion building on early experimental (Slovic & MacPhillamy, 1974) and then later theoretical proposals on the role of commensurability in decision making (Vlaev, 2011). Recent theorists have hypothesised, but not tested the effect of commensurability on decision making (e.g., Vlaev, 2011; Vlaev, et al., 2011), however, this has not examined the validity of commensurability as a predictor of decision-making behaviour, and in the case of the current study - loss aversion. Whereas the current study has revealed that commensurability shapes the extent that decision makers display loss aversion. Moreover, the findings that incommensurable tasks judgment content preventing comparisons leads to a reduction of loss averse judgments coincides with research revealing that decision makers are unable to compare between different decision stimuli and decision options (Kusev et al., 2009; Stewart et al., 2005; Vlaev et al., 2011; Vlaev et al., 2011). Hence chapter two has highlighted the potential for commensurability/incommensurability to shape decision making reiterating early experimental research on commensurability (Slovic & MacPhillamy, 1974), as well as supporting recent theoretical suggestions of commensurability (Vlaev, 2011).

In the third experimental chapter examining the impact of introducing incommensurability choice options (and in turn preventing comparisons between the choice options) on the attraction and compromise effects has built on earlier explanations of the both effects respectively. Specifically, theorists when looking to explain both effects have made proposals that the effects occur due to the comparability of decision options, and in turn, comparative decision making processes which produces the effects (e.g. in the case of the attraction effect

Simonson, 1989 and the compromise effect Dhar & Simonson, 2003). Specifically, the studies have demonstrated that both the attraction and compromise effects depending on the commensurability of the respective choice options (highlighting the comparative psychological processes inducing the effects). Specifically, the importance of comparative processes for the effects was reiterated as when an incommensurable choice option was introduced and in turn comparisons between the options was prevented (and accordingly the effects were dissipated).

The fourth chapter has highlighted the role of both option and task commensurability on choice blindness. Specifically, option and task commensurability address two separate aspects of the role of commensurability on loss aversion. Option commensurability sought to expand on choice blindness research which has offered mixed results for the effect of stimuli similarity on choice blindness detection rates (e.g. Steenfeldt-Kristensen & Thornton, 2013). Specifically, the effect of dissimilar stimuli compared to similar stimuli has been shown to reduce the proportion of respondents who display choice blindness, only if the stimuli were not only dissimilar, but importantly if the stimuli belong to two separate categories (Steenfeldt-Kristensen & Thornton, 2013). Experiment seven built partially on the suggestion the effect of dissimilar stimuli (specifically stimuli belonging to separate categories) reduces choice blindness. Incommensurable stimuli reduced the proportion of respondents who displayed choice blindness compared to the commensurable condition. Secondly, task commensurability dictated whether decision makers compared between their initial decision and the secondary justification of the decision. An increase in task commensurability increased the proportion of respondents who displayed choice blindness. The level of commensurability between the initial task and the secondary justification task shaped

the proportion of respondents who displayed choice blindness. The suggestion of shared reference points is similar to Steenfeldt-Kristensen and Thornton's (2013) proposal with the feature matching hypothesis i.e. items sharing the same types of features are more likely to produce choice blindness. Whereas, contrasting items with unique features will not be compared but rather recognised as unique and therefore any switching of these options was expected to be detected.

One limitation running through the eight studies is the extent that commensurability/incommensurability has been manipulated throughout the studies. This issue is compounded by the variety of definitions and debates surrounding the effect of commensurability/incommensurability (e.g. Griffin, 1986; Wiggins, 1997). Throughout debates surrounding incommensurability the definitions and stringencies placed on incommensurability vary. The varying stringencies and variety of definitions placed on incommensurability is exemplified by the variety of increasingly de-escalating definitions of value incommensurability offered by Griffin (1986) from the stringent incomparability to the weaker discontinuity. It could be seen to damage the scope of the research by not adopting a more stringent definition of incommensurability than Sunstein's (1994) proposal that two values or items are so dissimilar that they cannot be placed on a single scale for comparison. However, whilst this definition of incommensurability may seem vague, it was utilised specifically as it offered a broadly applicable form of incommensurability. The broad definition of incommensurability not only allowed incommensurability to be applied in the present research, but also for incommensurability to be applied to future research, examining and applying the effect of incommensurability on decision making behaviour. Moreover, this variety of explanations of commensurability does raise the question as to whether commensurability has been manipulated

