HEDGING IN DECISION MAKING IN DISORDERS OF THE IMPULSIVE-COMPULSIVE SPECTRUM

by

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Hedging in Decision Making in Disorders of the Impulsive-Compulsive Spectrum

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Abstract

This dissertation comprises three studies that investigated the construct of hedging as a decision making strategy in individuals with Obsessive-Compulsive Disorder (OCD). Hedging refers to the tendency to keep options available when there is a threat of loss of the options that is motivated by the underlying construct of loss aversion (i.e., Prospect Theory). Hedging introduces a behavioural economic approach to the study and understanding of the impact of loss aversion on decision making.

Participants played two conditions of the Doors Game (Shin & Ariely, 2004) in which they were instructed to maximize their earnings by tapping three doors in any order: i) constant availability (CA), where all doors remain available; and ii) decreasing availability (DA), where doors fade and disappear if left untapped after a short time (to elicit hedging). In Study One, undergraduates (N = 108) played both the CA and DA conditions and evidence indicates more frequent switching in the DA than the CA condition. There was also a significant negative association between hedging and the cognitive concern subscale of anxiety sensitivity. Study Two examined other psychological correlates of hedging in another undergraduate sample (N = 63) and yielded significant negative associations with the physical component of state anxiety and experience seeking. In Study Three, the results of a comparison of hedging among OCD, Gambling Disorder (GD), and Healthy Control (HC) groups yielded no significant differences.

Correlates of hedging, however, differed among the groups and regression analyses suggest that hedging in OCD is negatively predicted by obsessiveness and decisiveness (subscale of the Need for Cognitive Closure; NFC), and positively predicted by experience seeking (subscale of the Sensation Seeking Scale). In the GD group, closed-mindedness (subscale of NFC) positively predicted hedging. In the HC group, fun-seeking (subscale of Behavioral Inhibition and Behavioral Activation Scale) positively predicted hedging.

Implications: This work is the first to demonstrate predictors of hedging in OCD using a loss aversion paradigm where evidence suggests that obsessional and motivational drives lead to premature choice selection. Pursuing the loss aversion perspective could significantly advance the decision making research in OCD and in other clinical populations.

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Personal

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Chapter 1: General Introduction

Overview

There is growing research interest in decision making in Obsessive-Compulsive Disorder (OCD) given that a number of studies have demonstrated deficits in performance on neuropsychological decision making tasks (Cavedini et al., 2002a; Dittrich, Johansen, Landrø, & Fineberg, 2011) that also correspond to atypical neurofunctioning (Cavedini, Gorini, & Bellodi, 2006; N. S. Lawrence et al., 2006; Stern et al., 2013). The call to examine OCD as a disorder of decision making was to inspire investigations that connect behavioural, neuropsychological, and neuroimaging evidence to improve understanding of the disorder (Fineberg et al., 2010; Sachdev & Malhi, 2005). In light of the gaps identified in the literature, the work in this dissertation was guided by two overarching goals. The first purpose was to explore a novel facet of decision making referred to as 'hedging' in individuals with OCD as compared to healthy controls (HC). The second purpose was to compare hedging of individuals with OCD to individuals with Gambling Disorder (GD), a clinical group that shares overlapping conceptual etiology and symptomology (Abramowitz, Storch, McKay, Taylor, & Asmundson, 2009; el-Guebaly, Mudry, Zohar, Tavares, & Potenza, 2012).

Organization of Dissertation

Given the diverse literatures that are drawn from for this dissertation, the presentation of information will occur as follows. In this introductory section, following a brief review of the prevalence and phenomenology of OCD, the rationale for studying decision making in this population and the research to date on decision making in OCD will be described. Next, the argument will be made that the inherent design of the most common of decision making tasks, the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994) limits progress in this field of study. Having established the rationale for using a new paradigm, the unique properties of the Doors Game to potentially reveal a new dimension of decision making called hedging in OCD will be explicated. The Doors Game elicits hedging when respondents are asked to maximize earnings by choosing rewards associated with three doors when those doors are fading.

Study One will present Prospect Theory (Tversky & Kahneman, 1973) as the overarching theory for understanding the hedging phenomena elicited by the Doors Game. In addition, the research on how emotions, in particular anxiety and mood, drive decision making will be reported. Study Two is an extension of the previous study undertaken to examine the potential relevance of additional personality variables. Research findings from a second study on the relation between impulsivity and sensation seeking on decision making will be described. Study Three will discuss the research to date on decision making in individuals with GD, and outline the similarities and differences in decision making in OCD and GD. One chapter for each of the three studies contains sections on the related literature, as well as the methods, results and discussion. The General Discussion in Chapter 5 will summarize, integrate, and relate the contributions of this dissertation to the extant literature, as well as suggest potential applications of these findings, and future directions for research.

Definitions and Goals

Decision making is a vastly studied topic with its roots first established in economics (Edwards, 1954). Others have studied decision making as an executive function in neuropsychology (Clark, Cools, & Robbins, 2004), as instrumental behaviours or neural responses to reward-based tasks (Bechara & Damasio, 2005; Toplak, Sorge, Benoit, West, & Stanovich, 2005), and as a multi-component cognitive process (Bishara et al., 2009). Hedging is defined as a behavioural facet of decision making to keep options available. This behavioural construct was first introduced as the options availability effect (Shin & Ariely, 2004) to denote a normative response when decision makers invest effort and resources in keeping options available and that increase as options appear to be disappearing. Hedging concerns the psychological process that occurs before decision makers commit to their final choice after having searched and explored their options. In behavioural economics, decision making has historically been dominated by studies that identify processes that lead to optimizing the outcome of decisions (Krijnen, Zeelenberg, & Breugelmans, 2015; Ratchford, 1982), but research is lacking in other decision making processes, such as hedging. This dissertation on the psychology of hedging adds to the literature by introducing a novel facet of decision making that is in line with recent research interest on loss aversion (Barberis, 2013; Ert & Erev, 2013; Rick, 2011), which is the assumed underlying process motivating hedging.

Hedging is posited to be motivated by an aversion to loss (Shin & Ariely, 2004). The term loss aversion is a construct derived from the robust evidence that humans are more sensitive to losses than gains (Kahneman & Tversky, 1979). Loss aversion has been demonstrated to be a reliable trait across different domains varying from risky decision making (probability-based decision making) to riskless decision making (e.g., when probability estimates are not involved in decisions of sellers and buyers) (Novemsky & Kahneman, 2005). It is also known that loss aversion tends to be greater among older people than younger people, less educated than higher educated, and higher wealth than lower wealth (Gächter, Johnson, & Herrmann, 2010).

Hedging is measured by the Doors Game (Shin & Ariely, 2004). The design of the task provides a method to better understand why people tend to “hedge their options” by keeping options available particularly when there is a threat of losing them. The findings of the Doors Game have not yet been replicated by an external laboratory. Thus, before examining the Doors Game with the populations of primary (OCD) and secondary interest (GD) for the purposes of this dissertation, the goals of the first and second studies were to replicate the findings of hedging previously reported by Shin and Ariely (2004) in a population of healthy controls (HC). Another goal of the first and second studies was to explore the associations between hedging and emotional and personality factors that typically affect decision making in the general population such as anxiety and impulsivity, and which are also present at elevated levels in OCD and GD. To achieve these goals, correlations of hedging with anxiety and depression, and correlations between hedging and the personality constructs of impulsivity and sensation seeking, were examined in Studies One and Two, respectively. Finally, Study Three compared hedging and identified hedging predictors between OCD, GD, and HC.

Obsessive-Compulsive Disorder

OCD is a chronic and often debilitating disorder that is characterized by distress-provoking obsessions (repetitive and intrusive thoughts, impulses, or images) and compulsions (repetitive behaviours or mental activities) (Abramowitz et al., 2009). OCD is frequently co-morbid with depression, eating disorders, and anxiety disorders, and may co-exist with neurodevelopmental disorders such as Tourette's syndrome and Attention Deficit Hyperactivity Disorder (Abramowitz et al., 2009). The disorder often has an early onset in childhood or later onset in young adulthood (mean age 9.7 and 21.1 years, respectively) in Canadians and tends to follow a chronic course (De Luca, Gershenzon, Burroughs, Javaid, & Richter, 2011). OCD affects 2 - 3% of the population worldwide (Fontenelle, Mendlowicz, & Versiani, 2006; Gentes & Ruscio, 2011), with comparable rates reported among Canadians (De Luca et al., 2011).

OCD results in high health care utilization and disability costs. According to the World Health Organization, OCD is ranked as one of the five leading mental health disorders that cause disability worldwide (Mathers, Boerma, & Fat, 2008). Most individuals with OCD respond only partially to treatment, and between 40 – 60% show no improvement in response to currently available pharmacological and psychological treatments (Anand, Sudhir, Math, Thennarasu, & Reddy, 2011; Mancebo et al., 2006; Pallanti & Quercioli, 2006). The illness is often accompanied by comorbid disorders which significantly impact quality of life and can lead to severe impairment in day-to-day functioning (Lochner et al., 2005; Mancebo et al., 2006; Rector, Richter, & Masellis, 2003). Emotional distress combined with time-consuming behaviours often interferes considerably with the individual's academic, occupational and social functioning, as well as interpersonal relationships.

OCD is considered a heterogeneous and complex disorder because of the variable onset, severity, insight, psychiatric comorbidity, anxiety, and symptom subtypes (Ruscio, Stein, Chiu, & Kessler, 2010). The intrusive nature of obsessions in OCD (and compulsions to some extent), are associated with anxiety. However, anxiety has not been consistently reported as a cardinal feature in all OCD cases (Stein et al., 2010). For example, OCD subtypes related to abnormal risk assessment and pathological doubt are associated with increased anxiety and comorbid anxiety disorders, whereas those related to feelings of incompleteness are not (Ecker, Kupfer, & Gönner, 2014; Rasmussen & Eisen, 1992; Summerfeldt, Kloosterman, Antony, Richter, & Swinson, 2004). Other subtype classifications of OCD include harming, hoarding, contamination, certainty, and obsessional (Foa, Kozak, Salkovskis, Coles, & Amir, 1998; Goodman et al., 1989). OCD is also associated with other psychological constructs such as perfectionism, a need for cognitive closure, intolerance of uncertainty, harm avoidance, and indecision (Berenbaum, Bredemeier, & Thompson, 2008; Obsessive Compulsive Cognitions Working Group, 1997; Summerfeldt, Kloosterman, Antony, & Swinson, 2014). Adding to the complexity is the presentation of other comorbid mental health disorders (e.g., anxiety, mood, impulsive control, and substance use disorders) (Rasmussen & Eisen, 1992; Ruscio et al., 2010).

Despite the heterogeneity of OCD, accumulating evidence from cognitive studies indicates that decision making deficits may be a common marker in individuals with the disorder (Cavedini, Zorzi, Piccinni, Cavallini, & Bellodi, 2010; Sachdev & Malhi, 2005). The next section will discuss the research on decision making in individuals with OCD.

Decision Making in Obsessive-Compulsive Disorder

Some researchers have proposed that impaired decision making is a common pathophysiological marker of OCD (Cavedini et al., 2010; Sachdev & Malhi, 2005). For example, findings from earlier research suggest that indecisiveness (Sarig, Dar, & Liberman, 2012; Summerfeldt & Endler, 1998) and excessive worry in OCD impairs decision making (Borkovec, Metzger, & Pruzinsky, 1986; Reed, 1976; Walker & Beech, 1969). In low-risk and non-threatening situations, as compared to controls, individuals with OCD required more repetitions of a faint auditory signal before deciding whether or not they had heard it (Milner, Beech, & Walker, 1971), needed more evidence before making judgments about probabilities (Volans, 1976), and required more information and time to solve a probabilistic inference task (Goodwin & Sher, 1992). In a later investigation, Foa et al. (2003) varied the levels of decision making risk: low (i.e., choosing car wax), high (i.e., selecting medical treatments for an injured relative), and high and relevant to OCD (i.e., choosing the safest stove). The researchers reported that individuals with OCD requested more OCD-relevant information, and more time and other information in the low risk condition. This is in contrast to the high-risk condition where individuals with OCD requested the same information and time as compared to controls. Noteworthy is the finding that higher-rated state anxiety had an effect on the amount of information and time needed to make a decision than lower levels of state anxiety did. Perceived risk was also reported to predict decision time and information requested in low-risk situations. Individuals with OCD behaved similarly to controls in the high-risk condition. The authors speculated that in the low-risk condition, some other unknown factors (e.g., perceived responsibility for causing harm, basic difficulty in making decisions) were likely responsible for discrepancies in OCD decision making. Together, these early psychological studies suggest the possibility of abnormal decisional processes in OCD.

Decision Making Findings based on the Iowa Gambling Task

Several neuropsychological studies have reported deficits in decision making in individuals with OCD (Cavedini et al., 2006; Cavedini, Riboldi, Keller, D'Annucci, & Bellodi, 2002b; Dittrich et al., 2011; N. S. Lawrence et al., 2006; Morein-Zamir et al., 2014; Watkins et al., 2005), including the author's Master's thesis work on the decision making of young adults with OCD (Pongracic, 2011). Research in decision making typically employs computerized gambling-type tasks that involve financial incentives or probability–based survey questions eliciting binary accept or reject responses. Of the computerized tasks, the Iowa Gambling Task (IGT) (Bechara et al., 1994) has become the de facto neuropsychological instrument to examine normative and impaired decision making (Lin, Chiu, Lee, & Hsieh, 2007; Toplak et al., 2010) related to executive functioning, such as planning and problem-solving.

The IGT has been employed more frequently than any other task in decision making research in part due to its purported design that mimics 'real-life decision making' (Steingroever, Wetzels, Horstmann, Neumann, & Wagenmakers, 2013). In the IGT, participants are provided with a $2000 loan and are allowed to select 100 cards from four decks with the goal of maximizing their profit. Decks A and B are disadvantageous insofar as winnings and penalties are larger in the short-term, but in the long-run, selecting more cards from decks A and B leads to losing significantly more money than selecting from decks C and D. In Decks C and D, participants win less money for each selection, but their penalties are also lower, resulting in a net advantageous gain over the long-term. Risky decision making is computed as a composite of the total number of cards selected from the advantageous decks (i.e., C and D) less those selected from the disadvantageous decks (i.e., A and B). Over time, good decision-makers typically, but not always, choose more cards from the advantageous decks (i.e., after accounting for losses, their net winnings are positive) implying that they prefer decks with smaller individual rewards that accumulate to larger overall gain. In contrast, impaired decision-makers reportedly choose more cards from the disadvantageous decks (i.e., their net winnings over time are negative) showing a preference for decks with larger individual rewards but higher costs that accumulate to smaller overall gain. A negative value is also interpreted as characteristic of risky decision making.

The IGT has been employed to provide support for the neurologically-driven 'somatic marker hypothesis' (Bechara et al., 1994; Bechara, Damasio, Tranel, & Damasio, 2005) that relates impaired decision making in individuals of normal intellect with ventromedial prefrontal cortex (VMPFC) lesions. The main premise of the somatic marker hypothesis is that financial decisions and biases are guided by bodily feedback signals (i.e., changes in heart rate, blood pressure, digestive motility, and glandular secretion) (Reimann & Bechara, 2010). Such visceral changes are consistently found to be mediated by the VMPFC, medial orbital frontal cortex (OFC), and dorsolateral prefrontal cortex (DLPFC), and to a lesser extent, the amygdala

(Reimann & Bechara, 2010a). Impaired performance on the IGT is explained by the reduced capacity to detect physiological cues (e.g., absence of somatic markers such as increased heartbeat, galvanic skin conductive response) that signal potentially harmful decisions (Bechara et al., 1994). The somatic marker hypothesis proposes that somatic markers are generated within the neurocircuitry of the VMPFC and project to the somatosensory cortex or generated directly within the somatosensory area (Bechara, Damasio, & Damasio, 2000). Somatic markers are thought to be critical for quicker intuitive responding (Werner, 2009) and lesions to this area dampen the generation of such signals and behavioural responding. In contrast, healthy individuals have demonstrated detectible anticipatory somatic markers prior to the selection of cards from the risky decks A and B as compared to the advantageous decks C and D (Bechara & Damasio, 2002; Bechara, Tranel, Damasio, & Damasio, 1996; Crone, Somsen, van Beek, & van der Molen, 2004; Tomb, Hauser, Deldin, & Caramaza, 2002). On the other hand, impaired decision makers chose more cards from the disadvantageous decks even though they were provided with feedback and recognized that their decisions were suboptimal (Reimann & Bechara, 2010a). Hence the coining of the term, '*myopia to future consequences*' implies the aberrant behaviour of favouring immediate larger individual gains that result in a net loss over smaller individual rewards that result in an overall gain (Reimann & Bechara, 2010). The preference for large immediate rewards despite a net disadvantage has been shown to be related to dysfunctional emotional processing that relies on ventromedial prefrontal circuits (Denburg et al., 2007).

Shortfalls of the Iowa Gambling Task

Much has been learned about emotional decision making using the IGT. However, many inconsistencies have also been reported (Steingroever et al., 2013; Toplak, Sorge, Benoit, West, & Stanovich, 2010). Steingroever et al. (2013) conducted two literature reviews, analyzed seven published data sets as well as their own data set, and presented evidence that challenges several assumptions underlying the interpretation of IGT data. One assumption that is relevant to the present research is that healthy participants prefer the advantageous options (Decks C and D) to the disadvantageous options (Decks A and B) because of their intact somatic marker responses. The review by Steingroever and colleagues is the latest study in a growing body of evidence that refutes the above assumption and provides methodological critiques that alternatively explain the widely published finding of a preference for Decks C and D in healthy decision makers (Dunn, Dalgleish, & Lawrence, 2006; Lin, Chiu, Lee, & Hsieh, 2007; MacPherson, Phillips, & Sala, 2002; Wilder, Weinberger, & Goldberg, 1998; Yechiam, Busemeyer, Stout, & Bechara, 2005). One only needs to examine the relative loss frequencies of each deck to see that Decks A and C have a greater number of losses than Decks B and D (Steingroever et al., 2013). However, because the conventional analysis is to collapse and count decks A and B together, and C and D together, the asymmetric preference of decks with fewer losses (e.g., Decks B and D) relative to lesser preferred decks with more frequent smaller losses (Decks A and C) are masked (Lin et al., 2007). Thus, Steingroever et al. (2013) present evidence that decision making in healthy individuals is perhaps motivated by the avoidance of a loss experience (e.g., Decks A and C because loss occurs more frequently) rather than a myopia for future consequences (Bechara et al., 1994).

According to Steingroever et al. (2013), sensitivity to frequent losses motivates healthy decision-makers to avoid selecting items with high loss frequency (e.g., Decks A and C) and instead preferentially choose decks that have fewer loss consequences (e.g., Decks B and D). This interpretation is in line with recent research attention on loss aversion as an underlying process that may explain deck selection on the IGT (He et al., 2010; Li, Lu, D'Argembeau, Ng, & Bechara, 2010). The IGT however, is unsuitable to examine loss aversion due to its inherent design, which has also been criticized for failing to meet its own payoff criteria (Lin et al., 2007). Finally, two design issues make the IGT unsuitable for the study of loss aversion. Firstly, the reward and punishment contingencies are different for each deck, therefore confounding whether people switch decks due to contingencies (i.e., reward/punishment) or fear of losing their options. Secondly, there are no time constraints or disappearing options to emulate the immediate perception of loss.

Other criticisms of the IGT point to the lack of associations between the IGT and other risk-taking tasks (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Bishara et al., 2009; Lejuez, Aklin, Zvolensky, & Pedulla, 2003) and highlight the complexity and multifactorial processes involved in the performance on this task. It is believed that there are at least two component processes of decision making that are involved in the IGT and that decision making involving risk-taking varies depending upon whether an individual is in the learning stage or the post-learning stage of the IGT (Brand, Recknor, Grabenhorst, & Bechara, 2007; Upton, Bishara, Ahn, & Stout, 2011). Correlations of risk-taking in later stages of the IGT and explicit knowledge of gains and losses on the Game of Dice (a task that relies on intact executive functioning) have demonstrated the dissociation of learning and executive processes to early and later stages of the IGT, respectively (Brand et al., 2005). Critically, conscious awareness of disadvantageous decision making during the IGT (i.e., learning) begs the question of whether a theory about unconscious processes (i.e., somatic marker hypothesis) is necessary to explain impaired decision making (Maia & McClelland, 2004; Steingroever & Wagenmakers, 2014)? Further, it is unclear how the IGT triggers somatic markers and how the role of emotions such as fear and anger might explain the decision making processes in the context of the somatic marker hypothesis (Cohen & Sanfey, 2004).

The orbital/ventral medial prefrontal regions of the brain have been associated with decision making on the IGT (Bechara et al., 1994; Li et al., 2010). These areas have also been implicated in tasks thought to measure loss aversion (De Martino, Kumaran, Seymour, & Dolan, 2006; Dreher, 2007; Fox, Tom, Trepel, & Poldrack, 2008; Kuhnen & Knutson, 2005; Yacubian et al., 2006). The distribution of losses and gains on the IGT act as reward incentives; however, the task itself is not a measure of loss aversion. Given the increasing challenges reported with the IGT as outlined above, an alternate task may better elucidate the relations between decision making and loss aversion. The simple Doors Game (Shin & Ariely, 2004) may serve as an alternative measure of dysfunction of these circuits and as a behavioural measure of hedging (and loss aversion) that can be used to better understand decision making.

The Doors Game (Shin & Ariely, 2004) is uniquely designed to assess decisions that are motivated by loss aversion. The Doors Game also has the advantage of eliminating the confound of decision making that may be motivated by large rewards (e.g., Decks A and B in the IGT) (Lin et al., 2007), since all options lead to the same payout of approximately $3.00 (Shin & Ariely, 2004). The review by Steingroever and colleagues (2013) also highlights the range of variability of switching between decks on the IGT that contradicts the notion that controls have homogenous preferences for good decks. In fact, some healthy participants also showed a strong preference for bad decks (Steingroever et al., 2013), suggesting that decision making in healthy controls is driven by motivations to avoid losses.

An Alternate Paradigm: The Doors Game

The Doors Game (Shin & Ariely, 2004) is a computerized task that illustrates the "options availability effect" (i.e., hedging). Using the Doors Game, it was demonstrated that when undergraduate students are faced with the threat of disappearing options, they tend to hedge more or invest more effort and money beyond the option's expected value in order to keep all options available (Shin & Ariely, 2004). This hedging behaviour (i.e., keeping doors/options open to avoid loss) persists even when respondents are equipped with prior knowledge about the payoff distributions (i.e., knowledge effectively removed uncertainty), given opportunities to practice, and penalized with higher costs for keeping options available. The decision processes leading to hedging behaviour are posited to be motivated by an aversion to loss that is associated with the psychological pain of giving up options (referred to as the pseudo-endowment effect) (Shin & Ariely, 2004).

In this sequential search task, respondents have the option to tap on one of three doors that pays a certain amount and varies according to a pre-specified payoff distribution). The expected value of $3 is consistent across the three doors. The goal is to maximize earnings given a set number of taps (e.g., 100). The experimental manipulation of interest is doors availability: constant availability (CA) or decreasing availability (DA). In the CA condition, the three doors remain available to search and tap for the entire trial. In the DA hedging condition, once a door has been tapped, the other two doors are reduced in size by 1/15, unless one of them is tapped, at which point that disappearing door returns to its original size. The second shrinking door continues to shrink if left untapped until the size of the door reaches zero and becomes invisible, eliminated as an option, and unavailable for tapping. Thus, respondents need to decide whether to stay with their current choice of payout or to search among the other alternatives. In the decreasing availability condition, respondents need to also decide whether or not to invest in keeping disappearing doors available.

Evidence Supporting Hedging

Shin and Ariely (2004) conducted four studies to demonstrate the robust effect of hedging, to rule out possible explanations for the behaviour (e.g., the need for information or the saliency of rewards), and show that hedging may instead be motivated by loss aversion. In the first experiment, two groups of undergraduate students were assigned to either the CA or DA condition of the Doors Game and were told to tap on the doors that would earn them the greatest amount of money within 100 taps. A 10-block analysis of the trials showed that switching between doors occurred significantly more often in the DA condition than the CA condition across the ten blocks. The findings, however, did not provide clues about why people hedged.

The authors surmised that increased switching might have been a strategy used to keep options open to gather more information about the distribution. To rule out the possibility that a lack of information was responsible for hedging, a second experiment manipulated the availability of information provided. Three groups were tested in both CA and DA conditions: 1) no-prior information; 2) practice-information; and 3) descriptive information. The no-prior information condition was essentially a replication of the first study. The practice-information group played the Doors Game twice; the first time allowed for 50 taps that were deemed as practice trials and the second 50 taps were real paid trials. The third descriptive group was told that the averages of the distribution were equal and shown a graph of the means, skewness, and variance of each distribution, but they did not know which door was assigned to which distribution.

The results replicated the finding that switching occurred more frequently in the DA condition; however, there were no significant interactions between option availability and the information provided. The lack of interactions indicates that people's higher switching tendency was not influenced by practice or descriptive information. Further, undergraduates were reported to abandon their least preferred option later in the DA condition than the CA condition, suggesting that letting go of even unattractive options was more difficult if there was a threat of losing them.

The third study tested the saliency of the cost of switching as a possible explanation of increased switching tendency in the DA condition. Even though it was explained to participants that switching doors would cost a tap, it was not clear whether respondents considered the cost of switching in their decision making. Thus, in the third iteration of the study, it was explained to another group of participants that an explicit cost to switch of three cents would be incurred, as well as loss of one tap from their allotment of 100 taps. Another group received the same instructions as in experiment one and two that did not charge a financial penalty for switching, but did cost a tap to switch. The respondents also had a chance to practice 100 trials (as opposed to 50 trials in experiment 2 before performing the real trials of both CA and DA conditions. The option availability effect was again replicated. The explicitness of the instructions (a cost of 3 cents to switch) was marginally significant, showing less switching between doors occurred than in the implicit condition, suggesting that charging a financial penalty did lead to less switching. The authors reported that the effect size of switching, however, was smaller for the explicit condition (i.e., information was provided) than the implicit condition ($\lambda = 3.48$ vs. $\lambda = 13.41$). This finding highlighted that the desire to keep options open persisted even when the cost was more explicit and when participants had more experience with the task (100 taps versus 50), thus suggesting an enduring trait for hedging.

Having demonstrated in the second and third studies that keeping options available was due neither to the lack of information nor cost saliency, the goal of the final experiment was to demonstrate that loss aversion motivates hedging. A possible alternative explanation for hedging is a desire to increase flexibility for future choices, in order to have more options to choose from. To address this alternative explanation, Shin and Ariely (2004) introduced a new manipulation to allow respondents the ability to reactivate or reincarnate a door that has disappeared. The rationale was that options could disappear but reactivation of the disappeared door would reinstate all possible outcomes at a cost of 0¢, 6¢, or 30¢ and thereby provide future flexibility of choice. However, if hedging is related to loss aversion, the ability to reactivate options should not affect the rate of hedging. This is because reactivation only brings back a lost item, but it does not eliminate its disappearance, which is considered a loss (Shin & Ariely, 2004). This clever design allowed the researchers to dissociate the motivation to switch to either a need for future flexibility or an aversion to loss. Another manipulation that was introduced was that all three doors paid different payouts (as opposed to all doors paying $3) as a counter test to determine whether respondents switched more because they had no reason to discard the other options. By varying the amounts ($2.5, $3, $3.5), individuals were provided with potentially a more compelling reason to switch (e.g., to maximize winnings by staying with the door that paid the most), although there was no direct test in the study to verify that participants knew about the unequal payouts.

There were five conditions administered: the original CA and DA conditions, and three reactivation conditions, 0¢, 6¢, or 30¢.

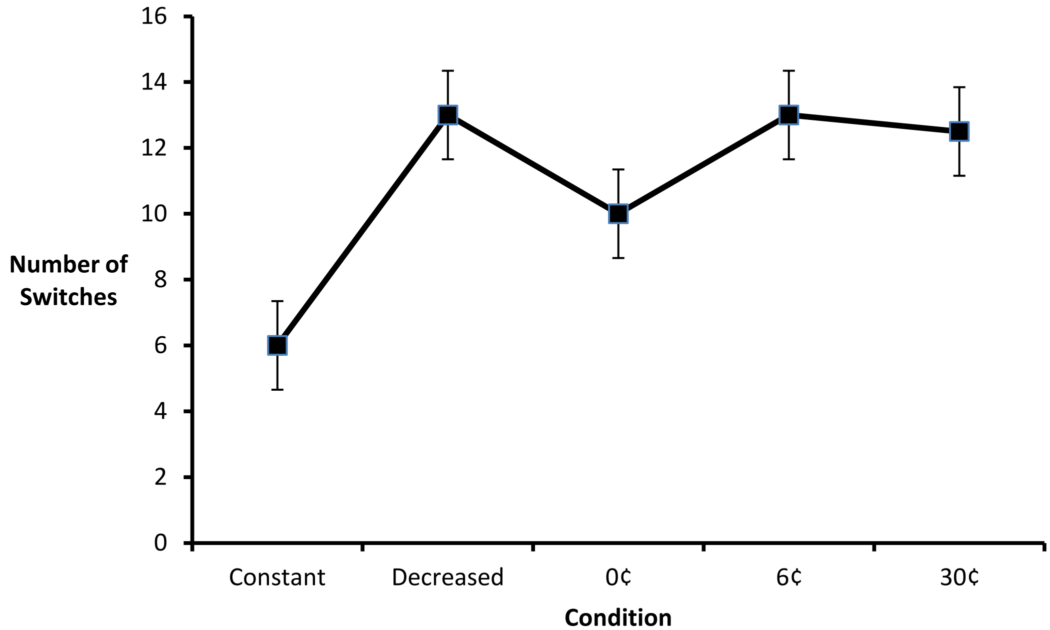


Figure 1. Switching in the constant and decreasing conditions, and three activation conditions.

These results provide strong evidence that aversion to loss is the motivation driving switching as opposed to the need for future flexibility of choices. This assertion is supported by comparing the 0¢ condition to the CA and DA conditions. If it costs individuals nothing to reactivate a forgone option, this condition is logically equivalent to the CA condition. Thus, if aversion to loss was not the motivation for switching, it was expected that switching in the 0¢ condition would not be different from the CA condition. However, this was not the case, demonstrating that even at a zero cost of having future options, individuals switched more due to the actual disappearance of the doors as opposed to the ability to reactivate the option.

It is noteworthy that there was marginally significantly more switching in experiment one (M = 12.11) than experiment four (M = 9.52; p = .057), suggesting that the different payout values may have influenced the degree of switching. Shin and Ariely (2004) replicated the first experiment with the new distributions (2.5, 3, and 3.5) and they once again found significantly more switching in the DA condition than the CA condition (M = 10.13 vs. M = 4.3, $p > .001$). The authors noted that the interaction between the distributions and option availability was not significantly different, indicating that the desire to keep doors available persisted despite the unequal distributions. Overall, the four well-conceptualized and well-controlled experiments demonstrate that doors that incrementally disappear are perceived as more valuable than doors that are always available. It appears that switching tendencies are motivated by loss aversion and not due to the need for future flexibility, the provision of information, and/or monetary penalty.

No independent replications of the hedging effect using the Doors Game (Shin & Ariely, 2004) are known to exist, although this concept has been cited in at least 30 publications varying from consumer research (Pham, Cohen, Pracejus, & Hughes, 2001) to core decision making research (Reimann & Bechara, 2010a). Thus, the first goal of this dissertation was to replicate the findings of Shin and Ariely (2004) using the Doors Game. Unlike hypothetical gambles or the IGT, this task at face value appears to parallel real-world decision making, thereby having the advantage of being more externally valid. On the surface, disappearing doors do not mimic ‘real life’ scenarios per se, but at a conceptual (and metaphorical) level, it does parallel temporally declining options of all sorts in real life situations.

Over the past two decades there has been an exponential growth in research studying the relationship between personality/emotions and decision making, although the need to delineate these relations have been considered in the formulations of the earliest decision making theorists in psychology (Edwards, 1954). Even though early decision making researchers isolated decision making as a purely cognitive process, state and trait affective states such as mood and anxiety have been demonstrated to influence judgment and decision making in the short- and long-term (Andrade & Ariely, 2009; Pham, 2007). Thus, this dissertation explores individual differences in hedging with respect to affective psychological variables in healthy controls and clinical populations diagnosed with OCD or GD.

Chapter 2: Study One

Literature Review: Decision Making Overview

The literature on decision making is amassed in multidisciplinary journals that range from psychology to neurobiology, economics, business, medicine, law, politics, mathematics, and marketing (Kahneman, 2003). The breadth of this literature is a testament to the importance of this cognitive ability in human functioning. Ward Edwards (1954) is credited with introducing to psychology the economic theories of decision making, which are concerned with mathematical models that predict optimal economic outcomes.

Edwards' seminal introduction of *The Theory of Decision Making* (Edwards, 1954) to the psychological field has spurred thousands of publications that describe the psychological, cognitive, emotional, and social factors that influence economic choice behaviours beyond the mere analysis of probability of an action (Weiss & Weiss, 2009). Behavioural economics as it is now called crosses over a number of large literature domains including heuristics and biases, ethical and medical decision making, perception, neurocognitive processes, and affective processes.

The early modern economic theories of decision making were the hedonically-driven philosophies of Jeremy Bentham and James Stuart Mill that were based on the principle that humans are driven to seek pleasure and avoid pain (Fishburn, 1981; for an historical account, see Mellers, 2000). "Utility" is a value metric of the pleasure or pain derived from making a decision. Positive utility equates to the pleasure derived from a decision and negative utility equates to the pain associated with the object or activity. Decision making was purported by early theories to engender outcomes that maximize utility. Therefore, according to Utility Theory, decisions are made based on the highest expected value of an option, which is derived from the product of the probability of gains and the magnitude of the gains (von Neumann & Morgenstern, 1944).

As pointed out by Edwards (1954), humans, however, are observed to behave 'irrationally' and contradictory to the predictions of traditional models of expected Utility Theory. For example, humans are not always completely informed and therefore are fallible to behaving in irrational ways in situations that involve risk (i.e., where probability estimates are known) and even in riskless situations (i.e., where probability estimates are unknown) (Lerner, Li, Valdesolo, & Kassam, 2015). Individuals also show preferences for certain probabilities (e.g., people prefer probabilities of 50% to other amounts such as 30% or 40%), therefore behave unpredictably according to economic theories, and consequently do not maximize utility. Indeed, this is one of many examples of the early notion of individual differences in decision making (for individual studies, see Edwards, 1954). Others have noted that human decisions are prone to subjective interpretation. For example, decisions may be swayed by prior experience (Savage, 1954) or the framing of outcomes (Kahneman & Tversky, 1984). As a result, psychologists have produced considerable empirical evidence to describe the exceptions to the rules of human decision making and proposed theories to better account for the discrepancies (Rabin, 1998; Stanovich & West, 1998; Weber & Camerer, 1987).

One of the most influential descriptive theories of decision making proposed by Edward's student, Amos Tversky and his long-time collaborator Daniel Kahneman is called Prospect Theory. Prospect Theory was introduced as a descriptive and mathematical theory that could account for the inconsistencies that Utility Theory could not explain (Kahneman & Tversky, 1979). Variations of the classical Utility Theory (Subjective Utility Theory and Expected Utility Theory) also could not adequately explain the finding that when individuals are offered the same choices that are formulated in different ways, they behave in risk-seeking and risk-averse ways (Dreher, 2007). Prospect Theory (Kahneman & Tversky, 1979) was able to show that loss aversion could explain the framing effect, risk-seeking, and risk-averse behaviours reported earlier. Prospect theory also helped to explain why individuals paradoxically overweigh and underweigh certain probabilities that lead to irrational behaviours. Prospect Theory also helped economists resolve other mathematical paradoxes (e.g., St. Petersburg Paradox, Allais Paradox; Camerer, 2005; Starmer, 2000) and revolutionalized the direction of research inquiry in human decision making that is motivated by risk-seeking and loss aversion.

Prospect Theory

The tenets of Prospect Theory (Kahneman & Tversky, 1979) and the updated version, Cumulative Prospect Theory (Tversky & Kahneman, 1992) are loss aversion theories, which are descriptive psychological accounts that explain decision making under risk and riskless circumstances. The updated Cumulative Prospect Theory advances the concept of Prospect Theory by incorporating the cumulative weighting of probabilities to help explain why decision makers tend to overweigh extremely rare events, which occur with small probability, as opposed to overweighing *all events* with small probabilities, as first depicted in Prospect Theory (Tversky & Kahneman, 1992).

A distinction has been made in the literature between descriptive and normative models. Classical approaches (e.g., Utility Theory) were based on the normative model and explained the theoretically best or ideal decision making in economic, mathematical, and probability terms (Baron, 2004). Critics of normative models recognized the limitations of describing decision making in terms of maximizing the utility of behaviours, which people did not often show. Earlier economic theories of decision making however, lacked psychological theories to account for non-normative behaviour (Edwards, 1954). Descriptive models of decision making thus report on observations of what people actually do when they violate the predicted mathematical models of behaviours (Einhorn & Hogarth, 1981). Such violations can be described in a set of principles outlined by prospect theory (Kacelnik, 1997). In summary, Prospect Theory filled the gap to describe the observed violations of Utility Theory using psychological principles.

In Cumulative Prospect Theory, "prospects" are defined as gambles or decision making under risk, where (x_{-i}, p_{-i}; x_{-i+1}, p_{-i+1};.., x_{n-1}, p_{n-1}; x_n, p_{-n}) denotes an outcome value, x_i with a probability, p_i. Thus, a prospect of a 50:50 gamble to lose $100 or gain $200 is expressed as (-$100, ½; $200, ½). A differentiation is made here about a riskless prospect versus a risky prospect. A riskless prospect is one that guarantees certainty of some amount, x and is expressed as (x, 1) or just (x). For example, a certain gain of $100 is riskless and is denoted as (100, 1) or simply (100). Choosing a gamble is considered risky, while choosing a riskless prospect is considered not risky. In Cumulative Prospect Theory, the prospect, f has a value, and V is evaluated as $V(f) = \sum_{i=-m}^{n} \pi_i \, v(x_i)$ where V is the value function and π are decision weights.

The four principles derived from Prospect Theory include reference dependence, diminishing sensitivity to losses and gains, probability weighting, and loss aversion. A brief description of each principle follows. Greater emphasis will be placed on loss aversion given that it has generated the most empirical research and is the core principle of Prospect Theory most relevant to this dissertation. It will be discussed last under its own heading.

The first principle of Prospect Theory, reference dependence, is the notion that decisions are based on some current reference point, which can then be a marker to identify decisions that result in gains (greater than the referent) and losses (less than the referent) (Kahneman &

Tversky, 1979). For example, by varying the presentation of outcomes, Kahneman and Tversky show that decision makers are unconcerned about final states of wealth, but are influenced by the net gain or loss of prospects. Consider two examples that lead to final states of wealth of $1500.

Problem 1: You have been given $1000. Do you choose:

Option A: (1,000, .50) or Option B: (500)?

Of 70 participants, 84% of participants chose option B, the certain riskless option.

Problem 2: You have been given $2000. Do you choose

Option C: (-1000, .50) or Option D: (-500).

Of 68 participants, 69% chose risky option C. Each of the preferences are significant at the 0.01 level.

The above two problems net a final wealth of $1500, but people exhibited differential financial decisions based on their initial wealth or referent. According to Utility Theory, it should not matter how the $1500 was obtained. However, Kahneman and Tversky showed that the potential for gain or loss does in fact influence decisions. When initial wealth ($1000) is less than the final wealth state ($1500), the certainty of obtaining additional $500 is preferred (i.e., risk aversion is observed since the preference for the certain choice is significantly more prevalent). However, when the starting wealth is higher than the final state ($2000 vs. $1500), the preference is to risk losing $500 rather than to accept the certainty of losing $500 (i.e., risk seeking behaviours are preferred since the risky gamble is chosen significantly more often than the certain choice). These examples thus illustrate that individuals base their decisions on a reference point and not final states of wealth.

Interestingly, this decision reference bias is observed in monetary and non-monetary behaviours. To exemplify the concept further, consider that the absolute change in the current state of wealth of a typically poor individual (e.g., graduate student being awarded $15,000) might be perceived as meager change to a wealthy tycoon who receives the same amount of money. From a non-monetary perspective, humans are more responsive to perceptual *changes*, such as changes in temperature, loudness, and brightness than they are to absolute values (Barberis, 2013). This reference bias concept has been shown to reliably translate to changes in health and wealth status (Barberis, 2013).

The second principle of Prospect Theory is the diminishing sensitivity to losses and gains, which is best illustrated by the value function, Figure 2 (S-shaped graph). Diminishing sensitivity is observed by the concave curve in the gains region, and convex shape in the losses region. For example, where substituting a $50 gain (or loss) with a $100 gain has a significantly larger utility impact as compared to substituting a $10,000 gain (or loss) with $10,050 gain (loss) despite the net gain/loss is the same $50 in each scenario. Geometrically, note the flattening of the slope of the curve as the absolute value of gains and losses increase to indicate the diminishing effect of larger values. The value of utility decreases significantly faster in the loss portion of the curve relative to the gains side. This finding implies that the rate of change in sensitivity follows a curvilinear functioning. A perceptual example illustrates this concept; it may be easier to distinguish a change between 3^{o} to 6^{o} degrees than it is to discriminate a change between 13^{o} to 16^{o} (Kahneman & Tversky, 1979).