consistently through the studies, and in turn, whether the commensurability manipulation has shaped the experimental findings of the studies. For example, to what extent can the manipulations of commensurability in the first four studies examining loss aversion be compared to the commensurability manipulations be compared to the manipulations in the fifth and sixth studies. Whilst these manipulations are varied, the outcome of the manipulations is that comparisons are either encouraged or prevented. Accordingly, future studies exploring the understanding of the effects of commensurability/incommensurability should focus on the effects that encourage or discourage respondents use of comparisons in decision making. Specifically, research examining the effects of encouraging/discouraging comparisons on decision making; moreover, the strong foundation of psychological research on similarity such as Tversky's (1977) contrast model of similarity. For example, the contrast model of similarity (Tversky, 1977) will provide a strong foundation for quantifying similarity and dissimilarity which will be able to inform further research looking at the processes of comparisons in decisions.

When examining the effect of commensurable task and judgement content on loss aversion, whilst the research identified that commensurability shaped whether loss aversion was displayed by participants. The effect of task judgement content commensurability also coincides with existing proposals of loss aversion that have emphasised the role of comparative processes in the production of loss aversion (e.g., McGraw et al., 2010; Walasek & Stewart, 2010). For example, whilst some accounts of loss aversion have emphasised an ingrained bias in the perception of gains and losses, or explanations tied to decision makers' perceptions of winning and losing (e.g., Kermer et al., 2006), others have emphasised the role which comparisons play in shaping decision makers' preferences (e.g., McGraw et al.,

2010; Walasek & Stewart, 2010). In other words, the effect of task judgement content commensurability should not be considered per se the cause of loss aversion, but rather as a factor dictating whether loss aversion will or will not be present in decision makers' judgements.

Whilst the research has highlighted the effect of task judgement content commensurability on loss aversion, the findings of the four studies equally emphasised the role of scale compatibility as highlighted by McGraw et al. (2010) on loss aversion. Specifically, scale compatibility is the ability for decision makers to compare their feelings towards winning and losing by using a neutral unipolar scale to evaluate both outcomes on the production of loss aversion was found to occur across the first four studies. Judgements of gain and loss gambles, made on unipolar scales, encouraged loss averse judgements irrespectively of whether there was or was not task judgement content commensurability. In other words, when decision makers cannot compare between the decision-making task and judgement scenario they will still display loss aversion, if encouraged to compare the outcomes of winning and losing on a neutral (unipolar) scale.

The third chapter, examining multi attribute decision making, found partial support for the effect commensurability on the compromise and attraction effects and equally for incommensurability to prevent both effects. Specifically, with the attraction effect, there was only an effect of option commensurability (the commensurability of the decision options in the choice set) when an orange option was the target, but not when an apple was the target. This pattern is proposed to occur as decision makers may have a stronger preference for apples over oranges; hence, even when the apple decoy was incommensurable, decision makers still preferred the apple target over the orange competitor. Moreover, when examining the compromise effect, there

also appeared to be a slight preference for the apple stimuli over the orange stimuli. An underlying preference for either the apple or orange stimuli was not anticipated to cause issues in the research, however, the preference for the apple stimuli over the orange stimuli in the research does reflect the preference for apples over oranges, that has been identified in UK consumers (Fresh Plaza, 2014). The occurrence of the apple effect emphasises the need for greater control of the stimuli used in future research, specifically, to avoid this effect from occurring, pre-test studies should have been conducted to ensure the general equivocacy of the stimuli.