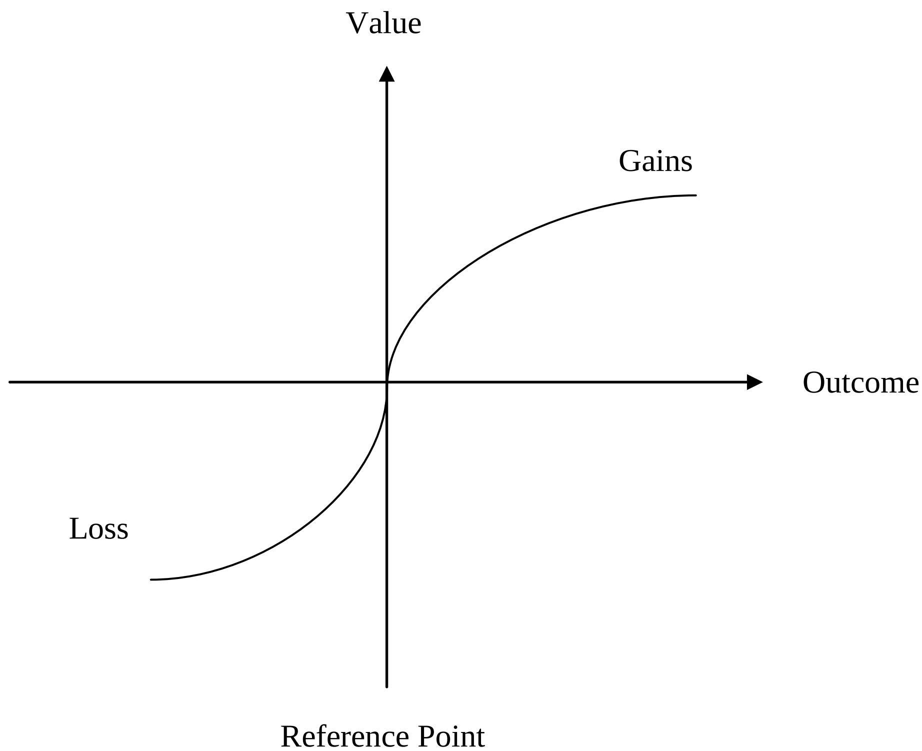


Figure 2. S-curve form of the Utility function denoting risk seeking and risk averse behaviour.

The third principle is the cumulative weighting of decision values. This idea was updated in the Cumulative Prospect Theory to allow for cumulative non-linear probability weighting to account for stochastic dominance, where certain prospects are preferred over others, and to extend decision analysis to prospects with many outcomes (Tversky & Kahneman, 1992). Four general risk attitudes were identified from the analysis of the curvature of the inverted S-curve weighting function (Figure 3).

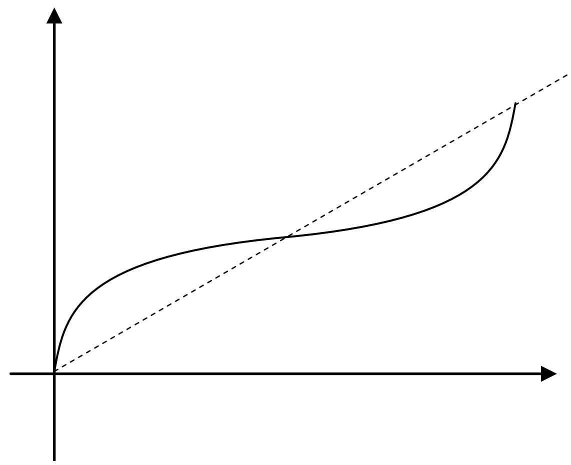


Figure 3. Inverted S-curve weighting function denotes overweighting of low probability (risk seeking behaviour) and underweighting high probability (risk averse behaviour).

It was shown that individuals tend to overweight the importance of small probabilities, which explains the propensity of individuals to buy insurance (risk aversion) and lotteries (risk seeking) for events that are highly unlikely to happen. Humans on the other hand also underweight high probabilities, which is associated with making risk-averse choices (i.e., they prefer to choose certainty to high probability gains), and overweight low probabilities, which is associated with risk seeking (i.e., they prefer high probability of loss of a larger amount than a certain loss of a smaller amount).

Loss Aversion

The final and most researched principle of Prospect Theory and Cumulative Prospect Theory is loss aversion. One of the major premises of Prospect Theory is that individuals are more sensitive to losses than they are to gains, and therefore act to minimize their losses (i.e., "losses loom larger than gains") (Kahneman & Tversky, 1979). In other words, humans have an inherent aversion to loss. Loss aversion has been demonstrated by the observation that significantly more individuals turned down gambles in which they had a 50% chance to lose

$100 or a 50% chance to win $110. This gamble is unappealing to individuals who are more loss-averse and who place more value on the pain of losing $100 than the pleasure of winning $110. Individuals' preference for gains over losses is depicted by an S-shaped function (Figure 2). The curve depicts a sharper convex shape where values are negative (losses), relative to a less concave curve for gains. A steeper slope in the loss function suggests people experience approximately twice as much pain with each unit of value lost (e.g., disutility) for the same value of unit gain. In other words, for individuals to accept gambles, the potential for gain must be at least twice as large as the loss (Novemsky & Kahneman, 2005; Tom, Fox, Trepel, & Poldrack, 2007; Tversky, 1994). The Prospect Theory value function depicting behaviour under risk has been reliably demonstrated in thousands of empirical studies (Barberis, 2013).

There is contention by some researchers that loss aversion paradigms do not reliably translate outside the laboratory and that loss aversion is more readily observed for anticipated, hypothetical outcomes as opposed to experienced outcomes (Gilbert, Morewedge, Risen, & Wilson, 2004; Kermer, Driver-Linn, Wilson, & Gilbert, 2006). Further, loss aversion may be reversed for small monetary outcomes such that gains loom larger than losses (Harinck, Van Dijk, Van Beest, & Mersmann, 2007). Loss aversion may even be diminished (Novemsky & Kahneman, 2005) based on one's budgeting intentions and whether the exchange or consumption of an object is evaluated as a loss or a foregone gain. Routine transactions between sellers and buyers also appear to bypass responses to loss aversion (Tversky & Kahneman, 1992) as is observed in experienced stock market traders (Sokol-Hessner et al., 2009).

Another boundary condition where the reversal of loss aversion occurs is in contexts that support autonomy (Chatzisarantis, Kee, Thaung, & Hagger, 2012). In other words, when the provision of choice fulfills intrinsic psychological needs, such as autonomy, competence, and interpersonal relatedness (i.e., self-determination theory; Ryan & Deci, 2000), this may induce a stronger positive affect during decision making that may counteract the negative effect of loss of options, leading to a smaller magnitude of loss aversion experienced. A more detailed discussion of emotions and decision making will be presented later in this chapter.

Other models have been proposed in light of empirical evidence that demonstrates inconsistencies in the asymmetric observance of losses to gains (e.g., prospects involving small sums of money, equal incentive structures of gains and losses) (Ert & Yechiam, 2010; Glackner & Hochman, 2011; Levy & Levy, 2002; Sokol-Hessner et al., 2009; Tymula, Belmaker, Ruderman, Glimcher, & Levy, 2013; Yechiam & Hochman, 2013a, 2013b). Perhaps the most striking inconsistent evidence presented to date is the absence of behavioural loss aversion during experimental tasks that show accompanying physiological arousal. For example, in one study, participants were asked to accept or reject visually presented gambles with mixed losses and gains. Even though behavioural loss aversion was not observed in most individuals, the increase in galvanic skin response (an indicator of sympathetic arousal) was reported in the loss but not gain condition (Sokol-Hessner et al., 2009). Studies using event-related brain potentials that detect responses to loss in the frontal error-related negativity signal (fERN) correspond to cortical potentials that appear 100 to 200 ms post-stimulus. This period is a precursor of autonomic response and concurs with the outcomes of an early evaluation of potential threat (Dywan, Mathewson, Choma, Rosenfeld, & Segalowitz, 2008; Hajcak & Foti, 2008). Several studies reported that increased fERN was not observed to co-occur with behavioural loss aversion and participants exhibited loss neutrality instead of loss aversion (Bush, Luu, & Posner, 2000; Critchley, Tang, Glaser, Butterworth, & Dolan, 2005; Fein & Chang, 2008;

Yeung & Sanfey, 2004). These findings indicate that behavioural loss aversion does not consistently concur with physiological markers.

An attention-allocation model was put forth as an alternative to loss aversion theory to explain such discrepancies. Whereas Prospect Theory predicts that loss aversion leads to behavioural responding to avoid losses, Yechiam and Ert (2011) have proposed that the experience of losses precedes loss aversion and that it is the redirection of the focus of attention following losses that increases the sensitivity to losses. The orientation of attentional processes due to the perception of loss is postulated to explain the physiological and cortical markers of arousal (Yechiam & Hochman, 2013b). Although interesting, this alternative model has not been validated by others.

Recent neuroimaging studies have examined loss aversion by mapping the experience of losses and gains to neural substrates involving the orbitofrontal and striatal regions (De Martino et al., 2006; Kuhnen & Knutson, 2005; Tom et al., 2007; Yacubian et al., 2006). Specifically, the s-shaped loss aversion function (Figure 2) has an analogue version coded in neural activation in the ventral striatum and the prefrontal cortex, depicting steeper activation (higher slope) for losses than for gains, respectively (Tom et al., 2007). This finding is the first to associate loss aversion to previous studies that have shown differential brain responses for losses and gains. Additional support of neural involvement of the amygdala, anterior cingulate cortex, and loss aversion has since been published (Canessa et al., 2013; De Martino, Camerer, & Adolphs, 2010; Fukunaga, Brown, & Bogg, 2012; Sokol-Hessner, Camerer, & Phelps, 2013).

In summary, a large body of evidence exists to suggest that humans are generally motivated to behave in ways to avoid loss across multiple life domains. Loss aversion is observed in decisions that involve risk as well as in riskless situations. Recent evidence linking the neurobiological encoding of loss aversion has furthered our understanding of this pervasive trait.

Applications of Loss Aversion

Many studies on the applications of loss aversion have elucidated economically-driven behaviours such as the endowment effect and others (e.g., the framing effect, the status-quo bias, and sunk cost effect) (Harinck et al., 2007; Kahneman, Knetsch, & Thaler, 1990; Novemsky & Kahneman, 2005), and applications in medicine, consumer behaviour, and marketing. The endowment effect is most pertinent to the present research, and is discussed below.

The endowment effect occurs when individuals develop an attachment to their possessions and will only agree to part with an item for a value that is higher than what they paid to obtain it, suggesting that a higher value is placed on the loss of possessions (Kahneman, Knetsch, & Thaler, 1990). To demonstrate the endowment effect, Kahneman, Knetsch, and Thaler (1990) endowed half of the participants in a study at Cornell University with coffee mugs, which retails for $6.00. The mug *sellers* were to contemplate how much money they were willing to accept to part with the mug. *Buyers* were asked to submit bidding prices for the same mugs. On hypothetical and binding transactions, it was reported that fewer than expected transactions occurred (less than half of the volume of expected trades), and sellers' median selling prices were approximately twice as high as buying prices. These findings suggest that sellers were reluctant to part with their mugs in real and hypothetical situations, and they expected twice as much money to part with their mugs than buyers were willing to pay.

Given that significantly fewer trades were made than were predicted by the authors, a follow-up experiment investigated whether low volume trades were a result of a reluctance to buy or sell. Three groups consisting of sellers, buyers, and choosers were presented with a series of prices ranging from $0.25 to $9.25 for mugs. Sellers were given mugs and buyers were asked whether they would be willing to buy the mugs at the seller's prescribed prices. Choosers were not given mugs, but were asked to choose, for each of the prices, whether they wished to receive the mug or that amount of money. Effectively, choosers and sellers are identical in that they have to decide between keeping the mug or receiving money. Despite choosers and sellers being in equivalent decision points, the results indicated that choosers behaved more like buyers than like sellers. Choosers and buyers had similar average price points, $3.12 and $2.87, respectively, as compared to sellers who wanted $7.12 for the mugs. The authors explained that the low volume trades made by sellers are due to an endowment effect of an object (i.e., ownership) that leads to an attachment rather than an unwillingness of purchasers to pay for the mugs. Thus parting with an option (i.e., selling) translates to feeling the associated pain of giving it up, which is postulated to be akin to loss aversion (Kahneman et al., 1990).

Other researchers have also shown that object attachment occurs even when the object is not in one’s possession (Carmon, Wertenbroch, & Zeelenberg, 2003). For example, a person can still develop attachments by merely having the *option* of owning an object. Consequently, one can become emotionally attached to options in the same way as real objects, and the loss of an option implies the loss of an item. The aversion to loss of options has been explicated by Shin and Ariely (2004) as the pseudo-endowment effect that was operationalized through the Doors Game. Attachments to target items may arise because people use their feelings about an item as information to evaluate and make judgments (Pham, Cohen, Pracejus, & Hughes, 2001). Using affect as information as opposed to rational reasoning has been demonstrated to be stable across individuals and may lead to faster decision making that is more in line with the valence of people's feelings (Carmon et al., 2003).

Relationship between Decision Making and Emotions/Personality

Decision making does not operate in the absence of emotional states (Loewenstein, Weber, Hsee, & Welch, 2001). The emotional states of anxiety and depression have been shown to interfere with decision making (Angie, Connelly, Waples, & Kligyte, 2011; Broman-Fulks, Urbaniak, Bondy, & Toomey, 2014; de Visser et al., 2010; Grupe & Nitschke, 2013), and in some situations, facilitate decision making (Paulus & Yu, 2012). Many studies have reported that anxiety is associated with attentional and interpretative biases, such that highly anxious individuals in non-clinical and clinical samples are prone to interpreting ambiguous stimuli as more threatening and are generally more risk averse (for review, see Blanchette & Richards, 2010), particularly for large negative consequences (Carr & Steele, 2010; Maner & Schmidt, 2006), than non-anxious individuals. However, most of these studies used verbal tasks (e.g., lexical tasks such as homophone-spelling task, word recognition), which are subject to conscious filtering and are indirect measures of the effect of anxiety on decision making (Blanchette & Richards, 2003). Non-verbal methods that used ambiguous faces did however report that clinically anxious individuals are more likely to interpret ambiguous faces as angry or fearful as compared to control groups (A. Richards et al., 2002; Sprengelmeyer, 1997). In light of these findings, anxiety appears to exert strong influences on the emotional processing of verbal and non-verbal information and should be examined in the context of hedging.

Threat-induced biased attentional processes are related to fear-based neurocircuitry that overlap with structures studied in decision making. For example, fear-induced responses to explicit and unattended ambiguous stimuli have been reported to activate signals in the amygdala and the prefrontal cortex of healthy controls (Bishop, 2009; Dickie & Armony, 2008; Etkin et al., 2004; A. Mathews & Mackintosh, 1998; Somerville, Kim, Johnstone, Alexander, & Whalen, 2004), and stronger activations in anxious individuals (Amir, Beard, & Bower, 2005; Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; J. Richards, Austin, & Alvarenga, 2001; Yoon & Zinbarg, 2008). Faulty decision making under threat or risk is associated with atypical activation of the DLPFC (Fecteau et al., 2007; Knoch, Gianotti, Pascual-Leone, Treyer, & Brugger, 2006), insula (Clark et al., 2008; Kuhnen & Knutson, 2005; Paulus, Rogalsky, Simmons, Feinstein, & Stein, 2003; Preuschoff, Quartz, & Bossaerts, 2008), amygdala (Hsu, Bhatt, Adolphs, Tranel, & Camerer, 2005), striatum (Kuhnen & Knutson, 2005; Tobler, O'Doherty, Dolan, & Schultz, 2007), anterior cingulate cortex (Christopoulos, Tobler, Bossaerts, Dolan, & Schultz, 2009; Engelmann & Tamir, 2009), and OFC (Krain, Wilson, Arbuckle, Castellanos, & Milham, 2006; Kuhnen & Knutson, 2005; Schultz et al., 2008). Collectively, these studies highlight the biological correlates of impaired decision making.

Hartley and Phelps (2012) have highlighted the fact that only four neuroimaging studies have examined individual differences in loss aversion. These studies provide evidence of the association between loss aversion and electrodermal arousal and neuronal activations in the amygdala, the striatum, and the prefrontal regions of the brain (De Martino et al., 2010; Sokol-Hessner et al., 2009, 2013; Tom et al., 2007). In light of the findings of association of shared neural activations of fear and anxiety with decision making, more researchers are beginning to examine individual differences in loss aversion (Borghans, Duckworth, Heckman, & Weel, 2008; Boyce, Wood, & Ferguson, 2016; Hartley & Phelps, 2012; Maner et al., 2007). Study One aims to address a gap in the literature by examining behavioural loss aversion (i.e., hedging) in a non-clinical population.

The literature on the effect of mood on decision making is not as extensive as that for anxiety. Early studies reported that positive mood induction led healthy controls to feel more confident about their skills-based abilities (Mellers, 2000) and make better and faster choices (Isen & Means, 1983). An interesting study used more real-life situations that business managers might encounter in order to examine risky decision making (Mittal & Ross, 1998). Business students were presented with either positive or negative stories (i.e., a medical student learns of his admission or a patient learns of a positive diagnosis of leukemia, respectively) and then were tasked with making spending decisions on nine business plans. Greater risk-taking decisions were observed in the group that read the negative mood induction story as compared to positive. This study highlights that induced depressed mood may lead to decisions that involve more risk-taking.

A series of three experiments further supported the theory that individuals who had dysphoric mood were biased in favour of making risky decisions related to gambling and job-selection as compared to anxious individuals who preferred low-risk options (Raghunathan, 1999). Several other studies suggest that sad states may induce more risky behaviours due to the depletion of energy resources typically allocated to manage negative affect, such that less available cognitive resources lead to poor decision making (Bruyneel, Dewitte, Franses, & Dekimpe, 2009), in part due to the redirection of resources needed to regulate emotions (Harlé, Allen, & Sanfey, 2010). In addition, it may be that individuals with anhedonic tendencies are less sensitive to rewards and have difficulty integrating reward-based contingencies (reinforcement) as compared to non-depressed individuals and therefore are more likely to make non-optimal decisions (Henriques, Glowacki, Davidson, 1994; Kunisato et al., 2012).

Studies that employed lexical tasks (e.g., semantic priming) have not found evidence of a depressed interpretive bias in decision making in depressed individuals as had been previously demonstrated in anxious individuals (Bisson & Sears, 2007; Lawson & MacLeod, 1999). In studies that induced dysphoric mood, response bias was observed (i.e., the tendency to report the more negative interpretation of the options presented); however, the induced-dysphoric group did not display more negative bias as compared to controls (Bisson & Sears, 2007). Even in a depressed clinical sample who responded to a comprehension task, interpretive bias was lacking, but in two other tasks that had room for response bias (i.e., homophone and memory tasks), response bias was present in the depressed group as compared to controls (Mogg, Bradbury, & Bradley, 2006). Another study demonstrated that clinically depressed individuals actually outperformed healthy individuals and participants recovering from a depressive episode in a sequential decision making task (von Helversen, Wilke, Johnson, Schmid, & Klapp, 2011). The authors noted that negative affect may motivate depressed individuals to assume control by thoroughly processing information more analytically and systematically. Overall, interpretive bias of ambiguous stimuli does not appear to affect individuals who are depressed and therefore may be less likely to be affected by decision making than individuals who are anxious.

Emotions and Hedging

Little empirical research has examined the association between hedging and emotions. Given that hedging is likely motivated by loss aversion, the latter which may share common neurocircuitry in the areas of emotional processing in the brain, it is important to examine the relationships among hedging, and anxiety and depression as the two emotions that have been demonstrated to be related to loss aversion. Given the numerous findings in the literature regarding the association between emotional states and decision making (Lerner et al., 2015), Study One aims to examine links between hedging and emotions, using psychometrically sound measures of anxiety and depression, which will provide the basis for further study of individual differences in hedging.

Replication of Doors Paradigm

The four studies conducted by Shin and Ariely (2004) show a robust and stable hedging trait in individuals. However, the hedging effect using the Doors Game has not been independently replicated. Given that the series of studies in this dissertation is based on this paradigm, the first research question is whether a replication of the paradigm can be demonstrated. Hence, the first goal of Study One is to replicate the hedging effect using the Doors Game. Shin and Ariely (2004) had found significantly higher switching in the DA condition as compared to the CA group in a between groups comparison design. Group comparisons are inherently prone to more systematic errors (Brooks, 2012) and require more subjects than a repeated measures design to achieve the same power. Thus, this study will use a within-subject experimental design to enhance the power and reduce errors attributed to group differences.

Research Questions and Hypotheses

Research Question 1: Can the effect of the Doors Game be replicated by showing that switching occurs more frequently when options are diminishing?

Hypothesis:

It is hypothesized that more switching between doors will occur in the DA than CA condition within individuals.

Association between Hedging and Anxiety and Depression.

The second research question involves examining the associations between anxiety and depression symptoms and switching.

Research Question 2: Are anxiety and depression symptoms associated with hedging in an undergraduate sample?

Hypotheses: Given the finding that hedging occurs due to a threat of loss of options, it is hypothesized that individuals with higher self-reported anxiety symptoms will hedge more due to their sensitivity to threat (Maner et al., 2007), and by extension to loss aversion. Individuals with higher depressive symptoms have been reported to make more risky outcome decisions (Bruyneel, et al., 2009; Raghunathan, 1999), suggesting that they are less sensitive to loss aversion. Thus, it is hypothesized that individuals with higher self-reported depression symptoms will hedge less.

Method

Participants

Undergraduate students (N = 108; 34 male and 74 female) from Ryerson University completed this 60-minute study in exchange for 1% course credit in an Introductory Psychology Course.

Measures

Computerized Instruments

Hedging was assessed by the Doors Game (Shin & Ariely, 2004), which was played on an iPad. Three doors can be selected sequentially for a maximum of 100 trials (see Figure 4). Participants were instructed to maximize their winnings by tapping any of the three doors. The Doors Game provides the option to play the game in cents or dollars. This study was played with an expected payout value in cents, totaling a maximum of approximately $3.00 following 100 trials regardless of which doors are selected; however, participants are unaware of the expected value. The three different distributions of payoffs (-2¢ to 12¢) were employed: i) mean of $3.00 was distributed in a higher concentration around the mean; ii) symmetric but diffuse around the mean of $3.00; iii) or skewed with high numbers with an overall mean of $3.00. Lower numbers appeared more frequently than higher numbers so that the mean value was $3.00.

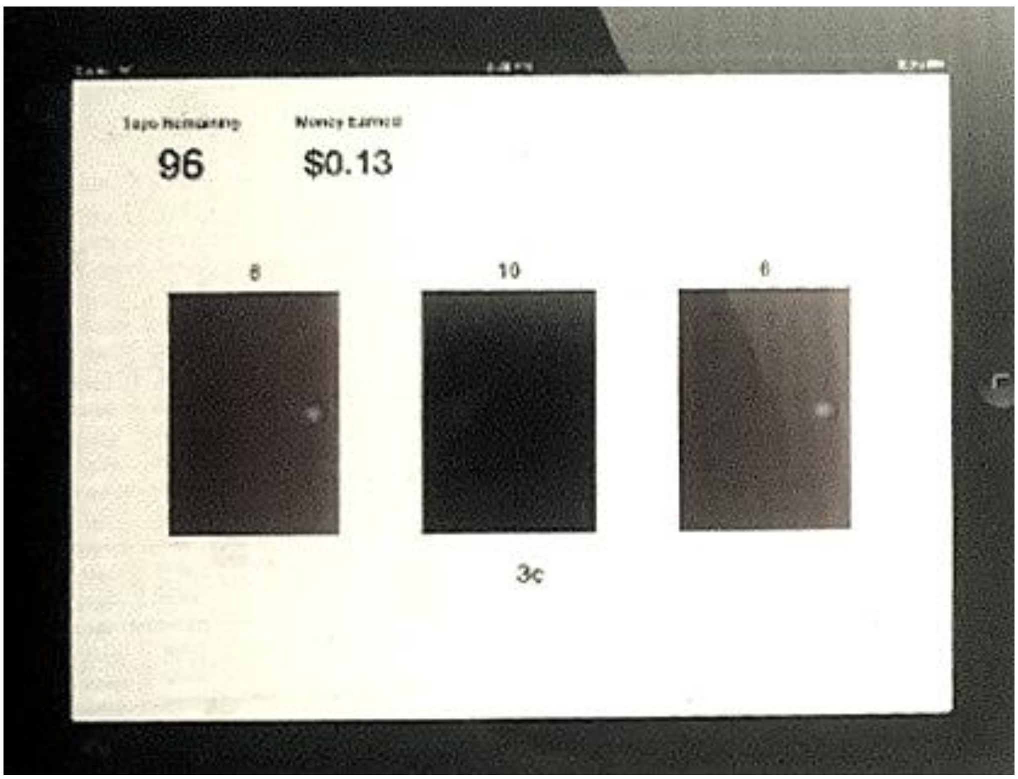


Figure 4. The Doors Game interface depicting three adjacent doors, the number of taps remaining and the cumulative earnings. Winnings for each tap are indicated below each door when the door is tapped.

There were two conditions presented. In the CA condition, participants can choose freely amongst the three doors for a maximum of 100 taps. Searching and tapping in the CA condition is operationally referred to as *switching.* In the DA condition, once any one door is tapped, the other two doors will begin to fade, and if either of the two fading doors is not tapped within 15 seconds, it will disappear forever. Once a door (i.e., option) disappears, participants cannot obtain payment from it. Switching and tapping in the DA condition is operationally referred to as *hedging*; however, hedging by keeping options available is also observed in the CA condition. This task takes approximately three minutes to complete. Participants completed both the CA and the DA conditions of the Doors Game in randomized order. Prior to playing the DA condition, in order to ensure participants understood the task, participants were asked "When the game starts, what happens when you tap on one door?" Participants who showed a lack of understanding of the task were provided instructions again and orally re-quizzed. All participants passed that quiz before proceeding.

Self-Report Questionnaires

Anxiety Sensitivity Index (ASI; Taylor et al., 2007) is an 18-item questionnaire that assesses physical, cognitive and social anxiety concerns. Self-report statements are rated on a 5-point Likert scale and are categorized into three subscales. The Cognitive factor is associated with concerns that changes in thought processes are signs of mental illness. The Social factor relates to beliefs that observable anxiety reactions will elicit negative social judgements or rejection. The Physical factor is associated with concerns about somatic sensations of anxiety. Data from a normative sample indicate that this scale shows good reliability and validity, and it has been normed in non-clinical Canadian participants, with a Cronbach's alpha = .79 and test-retest reliability of $r = .64$ (Taylor et al., 2007). Cronbach's alpha was .86 in the current study.

The Beck Depression Inventory-II (BDI-II) (T. A. Beck, Steer, & Brown, 1996) is a 21-item self-report questionnaire that assesses depression severity using 4-point response options. In the original psychometric study, Cronbach's alpha was .91 and test-retest reliability was r = .93 (T. A. Beck et al., 1996). Cronbach's alpha was .87 in the current study.

The State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA) (Grös, Antony, Simms, & McCabe, 2007) is a 21-item self-report questionnaire that assesses both cognitive and physical symptoms of anxiety in the moment (i.e., state anxiety) and as an enduring general characteristic (i.e., trait anxiety). The items are rated from 1 ("not at all") to 4 ("very much so"). Cronbach's alpha has been shown to range from .83 to .92, and test-retest reliability from r = .79 to .90 (Grös, et al., 2007). Cronbach's alpha ranged from .87 to .89 in the current study.

Procedure

The study received approval from the Institutional Research Ethics Board, and informed written consent was obtained at the beginning of the study. Participants completed self-report measures of anxiety and depression symptoms (as part of a larger battery of instruments for another project) and the Doors Game. Participants were debriefed and awarded 1% course credit at the completion of the study.

Analyses

Descriptive analyses involving normality, skew, measures of central tendencies, and visual inspection were conducted. To test the first hypothesis that switching would be more more frequently observed in the DA than CA conditions, paired sample *t*-tests were conducted on the entire sample. To test the second hypothesis regarding the association between anxiety and depression symptoms and hedging, correlational analyses were conducted between the number of switches (i.e., operationalized as an indicator of hedging) and scores on the ASI, STICSA, and BDI.

Descriptive Analyses of Hedging

Table 1 presents the mean, median, range, percentiles, skew, kurtosis, and normality in the CA and DA conditions. Both conditions exhibit non-normal distributions with the CA condition exhibiting a more pronounced quadratic form than the DA distribution. Four outliers were found at the upper end of the distribution in the CA condition. The removal of the outliers did not lead to significantly different results in the analyses of switching, thus to preserve power, the total sample size was retained for future analyses.

Table 1

Descriptive Analysis of Constant Availability (CA) and Decreasing Availability (DA) Conditions

Variable	CA	DA
Mean (SD)	31.4 (27.8)	39.2 (28.9)
Median	22.00	31.00
Minimum - Maximum	0 – 98	0 – 98
Skew	1.05	0.76
Switches at the 25th percentile	9.2	17.3
Switches at the 50th percentile	22.3	31
Switches at the 75th percentile	46.3	56.3
Kurtosis	0.08	-0.58
Test of Normality	D(108) = 0.15, *p* <.001	D(108) = 0.14, *p* <.001

The distribution of switches in each condition can be seen in Figure 5. There is a positive skew (i.e., leftward) in the CA condition and negative kurtosis (i.e., flatter) distribution in the DA condition with more switching distributed across the continuum of possible switches, and with higher frequency at the tail ends of the distribution.

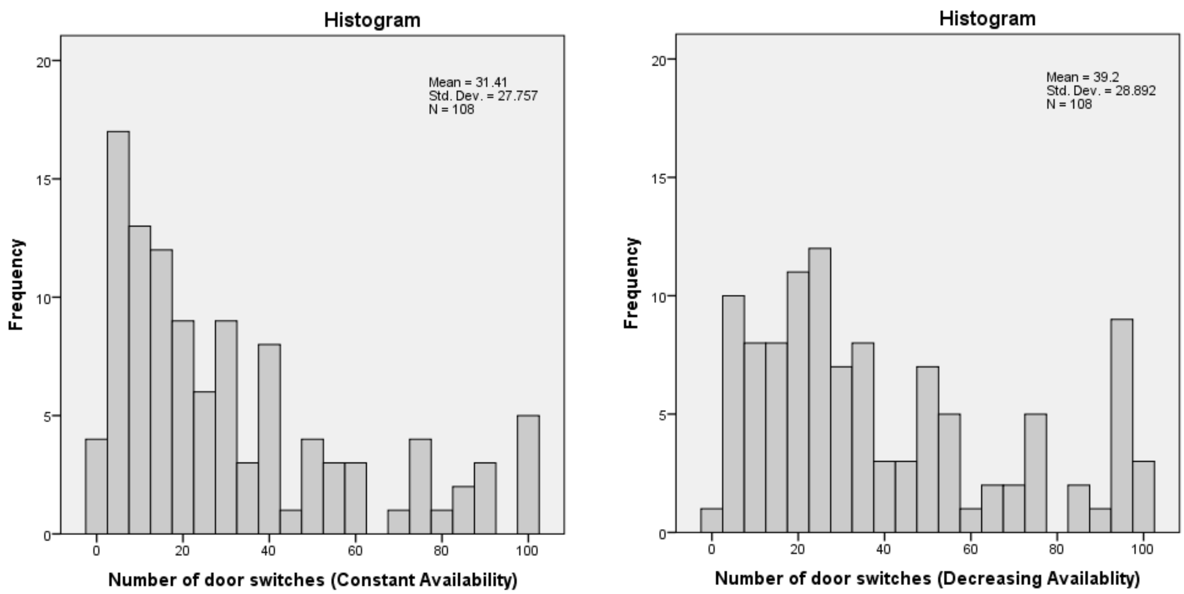


Figure 2. Histogram of switching in the Constant Availability (CA) and Decreasing Availability (DA) conditions.

Results

Given the non-normal distribution, a non-parametric Wilcoxon signed-rank test was conducted that yielded significantly higher hedging in the DA condition (Mdn = 31), $z = -2.68$, $p = .008$, $r = -.26$ than the CA condition (Mdn = 22). Parallel parametric analyses of individual hedging tendency using a paired *t*-test indicated similarly more significant switching in the DA condition ($M = 39.2$, $SD = 28.9$) than the CA condition ($M = 31.4$, $SD = 27.8$; $t(107) = 3.2$, $p = .002$, $d=0.28$). Hence, the results and effect sizes are similar in the parametric and non-parametric analyses. This moderate effect size concurs with the finding that hedging generally occurs more frequently when options appear to be disappearing. Put another way, hedging results in more switching than usual in an attempt to keep options available. A comparison of the effect sizes between this study and Shin and Ariely's (2004) study was not possible given the absence of published standard deviations. It was possible to derive the effect size however, for the main effect of hedging in ten blocks of 10 taps from the published study ($F(1, 1550) = 306.27$, $p < .00001$) and that yielded a large effect size (Cohen's $d = 2.811$). In this study, the effect size depicting more switching in the DA than the CA condition across the ten blocks was computed to be in the moderate range ($d = 0.48$) .

Emotional Correlates of Hedging

Descriptive measures of central tendency and variation of emotional indicators can been viewed in Table 2. Overall, self-reported depressive and anxiety symptoms, showed a positive skew, suggesting that the majority of individuals reported levels below the clinical range, leading to a non-normal distribution of scores. Only the ASI total composite yielded a normal distribution. The labeling of outliers method (Hoaglin, 1987) revealed one outlier in the upper end of the STICSA State Physical trait and was removed.

Table 2

Descriptive Statistics for Beck Depression Inventory (BDI), Anxiety Sensitivity Inventory (ASI), and State-Trait Inventory Cognitive Symptoms of Anxiety (STICSA)

Measure	Mean (SD)	Median	Min – Max	Skew	z_{skew}	Kurtosis	$z_{kurtosis}$	D
BDI	13.9 (8.1)	13	0 – 38	0.59	2.57	-0.10	-0.22	0.10^{**}
ASI								
Total	19.8 (11.6)	19	1 – 52	0.59	2.57	-0.06	-0.13	0.07
Cognitive Concerns	5.5 (4.8)	4.7	0 – 20	0.77	3.35	-0.26	-0.57	0.14^{***}
Social Concerns	9.5 (4.9)	4.9	0 – 24	0.41	1.78	0.13	0.28	0.07
Physical Concerns	4.8 (4.6)	3.0	0 – 20	1.25	5.43	1.37	2.98	0.18^{***}
STICSA								
State Total	33.7 (9.4)	31	21 – 65	1.12	4.81	0.86	1.87	0.16^{***}
State Cognitive	18.4 (5.9)	17	10 – 37	0.82	3.52	0.21	0.46	0.11^{**}
State Physical	15.1 (4.2)	13	11 – 27	1.38	5.92	1.42	3.09	0.21^{***}
Trait Total	36.58 (8.9)	34	23 – 59	0.57	2.45	-0.61	-1.33	0.14^{***}
Trait Cognitive	21.1 (6.0)	20.5	11 – 38	0.56	2.40	-0.12	-0.26	0.09^{*}
Trait Physical	15.5 (4.5)	14	11 – 31	1.27	5.45	0.96	2.09	0.20^{***}

Note. D: Kolmogorov-Smirnov Test of Normality

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .01$

The pattern of switches in the CA and DA conditions was analyzed for associations with anxiety and depression symptoms (see Table 3). Past research indicates that early responses reflect genuine responses that have not been adapted to learning of the task and may be a better indicator of automatic and prepotent processing (Salemink, van den Hout, & Kindt, 2007), thus correlations are tabulated for switching observed in the first block of each condition, as well as total switching. It appears that the ASI Cognitive factor (fear of cognitive dyscontrol) is significantly inversely associated with hedging in the DA condition of the first block and marginally for all the trials. The ASI Social factor (fear of publicly observable anxiety reactions) is significantly inversely related to switching in the CA condition and similar trends were observed in the DA condition of the first block. That is, higher scores on anxious cognitive and social concerns are related to less switching between doors. There are similar inverse correlational trends observed in the first block of switching in the CA condition and Trait cognitive anxiety on the STICSA. Depressive symptoms appear unrelated to hedging. Separate correlational analyses that are not shown here confirmed previously reported findings in the literature of modest associations between depression, anxiety sensitivity and trait/state anxiety (Grös et al., 2007; Taylor et al., 2007), with Spearman's correlation coefficients ranging between .33 to .58, $p < .001$ in this sample, which is considered to be in the moderate range for effect size.

Table 3

Spearman's Correlation Coefficients of Anxiety Sensitivity, State/Trait Anxiety, and Depressive Symptoms with Hedging in the Constant Availability Condition (CA) and Decreasing Availability (DA) Conditions in the Total Sample (N=*107*)

Measure	CA	DA	CA 1ST Block	DA 1st Block
BDI	-.09	-.02	-.12	-.02
ASI Total	-.16†	-.16†	-.20*	-.17†
ASI Cognitive Concerns	-.14	-.22*	-.13	-.19*
ASI Social Concerns	-.19*	-.18†	-.29**	-.22*
ASI Physical Concerns	-.10	-.01	-.09	-.01
STICSA State Total	-.01	-.14	-.16†	.13
STICSA State Cognitive	-.06	.13	-.19*	.12
STICSA State Physical	.10	.16†	.01	.14
STICSA Trait Total	-.05	.08	-.17†	.11
STICSA Trait Cognitive	-.09	.07	-.17†	.08
STICSA Trait Physical	.02	.07	-.11	.09

Note. BDI – Beck Depression Inventory; ASI – Anxiety Sensitivity Inventory; STICSA – State-Trait Inventory Cognitive Symptoms of Anxiety

* $p < .05$; ** $p < .01$, † $.05 < p < .10$

Discussion

The first goal of this study was to replicate the finding of Shin and Ariely (2004) that individuals tend to keep their options available when there is a threat of losing them (i.e., they tend to hedge). The second goal was to investigate whether hedging tendency is related to emotional factors, such as depression, anxiety sensitivity, and state/trait anxiety. The results support the notion that hedging is a normative behaviour that was observed in this sample of undergraduates. Further, in this replication of Shin and Ariely's (2004) findings, when individuals were faced with disappearing options, they tended to act to keep their options open by switching and tapping fading doors to prevent their disappearance. Noted in this sample is the non-normal distribution of switching in both the CA and DA conditions. A quadratic profile in the CA condition suggests that under normal conditions of no loss priming, a large subset of young people switch options sparingly. A few individuals in this subset switched excessively. Priming of loss in the DA condition elevates hedging overall for the sample. These individual differences in hedging beg the question of what related psychological factors may drive the discrepancies.

To answer this question, correlations were examined between hedging and depression and anxiety symptoms. Hedging in the DA condition appeared to be inversely related to the ASI Social and ASI Cognitive facets. Only switching (CA condition) was negatively associated with the STICSA State Cognitive subscale. Overall, these discrepant findings among anxiety measures were unexpected given the a priori hypothesis of a positive association between hedging and anxiety.

The relationship between hedging and anxiety was examined further in post-hoc analyses by subdividing the sample into quartiles of severity ratings of anxiety sensitivity and state/trait anxiety (see Appendix A). In the highest rated severity group (i.e., the fourth quartile) on State and Trait cognitive subscales of the STICSA (which is in the clinical range of severity), hedging tendency was observed to be much higher in the loss-priming condition (DA) than the no-loss condition (CA). This finding appears to fit with the hypothesis that more switching is associated with greater anxiety. Together, these findings suggest that individuals who endorse greater cognitive symptoms of anxiety prefer to keep their options open.

Unexpectedly, higher anxiety sensitivity scores were actually associated with less hedging behaviour. This finding is in contrast with the above findings, given that the construct of anxiety sensitivity overlaps with general anxiety constructs (Taylor et al., 2007), insofar as anxiety sensitivity *amplifies* pre-existing anxiety by bringing attention to physical sensations, thoughts of going mentally ill, or being judged negatively in social situations. In the present sample, anxiety sensitivity showed significant positive correlations with depression and all subscales of trait and state anxiety. However, it is possible that some individuals who reported high anxiety sensitivity are not chronically anxious, and such individuals may have a tendency to hedge less.

Correlations of ASI and hedging and switching appear to be in the same direction; however, the inverse is true for some STICSA variables. Specifically, State and Trait Cognitive and Total scores correlated negatively in the CA condition and but positively in the DA condition. Given these unexpected results, the patterns of hedging in these variables were explored further (see Appendix A). The overall finding from these post-hoc analyses appears to provide some support that hedging is the greatest among individuals with the highest rated anxiety levels, particularly cognitive anxiety.