When examining the effect of commensurability on choice blindness a decrease in option commensurability led to a reduction in the proportion of respondents who displayed choice blindness. However, the stimuli chosen in the high incommensurable condition an apple and a pepper belong to two separate categories opening the door for the categorisation explanation of choice blindness (Hall et al., 2010). The categorisation explanation suggests that options which can be placed in discrete and separate categories encourages switch detection (Hall et al., 2010). Due to this it cannot be established whether the reduction in choice blindness was due to the incommensurability of the stimuli, preventing feature matching and comparisons of the options, or as the stimuli could be placed onto distinct and separate categories (e.g., apples are fruits and peppers, in a colloquial or culinary sense, are categorised as a vegetables). Whilst this issue is particularly evident with the stimuli chosen, identifying stimuli for future research which are incommensurable yet can be placed into the same category, or equally stimuli that can be placed into different category yet are commensurable presents a challenge. Specifically, as incommensurable items as defined by Sunstien ([1994] as items that cannot be placed onto a single universal scale for comparison) are also likely to

belong to two separate categories, as incommensurability is synonymous with differences and non-compatibility; in other words, incommensurable stimuli are also likely to belong to different categories.

5.3. Future Directions and Applications

The future direction of research examining the effects of incommensurability on decision making and the applications of the impact of incommensurability on decision making are inexplicably linked. The future directions of the research are two-fold. Firstly, research should be conducted to examine the potential for incommensurability to prevent behavioural biases in an applied decision making setting and secondly to examine the effect of incommensurability further from a theoretical and experimental perspective. Specifically, the potential for incommensurability to de-bias decision makers when applied to noteworthy inconsistent patterns of decision making should be conducted. To this end several potential future studies have been tentatively outlined which offer further theoretical scope to apply and examine the effects of incommensurability on decision making behaviour, such as the reversal in preferences when decision makers are tasked with either accepting or rejecting choice options as detailed by Shafir (1993).

With regard to the fifth and sixth experiments examining the compromise and attraction effects the studies were hampered by respondents underlying preferences for apples over oranges. Hence, further research should be conducted to examine the attraction and compromise effects by utilising the same experimental methodologies as experiments five and six however, the stimuli should be changed to ensure that the stimuli used possess a general equivocacy.

Furthermore, future studies have been designed to expand understanding of commensurability/incommensurability on behavioural biases in decision making. Experiments seven and eight partially examined the effect of commensurability/incommensurability on the disparity between preferences elicited by judgements or choices, highlighting the need for further research to examine the effect of commensurability on the disparity in preferences elicited by judgements or choices. Lichtenstein and Slovic (1971, 1973) suggest that different strategies are used for judgements and choices these different strategies used to arrive at the different decisions results in a reversal of preferences. Specifically, decision makers are suggested to base their decision on the attribute of the options which is compatible to the manner of the assessment. In other words, the dimension that a decision is made on prompts decision makers to focus on making the decision based on the attributes that matches the dimension of their judgement. For example, when asked to judge a monetary gamble in terms of its monetary worth, decision makers attend to and base their judgement on the monetary value of the gamble ignoring the probability of winning or losing. Furthermore, Tversky et al. (1988) propose the cue response comparability hypothesis, which proposes that the attributes of the options that are similar to the nature of the judgement, loom larger than dissimilar attributes. A link can be seen between the cue response comparability hypothesis and previous research examining the effect of incommensurability, specifically, the evidence that decision makers, given the opportunity, over weight common commensurable attributes (Slovic & MacPhillamy, 1974) just as similar attributes are proposed to loom larger than dissimilar attributes (Tversky et al., 1988). Future research should investigate preference reversals, examining the proposal that the reversal of preferences elicited by judgements or choices occurs due to the

commensurability of decision attributes between the decision task and judgement. Moreover, it is suggested that creating incommensurability between the options attributes and the method of preference elicitation (judgement or choice) will reduce the proportion of participants who display preference reversals between judgements and choices.