Additional post-hoc analyses to determine the overlap of individuals with high anxiety sensitivity and trait anxiety revealed a 46% overlap of individuals whose self-reported anxiety symptoms fell in the fourth quartile of both measures. When viewed as a series from Q1 to Q3 (Figure A1), the hedging trend slopes downward in both the CA and DA conditions on all measures. Average hedging actually increased in the DA condition in the Q4 groups of State total anxiety, State cognitive anxiety, and Trait cognitive anxiety. Hedging only decreased in Q4 of ASI total. It is possible that the non-normal distribution of anxiety as measured on the STICSA explains the increased hedging. Additional research is required to clarify the discrepancy of hedging across anxiety measures (e.g., ASI vs. STICSA).

It is also conceivable that some of the highly anxious individuals who did not have high anxiety sensitivity possessed other traits that impact on hedging that were not assessed in this study. Note that the distribution of hedging mimicked a quadratic profile, delineating the presence of a group of high frequency hedgers. Other factors related to risky behaviours are known to modulate decision and may influence hedging. Individuals with Gambling Disorder or Attention-Deficit/Hyperactivity Disorder, for example, are reported to show characteristically higher risk-taking due to elevated impulsivity than nonclinical controls (Choi et al., 2012; Potenza, Koran, & Pallanti, 2009). Clinical groups with higher-rated anxiety traits such as individuals with OCD are also prone to maladaptive decision making (Maner et al, 2007). Individuals with clinical levels of impulsivity and anxiety might yield a different profile of hedging. Study Two will explore the relations between hedging and other traits such as impulsivity.

Finally, no significant associations between depression and hedging were observed. The absence of findings suggests that mood symptoms do not appear to influence choice selection in simulated loss scenarios. Other researchers have reported that dysphoric mood was associated with risky decision making (Mellers, 2000; Raghunathan, 1999) and reward insensitivity (Kunisato et al., 2012). The Doors Game is neither a risky decision making task nor a reward-contingent task, hence the lack of associations with hedging is not all that surprising. Cognitive load was noted to impede good decision making (Bruyneel et al., 2009); however, the cognitive resources needed for the simple Doors Game is low, thus the cognitive effort required for the task or to regulate emotions is unlikely a performance factor. Overall, depression is an unlikely correlate of hedging.

The strengths of Study One include the use of previously designed software to illustrate the hedging phenomenon. Replication using the same paradigm by two independent research groups provides more confidence in the hedging phenomenon. A reasonably-sized sample of participants (N=108) was recruited and this study reduced unsystematic errors and increased power by using a within subjects design analysis to examine hedging across the CA and DA conditions. The investigation of psychological correlates of hedging with psychometrically validated measures (e.g., BDI, ASI, and STICSA) provides initial understanding of psychologically relevant factors such as depression and anxiety that have been shown to influence decision making (Johnson & Tversky, 1983; Kirsch & Windmann, 2009).

The use of an undergraduate sample limits the generalizability of hedging behaviour. This is the second study to have used an undergraduate population to investigate hedging. Thus future studies should aim to recruit from the wider population base. The findings may reflect lack of variability of scores that made it difficult to interpret true hedging behaviour in people with high anxiety. State anxiety is an interesting variable to experimentally manipulate in order to examine the effect on hedging and would fit with much of the current research on incidental emotions that is prevalent in the literature (Yip & Côté, 2013). For example, state anxiety may be experimentally induced by having participants believe that they have to speak publically or do complex math questions (MacIntyre & Gardner, 1991). Many studies have shown that excessive high state anxiety leads to disadvantageous decision making (for studies, see Kirsch & Windmann, 2009). The data from this study provide mixed support regarding the association between hedging behaviour and various aspects of anxiety, therefore a replication is warranted to further explore this finding.

Overall, the findings from this study support Shin and Ariely's (2004) hedging phenomenon. This study is the first to provide independent evidence of possible individual differences that may be moderated by high anxiety. However, this area requires much more investigation. The findings do support the notion that the human motivation to keep options available becomes enhanced when there is a threat of loss of options. This finding supports previous research suggesting that the pseudo-endowment effect applies to options (Carmon et al., 2003), such that people value their endowed options and take actions to prevent losing them.

Chapter 3: Study Two

Literature Review: Emotions and Decision Making

Review of Hedging and Findings from Study One

Decision making is influenced by emotions and personality traits (Heilman, Crisan, Houser, Miclea, & Miu, 2010; Lauriola & Levin, 2001; Lerner et al., 2015), and "models of decision making cannot afford to ignore emotions as a vital and dynamic component of decisions and choices" (Harlé & Sanfey, 2012). The current study explored the associations between an aspect of decision making called hedging and anxiety, impulsivity, and sensation seeking given that empirical research has demonstrated the moderating influence of these variables on risk-taking in financial decision making (Engelmann, Meyer, Fehr, & Ruff, 2015; Lauriola, Panno, Levin, & Lejuez, 2014).

People like to have choices, particularly when making decisions in situations that involve risk (Starmer, 2000; Stewart, Chater, Stott, & Reimers, 2003). For example, having choice in medical decisions enhances treatment effectiveness (Geers et al., 2013). A natural intuitive response in uncertain circumstances is to delay decision making, thereby keeping all current options available to be decided at a later time (C. J. Anderson, 2003). This tendency to keep one's options open (i.e., hedging) has been demonstrated to be a robust phenomenon (Pongracic & Farvolden, 2015; Shin & Ariely, 2004). Unlike other gambling tasks that measure the sensitivity to future consequences (Weller, Levin, & Bechara, 2010), the Doors Game measures hedging, which is concerned with deciding what to do in the current moment with the available options. The continuum of hedging behaviour has implications for real life decision making. For example, hedging may be one way to regulate emotions in the face of threat of loss of options (Pongracic & Farvolden, 2015). Hedging already occurs in many financial strategies to allow for flexible options in the event of adverse market movements, but also in routine everyday purchases (e.g., paying more for additional selection at buffet restaurants, buying insurance for the protection against catastrophic events). However, deficits or excesses in hedging have the potential to be maladaptive, as exemplified by keeping options available due to excessive indecisiveness, doubt, or fear of harm (C. J. Anderson, 2003; Ettelt et al., 2008; Pitz & Sachs, 1984). The phenomenon of hedging using the Doors Game paradigm created by Shin and Ariely (2004) was replicated in Study One of this dissertation in an undergraduate population. Additionally, the results of Study One suggest that a tendency to hedge may be associated with certain emotional states, such as anxiety. Individuals in the CA condition who had higher ratings of cognitive state and trait anxiety (i.e., ratings that were in the fourth quartile) appeared to hedge less than the least anxious individuals (i.e., ratings that were in the first quartile). This trend was not observed in the DA condition where the top quartile of anxious individuals hedged significantly more than the rest of the group. Individuals with high anxiety sensitivity however, behaved similarly in the CA and DA conditions across quartiles. More specifically, switching and hedging frequency declined across quartiles of anxiety sensitivity. Together, these findings suggest that some emotional factors (e.g., anxiety) may be related to hedging. Study Two aims to further explore the relations among emotions and dimensions of personality traits and hedging. A review of the relations among anxiety, impulsivity, and decision making follows below.

Emotion and Personality Factors in Decision Making

Emotions and personality influence decision making and guide behaviour by shaping cognitions, thereby influencing cognitive processes (Capra, Jiang, Englemann, & Berns, 2013; Lerner et al., 2015; G. F. Loewenstein, et a., 2001). Fear-based emotions, such as anxiety, and personality subtraits of extraversion (e.g., impulsivity and sensation seeking) moderate decision making (Broman-Fulks et al., 2014; I. H. A. Franken & Muris, 2005; Maner et al., 2007). The effects of these traits can be studied along a continuum in the general population and further explored in clinical populations with elevated levels of these traits (e.g., anxiety disorders, GD). Study Two will examine associations between anxiety and hedging, and expand further upon Study One by examining potentially moderating personality traits of impulsivity and sensation seeking.

Anxiety and Decision Making

Anxiety is an aversive emotional response that arises from future oriented cognitive associations with fear and threat (Hofmann, Ellard, & Siegle, 2012), and is a stable personality subtrait of neuroticism (M. W. Eysenck, Derakshan, Santos, & Calvo, 2007). Levels of state anxiety can be manipulated in the laboratory by the introduction of ambiguous or aversive stimuli (e.g., linguistic, vocal tone, facial expression) or the evaluation of performance (Robinson, Vytal, Cornwell, & Grillon, 2013). Such incidental affect leads to risk-averse and conservative decision making that appears to be motivated by bottom-up processing to resolve ambiguity (Heilman et al., 2010; Miu, Heilman, & Houser, 2008). In an early study, Gaul (1977) asked individuals to choose lotteries with various distributions of wins and losses. This study demonstrated that individuals with low trait anxiety focused on the winning probabilities whereas individuals with high trait anxiety focused on the probability of loss. Johnson & Tversky (1983) corroborated the finding that anxious states bias probability estimates toward more negative consequences than positive outcomes. Butler and Mathews (1987) demonstrated that before examinations, undergraduate students with high trait anxiety predicted a higher probability of all negative events happening to them and a lower probability of experiencing any positive events. These global evaluations were not observed in individuals with high ratings of state anxiety, who only showed sensitivity to higher probability of negative events related to local and situational test-related mishaps (e.g., failing an exam). In terms of probabilistic and utility estimates (i.e., estimates of the pain or happiness obtained from an action), Stöber (1997) reported conflicting results in a study that induced state anxiety using music. They reported that state anxiety was not predictive of risk appraisal. However, trait anxiety was linked to both the appraisal of probability (positive and negative) and the utility of risky scenario descriptions. These studies suggest that trait anxiety may have a more consistent influence on decision making than state anxiety.

Recent findings reported in behavioural, cognitive, psychophysiological, and neuroimaging studies of anxiety and decision making in healthy and clinical populations suggest that anxiety is associated with risk-averse decision making (W. G. Anderson, Arnold, Angus, & Bryce, 2009; Engelmann et al., 2015; Hartley & Phelps, 2012; Maner et al., 2007; Miu et al., 2008; Raghunathan, 1999; Ramírez, Ortega, & Reyes Del Paso, 2015). More specifically, individuals with high ratings of trait anxiety in clinical populations (anxiety disorders and comorbid disorders, such as post-traumatic stress disorder) show significantly less risky decision making as compared to controls (de Visser et al., 2010; Xu et al., 2013). Risk-averse decision making has also been observed in high trait anxious and clinically anxious individuals (Maner et al., 2007). More specifically, suboptimal decision making on the IGT (Bechara et al., 1994) in highly anxious non-clinical individuals is attributed to deficits in neural, somatic, and emotional processing (Engelmann et al., 2015; Miu et al., 2008; Paulus & Yu, 2012; Xu et al., 2013).

Anxiety is thought to bias the allocation of attentional resources to the threat source and impair attentional control, such that the locus of attention is either on internal worries or external sources of threat (M. W. Eysenck et al., 2007; A. Mathews, Mackintosh, & Fulcher, 1997; McNally, 2001; A. Richards, French, Nash, Hadwin, & Donnelly, 2007). Another theoretical perspective suggests that the effect of anxiety on decision making is caused by the interpretation and appraisal of personal safety (Amir et al., 2005; Blanchette & Richards, 2010; Chen, Lewin, & Craske, 1996; Han, Lerner, & Keltner, 2007). An influential theory that attempts to explain affective motivators of decision making is the appraisal tendency framework (Lerner et al., 2015). The appraisal tendency framework posits that emotion triggers appraisal tendencies and motivates individuals to act in particular ways to resolve the appraisal dimension. For example, fear is marked by cognitive appraisal dimensions of high uncertainty and low individual control, thus fear motivates individuals to make decisions that increase certainty and control. Following this line of reasoning, fearful or anxious individuals are more likely to prefer low-risk, low-reward options where there is a perception of more control (Lerner & Keltner, 2001; Raghunathan, 1999, 2001).

Anxious individuals may be motivated to behave in a less risky manner to minimize exposure to loss situations which are perceived to be out of their control. Further, increasing one's choices may give the perception of control in matters of health, personal satisfaction, commitment, responsibility, self-efficacy, pain-tolerance, and business (Geers et al., 2013; Leotti & Delgado, 2011; Plunkett & Buehner, 2007; Surrette & Harlow, 1992; Woodall, Dixey, & South, 2014). The evidence suggests that when one hedges, choices are kept available by self-determination and control, possibly leading to more positive affective states. Thus, hedging could be conceived as a coping strategy to regulate anxiety, through an attempt to gain control and predictability of uncertain circumstances. In addition, hedging may act to counteract the unappealing affective response to loss aversion.

Sensation Seeking, Impulsivity, and Decision Making

Sensation seeking and impulsivity are facets of extraversion, which is one of the most stable personality traits found across lexical studies of personality structure (K. Lee & Ashton, 2004). Extraversion is typified by sociability, activity, talkativeness, and cheerfulness. Sensation seeking is viewed as an ‘uninhibited, nonconforming, impulsive, dominant type of extraversion (S. Eysenck & Zuckerman, 1978). Specifically, sensation seeking is defined as a need for a high level of excitement through new and varied sensations and experiences (Zuckerman, Kolin, Price, & Zoob, 1964) and is reliably associated with risky decision making and behaviours (Kelley & Lemke, 2015; Lejuez et al., 2002; Yechiam, Veinott, Busemeyer, & Stout, 2007) in the domains of sports, substance use, sex, and violence (Zuckerman, 2007; Zuckerman, Neary, & Brustman, 1970). It has been hypothesized that greater risk-taking involves novel experiences that evoke higher cortical arousal needed to satisfy high sensation seekers (Grable, 2000; Wong & Carducci, 2013).

Interestingly, the element of risk is not the only source of the arousal for sensation seekers (Zuckerman, 1994); rather sensation seekers avoid risk when possible in their pursuit of stimulation (Roberti, Storch, & Bravata, 2003). Nevertheless, in light of the reliable association with risky behaviours, sensation seeking is considered among personality theorists as a measure of real-world risk activities (e.g., extreme sports, unsafe sex, substance use), although not necessarily in the financial domain (Lauriola et al., 2014). Several studies suggest that the degree of sensation seeking influences the choice of vocations people enter and the potential for negative life outcomes (Fischer & Smith, 2004; Roberti, 2004), but this effect is moderated by the extent of deliberation of choice (Fischer & Smith, 2004).

Deliberation is described as planning and thinking ahead of acting. Lack of deliberation was found to contribute to some variance in maladaptive risk taking above and beyond the variance contributed by sensation seeking, but neither variable contributed power to predict adaptive risk taking (Fischer & Smith, 2004). Deliberation may provide a way to keep options available, and hedging is one possible way to allow the process of deliberation to occur.

A scale was developed by R. E. Franken (1993) that measured sensation seeking traits as the underlying personality trait driving the desire to keep one's options open. The author reported that the availability of options led to the likelihood of maximizing opportunities for variety, arousal, and complex experiences (e.g., thrill and sensation seeking for novel, spontaneous, or impulsive moments). However, the 'Keeping Your Options Open' measure (KYOO; R. E. Franken, 1993) was defined differently than the conceptualization of hedging used in this dissertation. The KYOO items measured the tendency to make last minute decisions, commit to only short-term tasks, abstain from holding values that may preclude novel experiences, and emotional insensitivity (i.e., lack of guilt) for cancelling commitments. Essentially, these items suggest keeping options open fulfill sensation needs, specifically for new adventures, variety, and change, and are not so much about maintaining *all* currently relevant and available options, which is the definition of hedging used in this dissertation. This difference in definition suggests the possibility that individuals who are high in sensation seeking, are also likely high in impulsivity (i.e., they have less deliberation tendency) and may choose options quickly without much deliberation, thereby foreclosing potentially advantageous choices.

A closely related construct of sensation seeking is impulsivity. A commonly accepted definition of impulsivity is a predisposition toward rapid, unplanned reactions with a lack of regard for long-term negative consequences of behaviours (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). Impulsivity has been demonstrated to be a biologically-driven multi-factorial construct that converges on at least two factors (e.g., response impulsivity, choice impulsivity, rapid response impulsivity, reflection, decision making) that are associated with sensation seeking traits (Evenden, 1999; Hamilton et al., 2015). Zuckerman (1994) constructed a unitary construct of sensation seeking and impulsivity termed 'impulsive sensation seeking' as a biologically based facet of personality. The finding that high school students who were high in both impulsivity and sensation seeking were more likely to engage in risky behaviours as compared to individuals who were high on either trait alone (Donohew et al., 2000), supported Zuckerman's (1994) impulsive sensation seeking trait. To further support these behavioural findings, a convergence of research suggests a genetic factor underlying a common biological mechanism between sensation seeking and impulsivity (Fineberg et al., 2014; Y. M. Hur & Bouchard, 1997). This common biological factor is thought to predict risky behaviour, including pathological gambling (Barrault & Varescon, 2013; McDaniel & Zuckerman, 2003; Zuckerman et al., 1970).

Others have proposed that sensation seeking and impulsivity are indeed two separable behavioural, biological, and genetic constructions, each with their own multidimensional facets (Duka & Crews, 2009; Evenden, 1999; Fischer & Smith, 2004; Hamilton et al., 2015; Y. M. Hur & Bouchard, 1997; King, Tenney, Rossi, Colamussi, & Burdick, 2003; Meda, Stevens, Potenza, Pittman, Gueorguieva, & Andrews, 2009; Wong & Carducci, 2016). One example is Xiao (2008), who reported that sensation seeking rather than impulsive decision making predicted marijuana use in high school students, suggesting that sensation seeking may have a moderating role in adopting addictive and risky behaviours (Roberti, 2004). One distinction between impulsivity and sensation seeking is the lack of planning and minimization of risk appraisal in individuals who are impulsive. On the other hand, where risk behaviours are involved, individuals who are high in sensation seeking tend to cognitively evaluate and weigh the positive rewards contingencies, such as arousal and novelty and consequences before acting (McDaniel & Zuckerman, 2003). A study of male inmates with mental illnesses and inmates with personality disorders found that sensation seeking is correlated with risk-taking among clinical and healthy control groups, but only impulsivity was correlated with risk-taking in inmates with severe psychopathology (Young, Gudjonsson, Goodwin, Perkins, & Morris, 2013). The finding from this study suggests that impulsivity is associated with more severe forms of mental illness as compared to sensation seeking.

Zematten (2005) identified that the lack of the premeditation facet of impulsivity (i.e., the tendency to pre-reflect on the consequences of an act) was linked to disadvantageous decision making on the IGT. Impulsive personality types who were typified as reward-responsive and fun-seeking, such as users of drugs, alcohol, and gaming activities, were reported to be most sensitive to rewards and less risk averse (Capra et al., 2013). Capra and colleagues demonstrated that individuals who classified themselves as "motivated" (i.e., controlled and emotionally stable and not impulsive) were more risk averse, but were also more optimistic about decisions related to low probability outcomes. A corollary is that impulsive individuals are more risk-seeking and less optimistic about low probability outcomes.

Reward sensitivity and impulsivity have been examined using the IGT. Reward sensitivity positively predicted better performance on the IGT, but impulsivity as measured by the Dickman Impulsivity Scale did not show sensitivity to this task (I. H. A. Franken & Muris, 2006). The authors explained that the discrepant finding to predict risk behaviours is likely due to the insensitivity of the impulsivity instrument used to measure a facet of rash impulsivity (i.e., the spontaneous behaviour to act without regard for risk and consideration of future consequences). A later study reported that after explicitly learning about the risks involved in the IGT, individuals with low trait impulsivity nevertheless showed a propensity to be risk seeking (Upton et al., 2011). Collectively these findings suggest that impulsivity is highly associated with risk-taking reward-based behaviours. These findings thus support examining relations among hedging and both sensation seeking and impulsivity.

Examining Hedging, Anxiety, Impulsivity, and Sensation Seeking

Hedging is construed as a strategy employed to reduce risk exposure. Given that negative affect (e.g., anxiety) is associated with risk-averse behaviour (Cassotti et al., 2012; Cryder, Lerner, Gross, & Dahl, 2008; Maner & Schmidt, 2006), high trait anxiety or increased state anxiety may cause individuals to hedge more than less anxious individuals as an attempt to increase certainty and control of their choices (Lerner & Keltner, 2001). In terms of hedging, in keeping with the appraisal tendency framework model (Lerner & Keltner, 2001), individuals who are more anxious are more likely to seek safe alternatives (i.e., hedge) in attempt to avoid loss associated with their appraisal of risky situations. On the other hand, individuals high in impulsivity and sensation seeking may not be as concerned about risks, certainty, and control, and thus may not deliberate or be motivated to hedge as much as less impulsive and lower sensation seeking individuals. Narrowing down the available options may lead to faster heuristics-based decision making (Carpenter, Peters, Västfjäll, & Isen, 2013; Isen & Means, 1983) that may be perceived as advantageous to these individuals.

Research Questions and Hypotheses

Study Two aimed to examine the relationship between hedging behaviour and anxiety, impulsivity, and sensation seeking. It was hypothesized that hedging would be positively correlated with anxiety, and negatively correlated with impulsivity and sensation seeking. More specifically, it was predicted that there would be more hedging with higher levels of reported anxiety and less switching with higher levels of sensation seeking and impulsivity in the DA condition.

Method

Participants

Sixty-three undergraduate students voluntarily completed this one-hour study in exchange for 1% course credit in the Introductory Psychology Course at Ryerson University. There were 55 females (87%) and 8 males (13%) with a mean age of 20.1 years (SD = 5.2). Participants were debriefed and awarded 1% course credit at the completion of the study.

Measures

Computerized Task

The Doors Game was administered on an Apple iPad (details can be found in the Methods section of Study One in Chapter 2). Based on the feedback from participants who played the Doors Game in Study One, there was some concern that the payout amounts from the Doors Game were too low. In Study One, payouts from each door ranged from -2 cents to 12 cents leading to concerns about the degree of external validity in predicting real life hedging since people tend to hedge options that have higher extrinsic value. Low payouts may minimize psychological effects whereas higher payouts provide more realistic estimation of real behaviours (Harinck et al., 2007). Thus, the observed hedging effect in Study One may have been suppressed. In order to reconcile the possibility of low external validity and a suppressed effect, the Doors Game was modified to reflect higher amounts (i.e., dollars instead of cents), ranging from -$2 to $12.

Self-Report Questionnaires

The State-Trait Inventory for Cognitive and Somatic Anxiety (Grös et al., 2007) assesses both cognitive and somatic anxiety symptoms in the moment (state anxiety) and in general (trait anxiety). The items are rated from 1 to 4, with 1 being "not at all" and 4 being "very much so". Internal consistency was reported with a Cronbach's alpha ranging between .83 and .92 (this sample's $\alpha = .88$) and test-retest reliability ranging between .79 and .90.

The Barratt's Impulsiveness Scale (BIS; Patton, Stanford, & Barratt, 1995) is a 30-item self-report questionnaire that assesses impulsivity on six factors (attention, motor, self-control, cognitive complexity, perseverance, and cognitive instability impulsiveness). Correlational analyses were conducted with all subscales. The BIS has demonstrated good internal consistency (Cronbach's alpha = .82) and test-retest reliability ($r = .83$) (Stanford et al., 2009). The Cronbach's alpha of .66 in the current sample was adequate.

The Sensation Seeking Scale-V (SSS; Zuckerman, 1996) is a 40-item Yes/No questionnaire that assesses the personality trait of searching for novel and stimulating experiences and feelings. The questionnaire is comprised of four subscales to assess the traits of thrill and adventure seeking, experience-seeking, disinhibition, and boredom susceptibility and impulsivity. The Cronbach's alpha of the total score was reported at .76 and subscales ranging between .62 to .75 (Deditius-Island & Caruso, 2002). The Cronbach's α of .64 in the current sample fell within the reliability range as the above reported study and is considered adequate.

Procedure

The consent procedure involved orally explaining the study, benefits, risks, and obtaining written signatures. The Doors Game and self-report questionnaires were administered to participants. The same procedure outlined in Study One was used to confirm participants' understanding of the Doors Game. The order of presentation of measures was as follows: the state component of the STICSA; one of the two conditions of the Doors Game; the remaining questionnaires in randomized order; and the remaining condition of the Doors Game. Participants were debriefed and awarded 1% course credit upon the completion of the study.

Results

Hedging Results

Given that the focus of Study Two is on the emotional correlates of hedging, the descriptive statistics analyses related to hedging and hedging analyses are shown in Appendix B. Outliers were removed for each scale analyzed (i.e., one outlier from STICSA, four outliers from BIS, and one outlier from SSS), which normalized only the SSS scores. Overall, the effect of hedging was replicated for the second time with an effect size of 0.30, which is considered a moderate effect size.

Descriptive Statistics of Anxiety and Extraversion Traits

Descriptive statistics of psychological factors including the mean, median, normality, skew, and kurtosis are presented in Table 4. There was one missing data point from the state STICSA measure. Ratings on most measures were in the subclinical range leading to skewed, non-normal distributions. Mean ratings of state and trait anxiety indicate a sample with subclinical levels of anxiety. Patterns of scores on the SSS suggest that the sample has moderate sensation seeking traits. Overall, the sample exhibited low levels of anxiety and extraversion traits.

Table 4

Descriptive Statistics of State and Trait Anxiety, Impulsivity, and Sensation Seeking

Measure	M (SD)	Skew	z^{skew}	Kurtosis	$z^{kurtosis}$	D
NEUROTICISM FACETS						
STICSA STATE TOTAL	34.50 (9.17)	0.60	2.00	-0.21	-0.35	$.15^{**}$
STATE – Physical	15.47 (4.68)	1.47	4.90	2.11	3.52	$.17^{**}$
STATE – Cognitive	19.03 (6.05)	0.42	1.40	-0.85	-1.42	$.12^{*}$
STICSA TRAIT TOTAL	35.32 (9.53)	0.86	2.87	0.57	0.95	$.11^{\dagger}$
TRAIT – Physical	15.61 (4.43)	1.01	3.37	0.35	0.58	$.17^{**}$
TRAIT – Cognitive	19.71 (6.39)	0.69	2.30	0.01	0.02	$.15^{**}$
EXTRAVERSION FACETS						
BIS Total	66.29 (9.90)	0.56	1.85	0.09	0.15	$.10^{**}$
Attentional	11.33 (3.05)	0.16	0.53	-0.55	-0.92	.10
Cognitive Instability	6.76 (1.92)	-0.05	-0.17	0.04	0.07	.12
Motor	15.78 (3.62)	0.59	1.95	0.17	0.29	$.15^{**}$
Perseverance	7.76 (1.92)	0.01	0.03	-0.79	-1.33	$.11^{*}$
Self-Control	12.57 (3.10)	0.85	2.81	1.30	2.18	$.14^{**}$
Cognitive Complexity	12.08 (2.27)	-0.03	-.10	-0.36	-.61	.10
SSS Total	95.00 (14.32)	0.65	2.17	0.33	0.55	$.12^{*}$
Thrill & Adventure Seeking	22.78 (5.87)	0.37	1.23	-0.18	-0.30	.07
Experience Seeking	27.08 (4.18)	-0.03	-0.10	-0.35	-0.59	.08
Disinhibition	24.37 (4.91)	0.47	1.57	-0.69	-1.16	.16
Boredom Sus. & Imp.	20.78 (4.25)	-0.12	-0.40	0.02	0.03	.09

Note. BIS – Barratt's Impulsivity Scale, D – Kolmogorov Smirnov Test; SSS – Sensation Seeking Scale; STICSA – State - Trait Inventory Cognitive Symptoms of Anxiety

$^{*}p < .05$; $^{**}p < .01$

Correlational Analyses

Correlational analyses were conducted to explore the associations between hedging behaviour and anxiety, impulsivity, and sensation seeking (Tables 5, 6, and 7). Given that learning and changes in hedging occurred over the duration of the task (see Appendix B), associations of hedging in the first block are believed to reflect a spontaneous or initial decision making strategy. As such, correlations between the number of switches in the first block and the psychological factors may have more external validity in novel situations. That is, individuals do not have the opportunity to learn of the consequences of an action before a decision is made and their switching likely mirrors true initial responses to loss aversion.

Table 5

Spearman's Correlation Coefficients of State/Trait Anxiety with Switching and Hedging in the Constant Availability (CA) and Decreasing Availability (DA) Conditions

Measure	CA 1ST Block	DA 1st Block
State Total	.01	-.22†
State Cognitive	.11	-.09
State Physical	-.12	**-.30***
Trait Total	.10†	-.01
Trait Cognitive	-.04	.02
Trait Physical	-.15	-.04

Note. *$p < .05$; †$.05 < p < .10$

Table 6

Spearman's Correlation Coefficients of Extraversion Traits: Sensation Seeking in the Constant Availability (CA) and Decreasing Availability (DA) Conditions

Measure	CA 1ST Block	DA 1st Block
Experience Seeking	**-.25***	-.04
Thrill and Adventure Seeking	.02	.07
Disinhibition	-.10	-.07
Boredom Susceptibility & Impulsivity	-.13	-.05
Total	-.14	-.02

Note. $^{*}p < .05$;

In terms of anxiety (Table 5), hedging in the first block of the DA condition was inversely related to the physical state component of the STICSA with a small effect size of 0.09, suggesting that higher rated physical aspects of state anxiety levels are associated with less switching. No significant associations were observed between hedging and any of the trait subscales of the STICSA.

Regarding extraversion traits (Table 6), only sensation seeking was significantly associated with switching. There was a significant inverse relation between switching in the first block of the CA condition and the experience-seeking subscale of the SSS, indicating that less switching is associated with higher levels of experience-seeking. Noteworthy is that the effect size of this association is small (.06).

With regard to the BIS, there were marginally significant negative inverse relations between the DA condition of total blocks and the Cognitive Instability subscale of the BIS (r_s = -.24, p = .07).

Table 7

Spearman's Correlation Coefficients of Impulsivity with Switching and Hedging in the Constant Availability (CA) and Decreasing Availability (DA) Conditions

Measure	CA 1st Block	DA 1st Block
BIS Attention	-.01	.08
BIS Motor	-.09	.04
BIS Self-Control	-.12	.03
BIS Cognitive Complexity	-.11	.20
BIS Perseverance	-.22†	-.20
BIS Cognitive Instability	-.21†	-.21†
BIS Total	-.18	.01

Note. BIS – Barratt's Impulsivity Scale

† *p <.10*

Discussion

This study sought to determine how anxiety and personality constructs, such as sensation seeking and impulsivity, are related to hedging. As in Study One, this study demonstrated that hedging is elevated when conditions of threat of loss are present (i.e., in the DA condition). The replication of the results of Study One was observed despite changing the payout to dollars instead of cents. A comparison of the effect size of hedging between Study One (d=0.28) and Study Two (d=0.30) indicates a similar effect size in Study Two suggesting that increasing the reward payout did not influence hedging behaviour. Overall, there appears to be a stable moderate effect size for hedging despite the smaller sample size in Study Two and this finding gives credibility to the notion that hedging occurs irrespective of the magnitude of rewards. Generalization of hedging is thus not dependent on large rewards, which leads to practical implications for future studies for example with limited funding to run the Doors Game (i.e., there is less threat to the validity of the results).

The associations observed between hedging and impulsivity, sensation seeking, and anxiety provide a novel contribution to the literature. The initial hypothesis was supported with respect to the associations between sensation seeking and hedging, but the results did not clearly support associations with anxiety and impulsivity. Correlational analyses of sensation seeking suggests that experience seekers tend to hedge less than individuals who are less apt to seek novel experiences. Higher ratings of cognitive impulsivity (i.e., cognitive instability) and perseverance dimensions of impulsivity showed some association with less hedging. These findings are in line with the a priori hypothesis, which suggests that these facets of extraversion would result in less deliberation and reflection that undervalues the maintenance of available options. The results also imply that individuals who are high in sensation seeking may be less sensitive to loss aversion.

Interestingly, the relationship between switching and sensation seeking was more consistently observed in the CA condition as compared to the DA condition. This suggests that the unique effect of loss aversion in the DA condition attenuates the hedging phenomenon across higher sensation seekers. This discrepancy may be explained by the stronger effect that loss aversion has on individuals with high sensation seeking traits by suspending their preferences for responding relative to individuals with high impulsivity. On balance, the findings of this study support the notion that maladaptive decision making (e.g., less hedging) is related to high sensation seeking. Even when little loss is at stake, high sensation seekers are not interested in keeping their options open and instead stick to their decision making preferences. These preferences, however, appear to give way when the threat of loss appears, suggesting that the effect of a potential loss of choice motivates preference changes in high sensation seekers.

Although few indicators of anxiety showed associations with hedging, the state rating of physical symptoms of anxiety was inversely related to hedging. However, this effect was only observed in the DA condition, suggesting that the awareness of physical symptoms of anxiety is more related to hedging than cognitive factors. This association is consistent with the previous finding in Study One, where ratings on the Anxiety Sensitivity Index (ASI; Taylor et al., 2007) were also negatively associated with hedging. However, the results of Study Two when compared to Study One were mixed since opposite relationships were found for the two anxiety measures (the ASI and the STICSA in Study One). More specifically, hedging was found to be inversely related to ASI, while hedging was positively related to the STICSA. The ASI is reported to measure a person's sensitivity to anxious cues (i.e., cognitive and physical) (Taylor et al., 2007) and it is possible that hedging is influenced by immediate, state-dependent characteristics, as opposed to long-term trait-based anxiety. As noted, this sample consisted of a non-normal distribution of anxiety scores with the preponderance of ratings falling in the subclinical level. This was also the case in Study One, where the data were collected from a university student sample. In contrast, total scores on the ASI in Study One reflected a normal distribution and this wide range may explain the significant finding. The mixed results may be clarified by comparing hedging in individuals with higher levels of anxiety, such as those with anxiety disorders, relative to individuals with non-clinical levels of anxiety.

Strengths of this study include the use of a repeated measures design which reduces systematic errors as well as minimizes the effects of intra-individual differences. The concurrence of findings by an independent investigator adds another line of evidence to support the finding of elevated hedging under conditions of potential loss. This study also contributes novel knowledge relating hedging to personality factors such as sensation seeking and possibly impulsivity. The use of the Doors Game provides support that this decision making task appears to be externally valid in reflecting potential reactions to unexpected threat of loss in real life scenarios. Some real life situations might include hedging to keep all options available amid rumours of job lay-offs or cuts in budgetary funding. Concretely, individuals fearing the loss of their current job may increase effort to sustain all currently available options, which they might have otherwise not considered prior to the threat of loss. Hence, an implication of this study is the application of the Doors Game to real life situations offers potential benefit to the decision making literature.

The results of the study should be considered in light of several limitations. First the positively skewed distribution of personality traits (i.e., low levels of impulsivity and sensation seeking observed in the sample) may have masked possible effects. The small effect size between the association of sensation-seeking and hedging may be due to the multiple number of correlations conducted. Further, the constraint of collecting data from a university student population is that lower ratings obtained on some of clinical questionnaires may not be representative of the general population and the possible range of behavioural ratings. Hence, the recruitment of diverse participants is an important consideration for researchers examining personality and decision making.

Core personality constructs that are better captured in personality scales, such as the NEO personality inventory (McCrae & Costa Jr., 1997), were not examined. There are indications that extraversion is related to some decision making strategies under normal conditions of choice (Nicholson, Soane, Fenton-O'Creevy, & Willman, 2005). However, in decisions involving potential loss, these traits may play less of a role in hedging. Impulsivity does not appear to differentiate hedging behaviour in either the DA loss aversion or CA constant available condition, in contrast to a significant negative association between hedging and sensation seeking in the CA condition. These findings suggest that sensation seeking may be more a sensitive measure that is related to hedging than impulsivity, but this may only be true in a non-loss condition. Future studies have the potential to identify a more sensitive measure of hedging in the DA condition.

Past research indicates associations between personality traits and decision making. For example, the personality traits of extraversion and openness to experience both show strong associations with risk taking behaviours (Lauriola & Levin, 2001; Nicholson et al., 2005) and have been examined as frequently as neuroticism. Thus future studies should investigate other personality constructs, such as openness to experience, conscientiousness, agreeableness (McCrae & Costa Jr., 1997), and honesty (K. Lee & Ashton, 2004) and their associations with hedging. It appears that extraversion exerts an effect on decisions to achieve a gain, but openness to novel experiences better predicts decision making in loss conditions (i.e., participants who were more open to experience were more willing to take risks). Those with higher ratings of openness to experiences are also drawn towards the thrill associated with risky behaviours (Wong & Carducci, 2013, 2016), thus openness to novel experiences may be associated with more hedging in the DA condition.

While no relation between hedging and anxiety was found, exploring other facets of neuroticism such as dependency, guilt, and anger may be an interesting direction for future research. Anger and fear, for example were reported to differentially affect decision making even though they are both negatively-valenced emotions (Lerner et al., 2015). Disgust, guilt, and anger have demonstrated moderate effect sizes in studies of decision making (Angie et al., 2011) and are also worthy of investigation.

Some evidence suggests that state-dependent anxiety (i.e., cognitive and physical) may correlate with hedging. Future research could corroborate these findings by inducing state anxiety and examining the impact on hedging. The results have real life implications, since individuals who face threats of loss (e.g., rumour of a looming job loss) may hedge in ways that are more or less adaptive. Research that explores the real life consequences of extreme hedging (i.e., too much or too little) is another avenue of potentially fruitful applied research.

The results of this study further suggest that divergences in hedging in individuals with high and low dimensional ratings of personality traits are worthy of study. Clinical populations score on the extreme ends of some personality traits and facets. Individuals with OCD, for example, score high on neuroticism, whereas individuals with gambling disorder score high on extraversion (Lorains et al., 2014). There is robust evidence that individuals with psychological disorders score high on impulsivity and that such elevations are associated with impaired decision making (Hamilton et al., 2015). Impulsivity appears to be a predisposing personality risk factor that precedes the development of chronic gambling disorders (Billieux et al., 2012; Dussault, Brendgen, Vitaro, Wanner, & Tremblay, 2011), and other forms of mental illness such as substance use, attention deficit/hyperactivity, bipolar, eating, and personality disorders (Evenden, 1999; I. H. A. Franken, Muris, & Georgieva, 2006; A. J. Lawrence, Luty, Bogdan, Sahakian, & Clark, 2009a; Winstanley, Eagle, & Robbins, 2006). The shared presence of impulsivity across many disorders, including OCD (Abramowitz et al., 2009; Timpano et al., 2013) is based on biological substrates that correspond to behavioural deficits leading such individuals vulnerable to impaired decision making involving risk-taking in various domains (e.g., sex, health, financial) (Evenden, 1999; Moeller et al., 2001). Given some of the emerging patterns of the correlates of hedging observed in the tail ends of the distribution in a non-clinical undergraduate sample, future research with clinical populations can aid investigations of hedging behaviour.

Chapter 4: Study Three

Literature Review: Comparison of Decision Making in Gambling Disorder and Obsessive-Compulsive Disorder

Having replicated the effect of the Doors Game in two studies, and having established that hedging may be associated with certain emotional and personality facets, this third study was designed to address the main goal of this dissertation, which involves examining hedging in individuals with OCD. The literature related to OCD and decision making is discussed in the General Introduction of the dissertation. This section will outline the current interest in loss aversion as a determinant of decision making. Connections are made to the secondary goal of comparing decision making in individuals with OCD to those with GD.

Neural Correlates of Loss Aversion

The publication of neuroimaging evidence that implicated the association between loss aversion and the striatum, medial OFC, anterior cingulate cortex, VMPFC, and the coding of activations in response to probabilistic decision making significantly advanced the decision making and loss aversion literature (Tom et al., 2007). Tom et al. (2007) were the first to report that the aforementioned brain regions showed diminishing activity in response to increasing loss values and increasing activation in gain gambles. Interestingly, the neural sensitivity was attenuated in individuals who were more risk seeking (i.e., less loss averse). Thus, the case was made for future studies to examine neuropsychiatric populations (Tom et al., 2007), who typically show a higher risk tolerance and engage in activities (e.g., substance use) that may lead to risky decisions and behaviours (Dreher, 2007).

Functional magnetic resonance imaging (fMRI) has demonstrated that striatal regions are involved in coding expected utility of choice and loss aversion (Dreher, 2007). Using the

Balloon Analogue Risk Task (BART; Lejuez et al., 2002), other regions responsible for error monitoring and response conflict such as the anterior cingulate cortex, inferior frontal gyrus, and anterior insula previously associated with reward-based decision making were reported to signal in response to loss aversion (Fukunaga et al., 2012; Gottfried, O'Doherty, & Dolan, 2003; Hsu et al., 2005; Krawitz, Fukunaga, & Brown, 2010; Paulus et al., 2003; Shiv, 2005; Yechiam, Druyan, & Ert, 2008). Fukunaga et al. (2012) also reported that the left VMPFC responded to reward-seeking behaviours.