For example, the effect of incommensurability on the preference reversals between judgements and choices could be examined by introducing incommensurability between the initial decision-making information and the preference elicitation method. The experiment will use a 2 x 2 mixed measures design with the within subject's variable, preference elicitation (choice or judgement) and the between subjects' variable, presentation of worth either commensurable (monetary worth) or incommensurable (gold). The value of each of the gambles will be presented either as monetary worth (commensurable) or as grams of gold (incommensurable). It is suggested that gold is incommensurable to monetary worth, as since the end of the gold standard in 1931 in the UK the value of currency (GBP) is not directly proportional to gold.

Moreover, a second study will examine the effect of the incommensurable presentation of risks between judgements and choices. The likelihood of each outcome occurring will be presented either graphically or numerically. It is suggested that the commensurability of the outcome occurring - whether the two gambles can easily be compared, in terms of the likelihood of their occurrence, will affect the consistency of their preferences; incommensurability is predicted to prevent a reversal in preferences between judgements and choices. The experiment will utilise a 2 x 2 mixed measures design with the within subject's variable preference elicitation (choice, judgement) and the between subjects'

variable presentation of risk. Risks will be presented either graphically in a manner incommensurable to the typical presentation of risk for gamble decisions, (typically given numerically as a percentage or as an odds ratio) or in a commensurable manner as a percentage.

Another area of research where the implications of commensurability/incommensurability can be levied is to examine the potential for incommensurability in decision making to reduce the reversal of preferences between decisions requiring either an acceptance or rejection. Shafir, Simonson and Tversky (1997) have emphasised the importance of the process of reasoning and justifying choices, indicating that decision maker's preferences are constructed based on their ability to construct and provide reasons for their decision. This is used to explain the disparity in behaviour identified by Shafir (1993) in decision maker's behaviour when asked to either accept or reject the options being considered. In the task decision makers were given two options, however, one option was enriched (containing extreme positive and negative values) and one option was not enriched. Paradoxically, when asked to accept or reject an option, in both instances the enriched option is preferred by decision makers, in violation of procedural invariance. Considering proposals made in reason-based choice, it is not surprising that decision makers adopted different strategies based on the questions they were asked. Specifically, as the positive features of the enriched option are compared with the average option, whereas when choosing which option to reject the negative features of the enriched option are compared with the average option. Hence, decision makers both reject and select the enriched option.

It is proposed that the commensurability of the task will shape whether decision makers either accept or reject the enriched choice option; specifically,

reducing the commensurability of the enriched attributes is predicted to reduce the extent to which these additional options are perceived as beneficial or positive, and in turn whether they are judged to be viable reasons with which to construct a choice.

An initial study could examine the proposal that the ability to integrate the enriched features with the core decision information, due to their commensurability, will encourage decision makers to choose the enriched option. Specifically, as used by Shafir (1993) pairs of gambles will be used with equal expected values. However, the enriched gamble will have a larger potential amount to win than to lose, whereas the non-enriched option will feature a lower amount to win; however, it will not feature an amount to lose. In each of the decisions the enriched option will be presented as incommensurable by presenting the loss in another currency or value (e.g., grams of gold).

Moreover, a second study could manipulate the commensurability of the method of preference elicitation, making it incommensurable to the attributes describing the options. A 2 x 3 mixed measures design will be used (accept or reject question) and task judgement content commensurability (commensurable or incommensurable or combined). In the commensurable condition participants will be asked which gamble they would prefer to accept and which they would prefer to reject, whereas in the incommensurable condition participants will be asked which gamble they feel is most positive and which gamble they feel is most negative. The combined condition has been designed to harness the effect of incommensurability to reduce behavioural biases, whilst retaining the elicitation of monetary judgements. This will be achieved by asking participants which gamble they feel most positively

about (or most negatively about), following this participant will be asked which gamble they would accept (or which gamble they would reject).