There is debate about the role of the amygdala in loss aversion. The amygdala has long been associated with emotionally-driven decisions in the context of fear, caution, vigilance, and uncertainty (Glimcher & Rustichini, 2004; Whalen, 2007). Tom et al. (2007) did not find significant activations in the amygdala during decision-based gambles that mimic loss aversion. Others however, have presented evidence to suggest that the amygdala codes for single losses, but does not code for gains, and mediates the response to loss aversion through arousal (Sokol-Hessner et al., 2013). Several studies have demonstrated that the amygdala has a role in evaluating the relevance of tasks as opposed to computing the magnitude of values (Bzdok et al., 2011; Ousdal, Reckless, Server, Andreassen, & Jensen, 2012; Sander, Grafman, & Zalla, 2003; Wright & Liu, 2006).

Two patients with bilateral amygdala lesions were reported to show a dramatic absence of loss aversion despite exhibiting a normal range response to reward incentives (De Martino et al., 2010). A very recent study provides evidence that the amygdala is involved in evaluating the ratio of gain to loss in mixed-gambles. However, the authors did not find the processing of single loss or gain magnitudes to be significantly associated with amygdala functioning (Gelskov, Henningsson, Madsen, Siebner, & Ramsøy, 2015). Gelskov et al. (2015) also found trends supporting medial OFC and VMPFC associations with loss aversion. In summary, there is mounting evidence to suggest that loss aversion maps onto several neuroanatomic regions that have been associated with certain neuropsychiatric disorders, such as OCD and GD.

The neuropsychological deficit in decision making in OCD has been shown to be most related to the neural correlates of loss aversion, and some have proposed that impaired decision making should be considered as an endophenotype of OCD (Sachdev & Malhi, 2005). Although gamblers show similar impaired decision making as in OCD, more recent evidence indicates that GD neuropathophysiology is more related to mesolimbic pathways that are associated with substance addictions (Leeman & Potenza, 2012). Although the focus of this study is to better understand hedging in OCD, given the overlap of symptoms and decision making deficits in OCD and GD, GD was selected to serve as a relevant comparison group. Thus, a review of the clinical and neural basis of decision making in GD and OCD follows.

Gambling Disorder

Gambling Disorder, once known as Pathological Gambling, was until recently considered an Impulse-Control Disorder Not Elsewhere Classified in the Diagnostic and Statistical Manual of Mental Disorders–IV-Text Revision (American Psychiatric Association, 2000). GD is now classified within the Addictions and Related Disorders in the updated version of the Diagnostic and Statistical Manual–5 (DSM-5; American Psychiatric Association, 2013). GD is described as a persistent and recurrent maladaptive non-substance-related disorder that causes significant impairment or distress over a 12-month period. Individuals must endorse four of the following criteria: loss of control due to gambling, changes in mood when attempting to cut down gambling, unsuccessful attempts to cut down gambling, preoccupation with gambling, chasing losses, and negative financial and social consequences due to gambling. Severity of gambling is indexed by the number of endorsed criteria.

Gambling is highly prevalent and popular in society, and numerous governments and private enterprises offer multiple venues and a multitude of ways to gamble (e.g., casinos, internet gambling, video lottery terminals, phone apps). Worldwide prevalence estimates of GD range from 0.2% (Norway) to 5.3% (Hong Kong) (Hodgins et al., 2012). In Canada, gambling participation by the general adult population was reported at 76% in 2002, while the prevalence of GD was reported at 2.0%, with the highest reported rates of GD in the Midwest provinces (2.9%) (Cox, Yu, Afifi, & Ladouceur, 2005). GD is frequently co-morbid with other mental health disorders, including substance-use disorders (SUD, including alcohol), anxiety, and mood disorders (Hodgins, Stea, & Grant, 2011). GD is a costly psychological disorder that is associated with potentially severe personal, social, and financial burdens (Hodgins et al., 2012). GD is also of concern because of the young age of onset of gambling behaviour (Huang & Boyer, 2007). Sixty-one percent of Canadians surveyed between the ages of 15 - 24 reported having engaged in gambling. In Ontario, the 12-month prevalence of GD among young gamblers was estimated at 2.75% as compared to 2% for adults (Cox, Yu, Afifi, & Ladouceur, 2005; Huang & Boyer, 2007).

Psychological Models of Obsessive-Compulsive Disorder and Gambling Disorder

OCD and GD have been conceptualized as disorders on the impulsive-compulsive spectrum. Impulsivity is characterized by an inability to resist impulses and urges, delay gratification, inhibit behaviour, and reflect on the potential consequences of their decision and (Berlin, 2014). Compulsive behaviours are repetitive actions that are excessive and inappropriate to a situation (Berlin, 2014). According to some researchers, OCD and GD are a class of disorders that share the characteristic hallmarks of an inability to resist, delay, or inhibit maladaptive repetitive behaviours (Hollander et al., 1996). In support of the view that OCD and GD are disorders that fall along a shared continuum of psychopathology (Skodol & Oldham, 1996), GD has been demonstrated to be more similar to OCD, as compared to other anxiety disorders, based on a similar profile of risk factors, response to pharmacological and psychological treatments (Durdle, Gorey, & Stewart, 2008), severity and frequency of obsessive and compulsive thoughts (Anholt et al., 2004; Blanco et al., 2009), and avoidance of obsessional fears (Frost, Meagher, & Riskind, 2001). Other researchers have also demonstrated overlapping compulsivity and impulsivity traits in individuals with GD (Blaszczynski, 1999; Potenza et al., 2009), have recognized the heterogeneous nature of clinical symptoms in GD, and have proposed subtypes of gamblers, such as obsessive, addictive and impulsive-type (Dannon, Lowengrub, Aizer, & Kotler, 2006).

While OCD and GD share the common feature of impairment in the ability to inhibit repetitive behaviours, their differences along the impulsive-compulsive spectrum can be characterized by the degree of harm avoidance and risk aversion. For example, OCD is characterized by high harm avoidance and high risk aversion and falls closer to the compulsive end, while GD is positioned closer to the impulsive end, and associated with low harm avoidance and high risk seeking (Hollander et al., 1996). Hence, the ritualistic behaviours of the compulsive type are undertaken in an attempt to reduce anticipatory anxiety as opposed to the impulsive type who are little affected by anxiety and are otherwise motivated by risk-seeking behaviours (Blanco et al., 2009; S. Y. H. Kim, Karlawish, & Caine, 2002; Tavares et al., 2007). With the conceptual understanding that OCD and GD can be phenomenologically classified along an impulsive-compulsive spectrum, a brief review on the findings of decision making in GD follows. The reader is referred to the General Introduction in Chapter 1 for findings of decision making in OCD.

Decision Making in Gambling Disorder

In GD, impaired monetary decision making has been reported in many studies using the IGT (Cavedini et al., 2002b; Forbush et al., 2008; Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2006; Petry, 2001; Roca et al., 2008). Across these studies, it has been reported that individuals with GD tend to choose more disadvantageous decks as compared to healthy controls. Further, individuals with GD tend to shift their card selection preference to more punishing decks as compared to controls who rapidly shift their card-picking preference to advantageous decks (Cavedini et al., 2002b). Other psychophysiological evidence has indicated that the GD group as compared to controls exhibit lower galvanic skin response and heart rate when deliberating whether to choose disadvantageous decks or not (Goudriaan et al., 2006). More specifically, their heart rate decreases after losses and wins, whereas healthy controls experience a decrease in heart rate after losses but an increase in heart rate following wins, suggesting that reward sensitivity is diminished in individuals with GD. In contrast, a study that used positron emission topography reported comparable behaviourial performance between individuals with GD and healthy controls (Linnet, Peterson, Doudet, Gjedde, & Møller, 2010). A novel finding was that increased dopamine release in the ventral striatum in GD was associated with risk and uncertainty that reinforces gambling and increases excitement for such maladaptive behaviours. In contrast, phasic dopamine release in HC was dependent on and followed their problem-solving approach and reinforced advantageous decision making on the IGT. Power, Goodyear, and Crockford (2012) demonstrated disadvantageous decision making on high risk decks that was correlated with increased activation of the OFC, caudate, and amygdala. Individuals with GD also showed impaired decision making on risky tasks with known probabilities and ambiguous tasks (i.e., IGT) (Brevers et al., 2012). Similar to previous studies, individuals with GD performed worse than controls and were more disordered in their card selection (Ochoa et al., 2013). Finally, relative to controls, individuals with GD did not differ in the shape of the utility function (i.e., increased weighting of gains) and choice consistency, but there were significant differences with respect to learning and loss aversion parameters (Lorains et al., 2014). In summary, the literature has generated consistent results regarding the impaired decision making profile of individuals with GD. The current study not only presents an opportunity to elucidate hedging in individuals with GD but also to contrast their performance with a clinical group that shares some similar clinical and psychological traits.

A Comparison of Decision Making in Obsessive-Compulsive Disorder and Gambling Disorder

The research conducted to date has demonstrated fairly consistently that individuals with OCD and GD exhibit impaired decision making on risky tasks such as the IGT. Similar neural structural activations in the OFC and striatal areas (Goudriaan et al., 2006; Tanabe et al., 2007, 2009) and psychophysiological changes (Goudriaan et al., 2006) have also been reported. Many studies have compared individuals with GD to substance users, who also appear to have similar neurofunctional profiles but substance users are also subject to changes in neurochemistry over time due to the effect of chronic dopamine agonists that act on the dopamine-sensitive mesolimbic reward system (Balodis, Lacadie, & Potenza, 2012; Leeman & Potenza, 2012; Reuter et al., 2005; Tanabe et al., 2007; Wiehler & Peters, 2015). The neurophysiological changes of addictions contrast with the stable neurophysiology of OCD throughout the course of the disorder (Chamberlain, Blackwella, Fineberg, Robbins, & Sahakian, 2005). Another distinction between GD and OCD is that individuals with GD may have frontocortical functional deficits (e.g., attention, working memory), which contribute to decision making impairment. For example, hypoactivation of frontal cortical activity in GD is associated with impulsive behaviours (Wiehler & Peters, 2015) in contrast to frontal hyperactivation in OCD which may lead to maladaptive decisional processes (e.g., repetitive behaviours) (Anholt, 2004). Differences in behavioural traits such as sensation seeking, harm avoidance, and personality traits along the impulsive-compulsive spectrum between the two groups however, do not appear to predict performance on the IGT (S. W. Kim & Grant, 2001). Similar neurocognitive functioning (e.g., executive functioning, verbal learning, memory) between OCD, GD, and healthy controls have been reported, with the exception of the clinical groups who showed weaker performance on a complex visual spatial drawing task relative to controls (Elman et al., 2013; J. W. Hur et al., 2012). Problem gamblers more consistently show decreased performance on probability estimates and delay discounting as compared to controls (Wiehler & Peters, 2015). Overall, there is evidence of shared decision making deficits in OCD and GD, but different mechanisms are likely underpinning the observed behaviours (Choi et al., 2012; J. W. Hur et al., 2012).

Summary of Decision Making in Obsessive-Compulsive Disorder and Gambling Disorder

A number of neurological substrates and functional correlates have been associated with the performance of individuals with GD on the IGT (Bechara et al., 1994). More specifically, deficits in real-life decision making as measured on the IGT are associated with altered functioning of the OFC, limbic, and striatal systems (Bechara & Damasio, 2005). Direct neurological insult to the VMPFC is directly related to *myopic* decision making where future consequences are disregarded in favour of immediate rewards (Bechara et al., 1994). Subsequent research has reported the dysregulation of circuits involving the OFC and connected striatal and limbic structures that appear to underlie both clinical phenomena, such as the expression of OCD symptoms and anxiety, and cognitive processes such as decision making (Cavedini et al., 2006; Chamberlain et al., 2007; Nielen, Veltman, de Jong, Mulder, & den Boer, 2002). Similarly in GD, blunted VMPFC and striatal activity were observed in several studies that employed reward processing and decision making tasks (de Ruiter et al., 2009; Hollander et al., 2005; Reuter et al., 2005). Based on the findings that individuals with OCD and GD have impaired performance on the IGT and common neurobiological deficits, the shared behavioural deficits may imply similarly affected psychobiological processes. Given that neurocognitive and neurofunctional correlates do not reliably distinguish between GD and OCD, reviewing psychological theories of decision making may help to better predict differences in decision making between these clinical groups.

Across a number of studies using the IGT, groups with OCD and GD as compared to controls, have tended to pick riskier cards from decks that have high rewards but result in a net loss. However, the IGT has been criticized as being a complex task that comprises several aspects of decision making (Brand et al., 2007; Steingroever et al., 2013). Therefore, the mechanism underlying relatively poor performance on this task is still unknown. It is possible that the performance outcomes on the IGT may be mediated by a decision making process that differs in OCD and GD based on individual differences in clinical (i.e., obsessive-compulsive), affective (e.g., anxiety), motivational (e.g., behavioural inhibition and avoidance, need for cognitive closure), and risk-taking (e.g., sensation seeking, impulsivity) factors. For example, anxiety is related to risk-averse decisions whereas impulsivity and sensation seeking are related to risk-seeking decisions corresponding to profiles of individuals with OCD and GD, respectively (Leeman & Potenza, 2012). The distinguishing personality traits in OCD and GD provide a natural psychological manipulation wherein individual differences in decision making processes such as hedging can be studied.

Psychological and Cognitive Perspectives of Decision Making

The evidence presented thus far connects behavioural loss aversion to corresponding neural substrates. However, a more rich and nuanced understanding of decision making must involve psychological and cognitive factors. A prominent psychological theory from behavioural economics is the risk-as-feelings model (Loewenstein et al., 2001), which centers on the premise that emotional responses such as anxiety, fear, and worry work in concert with cognitive processes to drive decision making.

The risk-as-feelings hypothesis (see Figure 6) treats feelings and cognitions as inputs, but feelings in particular are viewed as informational input sources that are evaluated. Behaviour is guided by the outcome of the evaluations, even if the ensuing behaviour or decisions are maladaptive (Loewenstein et al., 2001). Emotion provides information that is void of probability estimates, calculus, and cognitive evaluations to assist in directing cognitive processing to potentially higher priority concerns (e.g., danger) (Dickie & Armony, 2008; Zajonc, 1980) and leads to faster behavioural responses. For example, consider the incongruence of emotion and cognition in self-harm behaviours. Rationally, one is cognitively aware of the risks and dangers of self-harm; however, the stronger influence of the emotional state over rational thought motivates individuals to follow through with maladaptive behaviours repeatedly (Slovic, Finucane, Peters, & MacGregor, 2004). Such use of emotional information typifies risk-as-feelings decision making where the feelings associated with risky activities are used as information on which future decisions are based. It follows then that individuals who experience stronger emotional distress such as persons with mental illness are more likely to rely on their affect (e.g., anxiety, depression) as informational inputs for behavioural decision making (Barlow, 1988). Below is a discussion of affective factors that have been demonstrated to influence decision making.

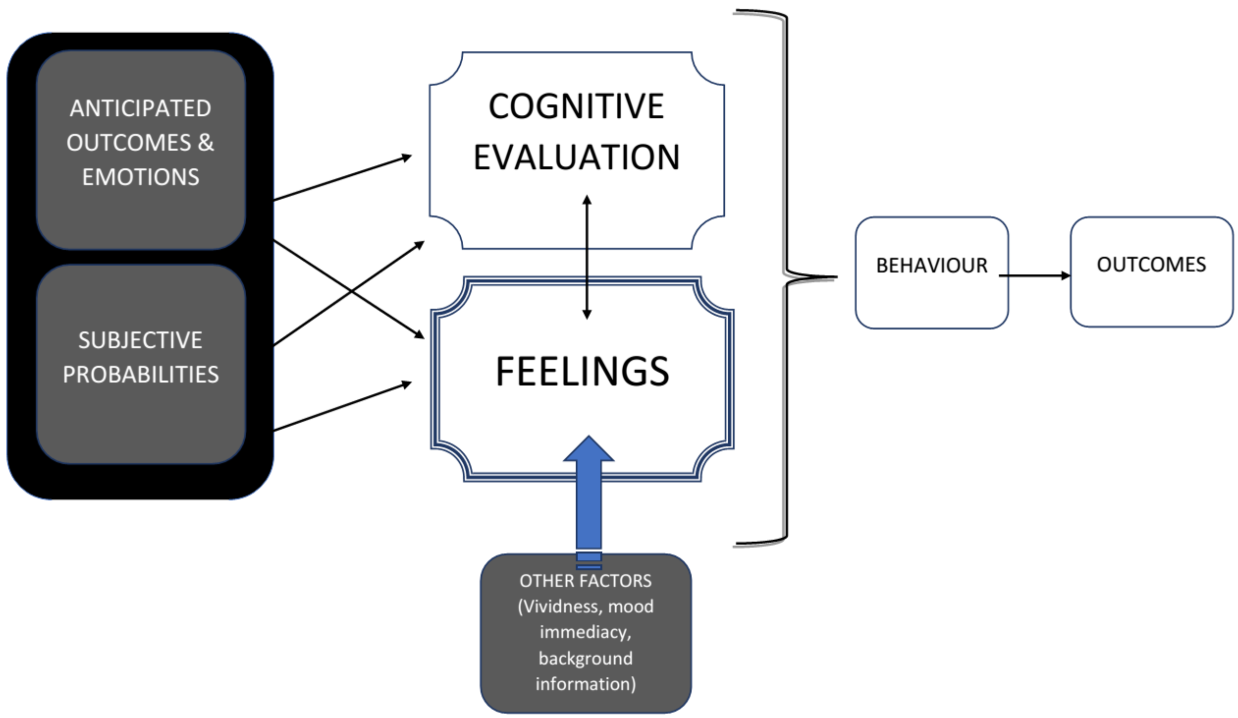


Figure 3. Risk-as-feelings theory views emotions as informational sources upon which cognitive evaluations are made, which together affect behaviours (e.g., decision making). (Adapted from Loewenstein, 2001).

Neurobiopsychological Basis of Affect

Affect has been linked to neurobiological substrates that motivate approach and avoidance behaviour (Gray, 1987). The Reward Sensitivity Theory links neural systems and motivation for behaviour that is postulated to be driven by individual differences in personality dimensions (Gray & McNaughton, 2000). On one dimension, the Behavioural Inhibition System (BIS) is driven by anxiety and regulates behaviour based on punishment or signals of non-reward. On the other orthogonal dimension, the Behavioural Activation System (BAS) is sensitive to impulsive acts and regulates behaviour according to reward and non-punishment cues. The two dimensions are postulated to be orthogonal, hence one can be high on BIS and BAS, low on both, or any of the degrees possible.

Carver and White introduced a psychometrically validated questionnaire, the Behavioral Inhibition and Behavioral Activation Scale (BIS BAS; Carver & White, 1994), that has been useful in research to isolate clinical groups whose affective makeup influences their approach and avoidance behaviours (Quilty, Mackew, & Bagby, 2014). The BIS BAS was effectively tested to relate higher-order personality traits to decision making on the IGT. Specifically, better performance on the IGT was positively associated with the activating/approach system of the BAS, but no associations were observed for the BIS (I. H. A. Franken & Muris, 2005). This study also reported a non-significant association between impulsivity on the Dickman Impulsivity Inventory (Dickman, 1990) and IGT performance, suggesting that BAS reward sensitivity is a distinct construct from impulsivity. The lack of association with BIS in the study by I. H. A. Franken and Muris (2005) is in contrast to an earlier study that reported that sub-clinical individuals with a combination of high BAS and low BIS performed poorly as compared to normal controls with low BAS and high BIS scores (Van Honk, Hermans, Putman, Montagne, & Schutter, 2002). Few other attempts have been made to explore the role of anxiety and impulsivity using the BIS BAS and the IGT. Other related constructs, such as the need for cognitive closure (NFC), hypothesized to be mediated by BIS BAS factors associated with decision making (Czernatowicz-Kukuczka, Jaśko, & Kossowska, 2014; Jaśko, Czernatowicz-Kukuczka, Kossowska, & Czarna, 2015) are discussed next.

Need for Cognitive Closure

The NFC is a construct that appears to predict decision making, and is mediated by the BIS neurobiological construct (Czernatowicz-Kukuczka et al., 2014; Jaśko et al., 2015) and physiological changes (Roets & van Hiel, 2008). Kruglanski (1989) defined NFC as a desire to reach a quick and unambiguous answer. Interest in the effect of motivational forces on decision making has guided researchers to find a positive association between NFC and BIS (Colbert, Peters, & Garety, 2006; Corr, Hargreaves-Heap, Tsutsui, Russell, & Seger, 2013; Czernatowicz-Kukuczka et al., 2014). High NFC may be adaptive for individuals with high BIS insofar as it motivates fast search algorithms, judgment, and decision making to reduce uncertainty. Indeed, such a finding was reported in individuals with high NFC and high BIS who sought less information before making a decision when they were tasked to pick the ideal job candidate among several choices. However, when the effect of high NFC was partialled out, individuals with high BIS requested unnecessary searches before making a decision (Czernatowicz-Kukuczka et al., 2014), suggesting that uncertainty and high anxiety which activate the BIS are related to prolonged search strategies that may provide more information to make a decision. The authors also considered the regulatory role of working memory on directing decisions, and reported that fewer requests were observed in participants with high but not low working memory capacity. This finding suggests that working memory, an aspect of executive functioning appears to supersede affective strategies (i.e., excessive searching) and streamline searches for efficiency.