In a general sense the core findings and theoretical proposals of the current thesis is that introducing incommensurability in decision making tasks has the potential to reduce decision makers propensity to exhibit and fall prey to behavioural biases is broadly applicable. The findings are applicable to several areas of human decision making, where the consistency of human decision making has been called into question such as marketing (Yang & Lynn, 2014), financial and consumer decision making (Kahneman, 2003).

Specifically, chapter two revealed the effect of incommensurability to reduce loss aversion preferences, highlighting the potential for incommensurability to be utilised and applied to real world decision making where loss aversion has been implicated in shaping decision makers' judgements. For example, Shefrin (2001) has highlighted that there are many instances of, managerial and investment decisions, where managers are reluctant to terminate failing plans out of a fear of a substantial loss or failure despite continued ongoing small losses. In other words, decision makers display an aversion to accept previous investments as a loss, and so continue to invest and persist with their plans further compounding their loss causing further financial deficits.

Moreover, the endowment effect (Kahneman, Knetsch & Thaler, 1991) - a behavioural bias where decision makers set a higher price for an item they are selling compared to the price which they would be happy to pay for the item has been attributed to loss aversion. Specifically, the endowment effect has been suggested to occur as the loss of the item by selling it is perceived as more

aggravating than the positive experience of buying an item. Importantly, the endowment effect has not only been highlighted in experimental or laboratory settings, but also in real world decision making. For example, Furche and Johnstone (2006) revealed that the endowment effect was present in the behaviour of traders in the Australian Stock Exchange. Traders valued their own stocks and shares more than stocks and shares they were considering buying, irrespectively of the market value of the stocks and shares. The traders frequently placed sell orders further away from the market value than the buy orders. Whilst it may seem simply as through the sellers were seeking to maximise their potential gains, the presence of the endowment effect when selling stocks and shares has been suggested to damage the stock market, impeding the fluidity of the market slowing down the buying and selling process. Therefore, research should be designed to extend understanding of the potential for incommensurability to reduce loss averse preferences, in turn preventing the endowment effect. This research could then be extended to examples of the endowment effect in real world decision making to reduce the disparity between buyers and sellers price evaluations' reducing friction and improving cohesion in trading.

The third chapter revealing the potential for incommensurability in the decision making task to prevent the attraction and compromise effects also presents further the potential for the incommensurability effect to be utilised to promote rational decision making in the real world. Doyle, O'Connor et al. (1999) have demonstrated that the attraction effect can be produced in real world purchasing behaviour, by positioning one item in a product range as a decoy option, in turn creating one product as a target option which was overwhelmingly preferred by customers in a grocery store. Moreover, Pinger et al. (2016) revealed that in the applied setting of a

German restaurant chain positioning specific food items as a compromise option, produced a shift in food orders with decision makers preferring the compromise option. Evidence revealing that both context effects (compromise and attraction effects) occur in real world decision making indicates the potential for incommensurability to be introduced to decision making scenarios to inhibit context effects promoting rational consumer decision-making. Specifically, further research should be conducted initially to establish real world decision-making scenarios where decision makers fall susceptible to context effects biasing their decision making. Following, establishing the circumstances where decision makers fall prey to real world contextual effects, research should be designed to introduce incommensurability in these scenarios in order to verify the real world potential of incommensurability in preventing these contextual biases. Following the verification of incommensurability as a factor reducing context effects in real world, decision making research should be designed to introduce incommensurability further to real word decision contexts to leverage the power of incommensurability. Whilst the applied examples have been relatively innocuous choosing grocery items or a meal, other researchers have shown that the compromise and attraction effects can occur with high value items such as cars (Nagochi & Stewart, 2014), further emphasising the need to apply incommensurability to de bias decision makers preventing them from falling prey to context effects. Moreover, as the work by Nagochi and Stewart (2014) has demonstrated that decision makers make pairwise comparisons between the attributes, leading to the production of the context effects (attractions & compromise effects), the case is strengthened for introducing incommensurability to prevent decision makers from being easily able to conduct pairs wise comparisons when evaluating their decision options. In addition, this approached could be

adapted to Nagochi and Stewart's (2014) experimental stimuli – cars presenting the option attributes in an incommensurable manner in order in an attempt to reduce the context effects. This proposal would not only test the impact of incommensurability on decision making within a scenario cognisant of a real-world choice but would also asses and evaluate how incommensurability changes the actual strategies used by decision makers, not just the outcome of the decision. This would be possible if used in conjunction with eye-tracking technology as used by Nagochi and Stewart (2014) and would allow for bench marking of the suggestion that incommensurable options prevents comparisons. Specifically, as the eye-tracking data would allow the assessment of whether comparisons are prevented with incommensurable content just as in the initial work Nagochi and Stewart (2014) established that decision makers do make binary comparisons between decision attributes.

Whilst the proposal that discouraging decision makers from making comparisons with incommensurable decision content reduces behavioural biases, by preventing decision makes from using biased comparative decision-making strategies is simple in nature, it stands in stark contrast with current trends for improving consumer decision making in the financial arena. For example, the FCA's recent ruling dictating that banks must publish information specifically designed to allow consumers to easily make comparisons between banks when deciding who to bank with, such as call centre opening times and how long it will take a consumer to receive a replacement bank account (FCA, 2017). Moreover, the sentiment of encouraging and facilitating comparisons in financial legislation is echoed internationally in the consumer credit directive, as it advocates for the standardised presentation of credit information to aid consumer comparisons (European Parliament, 2008). Attempting to promote effective and rational consumer decision-

making by creating legislation forcing retailers to present products in a manner allowing consumers to make comparisons, should not be taken for granted as effective ways to “improve” decision making. Specifically, the findings of the thesis should be taken as a cautionary tale – that whilst on the face of it could be seen that allowing comparisons will aid decision making, this may not be the case. Empowering consumers by providing comparable information and opportunities for comparisons, in fact, may do more harm than good.

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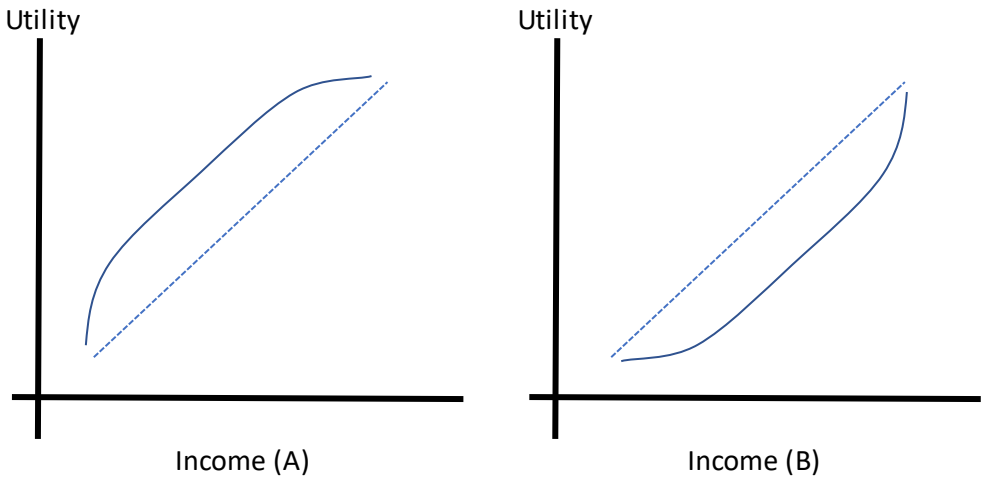
Appendix

Appendices A – Illustrations of Utility Curves involving risk (A risk seeking preferences, B risk averse preferences (Friedman & Savage, 1948 [these figures are also discussed by Machina, 1987])



Appendices B - Typical Function Curve (Friedman & Savage, 1948)