Contrary to the above finding, individuals with high NFC more than low NFC were likely to prolong search activity in order to obtain a satisfactory level of certainty (Jaśko et al., 2015). In the study by Jaśko et al. (2105), participants were asked to decide which of two colours presented were more prevalent in an array of 25 possible swatches. Participants were free to view as many of the covered swatches as they liked before making a decision. BIS scores, correct guesses, and decision time were measured. A significant positive association between BIS and NFC (r = .50, p < .001) confirmed the results of previous studies, and was explained in terms of NFC acting as a motivational force that directed decisions to reduce anxiety and uncertainty in individuals with high BIS scores (Czernatowicz-Kukuczka et al., 2014; Jaśko et al., 2015). Another finding was that only NFC was positively significantly associated with search number (i.e., higher NFC was related to higher number of swatches viewed before making a decision) and decision time (i.e., individuals with higher NFC took longer to decide). The findings were interpreted to mean that individuals with high NFC searched at relatively low cost to reduce uncertainty.

A follow-up study manipulated uncertainty by manipulating the presence or absence of concrete strategies to assist with decision making (e.g., use more or fewer searches). This manipulation resulted in a significant difference in decision making. Individuals with high NFC utilized the strategy that they were provided with in contrast to individuals with low NFC who did not change their strategy based on the information they received. Together, these findings indicate that individuals with high NFC use information to reduce uncertainty and are more likely to act on the information provided than are individuals with low NFC, who make decisions based on their own analysis of the situation (Jaśko et al., 2015). Put somewhat differently, individuals with high NFC placed more credence on available concrete information to direct their decision making in order to reduce uncertainty, while individuals with low NFC were more able to balance and evaluate information provided and tolerate learning through experience to direct their decisions.

Research on the motivational influence of NFC on decision making in psychiatric populations is sparse and only a handful of studies have been conducted in individuals with OCD. For example, Mancini et al. (2002) did not find consistent associations between NFC subscales and obsessive-compulsive (OC) symptoms in a normal population aged 18 – 35. The ratings of anxiety, depression, and OC symptoms in the sample were all in the sub-clinical range, possibly limiting the variance of the sample, thereby not reflecting scores that are more typical of individuals with OCD. The authors concluded a lack of association between OC symptoms and NFC, and acknowledged that meta-cognitive processing (e.g., appraisals over-responsibility) and dysfunctional beliefs are more directly related to OC symptoms. However, Bar-Tal and colleagues (Bar-Tal, 1994; Bar-Tal, Kishon-Rabin, & Tabak, 1997) argued that high OC traits are linked to a high need for structure, but low ability to implement decisions, hence leading to ineffective and effortful processing and decision making. Hypervigilance that is characterized by hyperactive BIS signals impede the ability to ignore nonessential information leading to difficulty in categorizing information effectively (Gray, 1987). The decision making profile thus reflects effortful, less efficient, and increased information search (Bar-Tal, 1994; Bar-Tal et al., 1997).

Given that NFC is related to BIS, anxiety and other constructs related to OCD (e.g., obsessive-compulsiveness) and is an understudied construct, examining this factor in the context of decision making in OCD would make a contribution to the literature. In terms of hedging, the absence of an explicit decision making strategy in the Doors Game forces respondents to learn by trial and error. Hence, in this uncertain situation with little structure, individuals high in NFC and BIS who are more hypervigilant and less apt at efficient cognitive structuring are predicted to exert more effort and time searching than controls. More specifically, individuals with OCD are presumed to have the highest NFC and BIS scores and therefore should tend to hedge the most.

Examining Decision Making in a Novel Way

Current decision making paradigms such as the IGT have been studied extensively and several criticisms highlight the limitations of furthering our understanding of decision making by using this paradigm (Maia & McClelland, 2004; Steingroever et al., 2013). The Doors Game (Shin & Ariely, 2004) is a paradigm that illustrates how behavioural loss aversion may affect the selection of options. This task dovetails with recent neurobehavioural economics research that has incorporated models of loss aversion (e.g., prospect theory) with neuroimaging, neuropsychological, psychiatric, and psychological research. The current study sought to examine hedging in neuropsychiatric populations, specifically those with OCD and GD, whose neuropathophysiology are also implicated in loss aversion processing. Given that decision making is affected by clinical and psychological factors, the purpose of this study was to examine the associations between hedging and affective, cognitive, motivation, and a risk-taking factors to hedging. Based on past studies on the effect of anxiety on decision making (Maner et al., 2007), the OCD group was presumed to have the highest anxiety ratings relative to GD and HC groups, and predicted to hedge the most (i.e., continue searching to reduce uncertainty). Individuals who are less sensitive to risk and loss, such as those with high trait impulsivity and sensation seeking (i.e., individuals with GD), were predicted to hedge less relative to OCD and HC groups.

The two previous studies in this dissertation explored hedging in non-clinical undergraduate samples and found some variation in hedging depending on the degree of self-reported impulsivity and anxiety. In Study One, an inverse association between hedging and anxiety sensitivity was demonstrated. Additionally, participants who scored in the top quartile for cognitive anxiety tended to hedge more in the face of threat of loss of options. In Study Two, physical anxiety symptoms were associated with hedging in the DA condition, and the experience seeking subscale of the Sensation Seeking Scale was associated with hedging in the CA condition. Higher self-reported cognitive and motor impulsivity also showed trends toward less hedging. Thus, there is some evidence to suggest that hedging may be related differentially to factors on the impulsive-compulsive continuum. Given the preponderance of sub-clinical levels of anxiety in the general population, examining groups of individuals who are characteristically high in trait anxiety and compulsive tendencies (i.e., OCD) and trait impulsivity (e.g., GD) may help demonstrate the association of psychological factors and hedging.

Research Questions and Hypotheses

Research Question 1: How does the hedging behaviour of individuals who meet the diagnostic criteria for OCD and GD compare to controls?

Hypotheses: Individuals with OCD will hedge more as compared to controls and individuals with GD. Individuals with GD will hedge less as compared to controls.

Research Question 2: How does hedging behaviour relate to psychological and cognitive measures (e.g., anxiety, sensation seeking, NFC, OC traits) between the sampled groups?

<u>Hypothesis</u>: Hedging will be positively correlated with anxiety, need for cognitive closure, BAS, and OC traits in the OCD group. Hedging will be negatively associated with BIS and sensation seeking in the GD and HC groups.

Method

Participants

A sample of 104 participants were recruited to participate in Study Three (GD, *n* = 34; OCD, *n* = 30; HC, *n* = 40). The ratios of females to males in the GD, OCD, and HC groups were: 15/19; 15/15 and 23/17, respectively. There were indications that some participants were deemed to be inappropriate candidates during the recruitment process and following the study. For example, some participants attempted to complete the study twice or admitted to exaggerating their self-report of gambling symptoms when in fact the symptoms were not currently impairing or distressing to them. As well, there was evidence of underreporting and exaggeration of symptoms during the screening that did not match reported symptoms on self-report measures. Due to concern for the fidelity of the results and implications, clinical participants were selected based on them meeting the clinically significant cutoff criteria for symptom severity on the PGSI and the Yale-Brown Obsessive Compulsive Scale (YBOCS) (Goodman, Price, Rasmussen, Mazure, Delgado, et al., 1989; Holtgraves, 2009). Participants in the GD group who did not meet the cutoff score of more than 8 on the Problem Gambling Severity Index (PGSI) were excluded from the analyses, as were participants in the OCD group who did not meet a threshold of 10 on the YBOCS. Eight individuals in the GD group and four individuals in the OCD group were excluded, resulting in a total of 26 individuals in each clinical group. Seven individuals in the HC group who reported a YBOCS score above 10 were excluded from the analyses, reducing the number of HC to 33. None of the HC individuals reported PGSI cutoff scores above 8. Individuals who reported symptoms consistent with Major Depressive Disorder were included in the study since prior studies did not find strong evidence of association of depression and hedging. Scores on the BDI for the GD and OCD groups were in the mild range and in the subclinical range for HC. No participants reported symptoms consistent with psychosis, substance dependence, or mania.

Demographics of Psychological Groups

This section describes the ratings of the clinical scales and the relative differences in group scores presented in Table 8. As would be expected, ratings on the YBOCS and PGSI were significantly higher in the OCD group and the GD group relative to the HC group, respectively. The mean score of 19.9 on the YBOCS in the OCD group indicated a mild severity of OCD symptoms. Individuals in the GD group rated themselves significantly higher on the PGSI than individuals in the OCD and HC groups. The mean score of 15.8 on the PGSI places the GD group in the clinical range of having a gambling problem (Currie, Casey, & Hodgins, 2010). The PGSI ratings of the OCD and HC groups fell in the non-clinical classification for problem gambling. The OCD group had the most elevated scores relative to the GD and HC groups on the Obsessive-Compulsive Inventory (OCI; Foa et al., 2002). This significant difference was observed for all OCI subscales (obsessions, compulsions, ordering, checking, neutralizing, washing, and hoarding).

Table 8

Mean Obsessive-Compulsive and Gambling Severity Ratings Across Groups

Scale	GD	OCD	HC	F	Group Contrasts
	M (SD)	*M (SD)*	*M (SD)*		
YBOCS TOTAL	7.32 (7.56)	19.91 (7.26)	4.72 (5.14)	47.97***	OCD>GD, HC***
YBOCS Obsessions	3.76 (3.91)	10.26 (3.57)	2.75 (3.27)	41.17***	OCD >GD, HC ***
YBOCS Compulsions	3.56 (4.17)	9.66 (4.24)	1.98 (2.20)	41.66***	OCD >GD, HC***
OCI Obsessing	2.56 (3.20)	7.00 (3.71)	1.88 (2.23)	26.8***	OCD >GD, HC***
OCI Ordering	3.68 (3.35)	6.33 (3.59)	3.25 (2.85)	8.81***	OCD >GD, HC***
OCI Checking	2.56 (3.16)	6.40 (3.04)	1.95 (2.20)	24.31***	OCD >GD, HC***
OCI Neutralizing	2.32 (2.79)	4.73 (4.00)	1.65 (2.06)	9.83***	OCD>HC***, OCD>GD**
OCI Washing	2.03 (2.69)	5.83 (3.83)	1.40 (2.05)	22.78***	OCD >GD, HC***
OCI Hoarding	3.65 (3.92)	5.73 (3.78)	2.55 (2.41)	7.73***	OCD>HC***, OCD>GD*
PGSI	15.81 (7.21)	0.75 (1.45)	0.33 (1.14)	135.93***	GD> OCD, HC***

Note. OCI – Obsessive Compulsive Inventory; PGSI – Problem Gambling Severity Index; YBOCS – Yale-Brown Obsessive Compulsive Scale;

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Ethical Considerations

This study used deception by informing participants that they had the opportunity to earn an additional amount of money ranging from \$0 – \$6 based on their performance in each condition of the Doors Game. In the original study (Shin & Ariely, 2004), participants were paid the amount they earned. In actuality, they were paid a pre-determined amount of three dollars in each condition. However, participants were led to believe that their potential winning was dependent on their performance, when in fact they were paid \$3 per game (total \$6), irrespective of how they did. This manipulation was designed to increase external validity (i.e., personal motivation and effort) in the task, so that individuals believed that there was a real potential financial loss/gain at stake. The nature and reason for using deception was explained during the debriefing of the study.

This study recruited individuals with clinical disorders who may be more influenced by some incentives of the study. Specifically, individuals with GD may be motivated by the financial incentive to participate in the study. However, the financial incentive offered in this study was reasonable to pay individuals for their time, and was within the range of amounts paid in previous studies that recruited individuals with GD (i.e., \$20 - \$50 for one hour) and other psychological experiments (Toneatto, 2005).

Materials

The Doors Game was employed as outlined in Study One.

The *Problem Gambling Severity Index* (Ferris & Wynne, 2001) assesses the overall severity of gambling behaviour. This scale consists of 9 items rated on a 4-point Likert scale ranging from 0 (Never) to 3 (Almost Always) regarding involvement in various gambling activities, adverse consequences resulting from gambling, other characteristics relating to GD, and sociodemographic characteristics. Reliability analysis yielded a coefficient alpha of .86 in the current study.

The *MINI* Version 6.0 (Sheehan et al., 1997) is a structured diagnostic clinical interview that was used in the current study to determine whether individuals met criteria for OCD. The MINI screen was utilized to screen for the presence of mental health disorders (e.g., OCD, mood disorders, anxiety disorders, substance use disorders, posttraumatic stress disorder, eating disorders, and psychotic disorder). The MINI is considered a valid (sensitivity =.62) and reliable (Kappa = .63) measure (Sheehan et al., 1997).

The self-report *Yale Brown Obsessive-Compulsive Scale (*YBOCS*;* Goodman et al., 1989) was used to assess OCD symptom severity. This scale consists of 5 items each for obsessive and compulsive symptoms, which are rated from 0 – 4 with increasing numbers indicating greater severity. This scale has good internal consistency (Cronbach's alpha ranged from .68 to .88) and test-retest reliability (*r* ranged from .61 to .97) (Goodman et al., 1989). This sample's Cronbach's $\alpha = .96$.

The *Obsessive-Compulsive Inventory Short Version* (OCI; Foa et al., 2002) is an 18-item questionnaire that assesses OCD severity. It provides a total score and subscale scores for six obsessive-compulsive factors (washing, checking/doubting, obsessing, mental neutralizing, ordering, and hoarding). The OCI demonstrates high internal consistency ($\alpha = .86$) (Foa et al., 2002). The current study's Cronbach's $\alpha = .94$.

The Behavioral Inhibition and Behavioral Activation Scale (BIS BAS; Carver & White, 1994) is a 4-point Likert scale consisting of 24 items that measure individual differences in approach (reward) and inhibition (punishment) motivational systems. Four subscales include three domains related to the approach motivational system: BAS (Drive, Fun Seeking, and

Reward Responsiveness), and one inhibition or avoidance system, BIS subscale. The BIS BAS scale has demonstrated moderate to good validity (α reported between .66 – .74) and test-retest reliability ($r > .70$) (Carver & White, 1994). This sample's Cronbach's α = .75.

The State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA) (Grös et al., 2007) assesses both cognitive and visceral anxiety symptoms in the moment (state anxiety) and in general (trait anxiety). The items are rated from 1 (not at all) to 4 (very much so). Subscales of physical and cognitive symptoms are measured for each state and trait dimension. Internal consistency was reported with a Cronbach's alpha ranging between .83 and .92 and test-retest reliability ranging between .79 and .90 (Grös et al., 2007). This sample's Cronbach's α of the state and trait components of the STICSA are both .94.

The *Sensation Seeking Scale-V* (Zuckerman, 1996) is a 40-item Yes/No questionnaire that assesses the personality trait of searching for novel and stimulating experiences. The items assess four traits: thrill and adventure seeking, experience-seeking, disinhibition, and boredom susceptibility and impulsivity. Test-retest reliability was reported at $r = .75$ and internal consistency was reported with a Cronbach's alpha of .80 (Zuckerman, 1996). This sample's Cronbach's α = .62.

The Need for Cognitive Closure Scale (NFC) (Roets & Hiel, 2011) is a 15-item 6-point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree). The NFC measures the desire for "an answer on any given topic." The NFC is comprised of the following five subscales: order, predictability, decisiveness, ambiguity, and closed mindedness. The items reflect a person's preference for order (i.e., structure), desire for a firm answer, aversion towards ambiguity, and sticking with one's own opinion. The decisiveness subscale refers to a craving for quick and unambiguous decisions (Kruglanski, Grada, Mannetti, Atash, & Webster, 1997).

Kruglanski et al. (1997) reported a Cronbach's alpha of .73 and test-retest reliability of $r = .86$. This sample's Cronbach's $\alpha = .88$.

Procedure

Participants were recruited through flyers, posters, and advertisements in the community. Individuals with OCD and GD were recruited from community groups by targeted flyers through email and administrative contacts and invited talks (e.g., OCD support groups, Gambler's Anonymous, forums) as well as in the community at large. Recruitment flyers offered $15 for participation time plus a chance to earn an additional nominal amount up to $6.00 (i.e., $3.00 for each of the CA and DA conditions). All participants were administered the Mini Neuropsychiatric Inventory (MINI Version 6.0; Sheehan et al. 1997) over the phone to screen for OCD, and the PGSI to screen for problem gambling. Individuals who were screened positive for GD or OCD were invited to participate. HC were invited to participate if they did not meet criteria for OCD, GD, psychosis, mania, or substance use disorder on the MINI.

The researcher went through the informed consent process (explaining the study procedures, benefits, and risks), and obtained written signatures. Participants completed the state component of the STICSA, Doors Game (either the CA or DA condition), self-report psychological questionnaires (in randomized order) and the alternate condition of the Doors Game. Participants completed both the CA and the DA conditions of the Doors Game in randomized order. In the Doors Game, participants were told that they could earn up to an additional $6.00 from the winnings of the Doors Game by earning a maximum of $3 from each of the CA and DA conditions. This form of deception was employed to improve external validity, participation, and motivation. Participants who endorsed symptoms consistent with OCD or GD or who experienced increased significant anxiety and/or distress during the experiment were provided with a resource sheet on community resources. Only one participant with OCD requested a referral sheet for treatment options.

Analyses

Descriptive analyses of the whole sample (N = 104) indicated non-normal distributions in both the CA condition ($D(104) = .17$, $p < .001$) and DA condition ($D(104) = .15$, $p < .001$). The removal of data based on clinical significance threshold levels of the PGSI and the YBOCS yielded normal distributions for the GD group in both CA and DA conditions and the OCD group in the DA condition. As with the previous studies in this dissertation, despite the non-normal distributions of hedging in the groups, the results from parametric analyses (i.e., ANOVA) are reported for several reasons. Firstly, parametric tests such as the F statistic are considered robust tests even in the face of violations of normal assumptions (Field, 2009). Secondly, results obtained through parametric analyses were similar to non-parametric statistics, and there exists no equivalent non-parametric analyses for Mixed ANOVAs. Statistical significance was evaluated at an alpha level of .05.

Results

Analysis of Hedging

Switching behaviour reported as an average of switching across all blocks as well as just in the first block between groups is presented in Table 9. A mixed ANOVA (3 Groups x 2 Door Conditions) indicated a significant main effect of the door condition across all blocks ($F(1, 82) = 26.09$, p = <.001) with greater frequency of switching in the DA condition, but no main effect of group or group by door interaction were observed. Similarly, for the first block, more frequent switching in the DA condition than in the CA condition was noted ($F(1,82) = 32.80$, $p < .001$), but no significant group effect or group by door interaction were observed.

Table 9

Mean Number of Switches in Each Group in the Constant Availability (CA) and Decreasing Availability (DA) Conditions in All Blocks and the First Block

Group	CA	DA
	M (SD)	*M* (SD)
Average of all blocks		
OCD	32.25 (29.68)	50.23 (34.57)
GD	35.27 (30.60)	51.73 (35.61)
HC	43.24 (32.03)	56.61 (33.99)
First Block		
OCD	4.62 (2.91)	5.73 (3.11)
GD	4.65 (2.77)	7.08 (2.37)
HC	5.06 (2.54)	7.12 (2.26)

Note. GD – Gambling Disorder; HC – Healthy Controls; OCD – Obsessive-Compulsive Disorder

Although not significant, simple planned contrasts revealed a possible pattern of differential switching between the groups in the first block (p = .11). Comparisons of a priori hypotheses may be still be examined following a non-significant omnibus interaction effect (Chen et al., 1996; Keppel, 1982). Figure 8 shows an interesting and visually discernible difference in switching in the DA condition in the OCD group as compared to the GD and HC groups that also supports further exploration. Given that the GD and HC groups showed similar patterns of hedging relative to the OCD group, the GD and HC data were combined and compared to the OCD group. A *t*-test conducted on the collapsed scores of the HC and GD groups as compared to the OCD group revealed significantly less hedging in the first block of the DA condition in the OCD group (M = 5.73, SD = 3.11) relative to the combined GD and HC groups (M = 7.10, SD = 2.29; $t_{(83)}$ = -2.27, p = .03, d = .53). The Jonckheere-Terpstra Test revealed a trend of increasing switches between groups that follows a relative rank order (OCD < GD < HC), J = 1196, z = -1.69, p = .09, r = -.18).

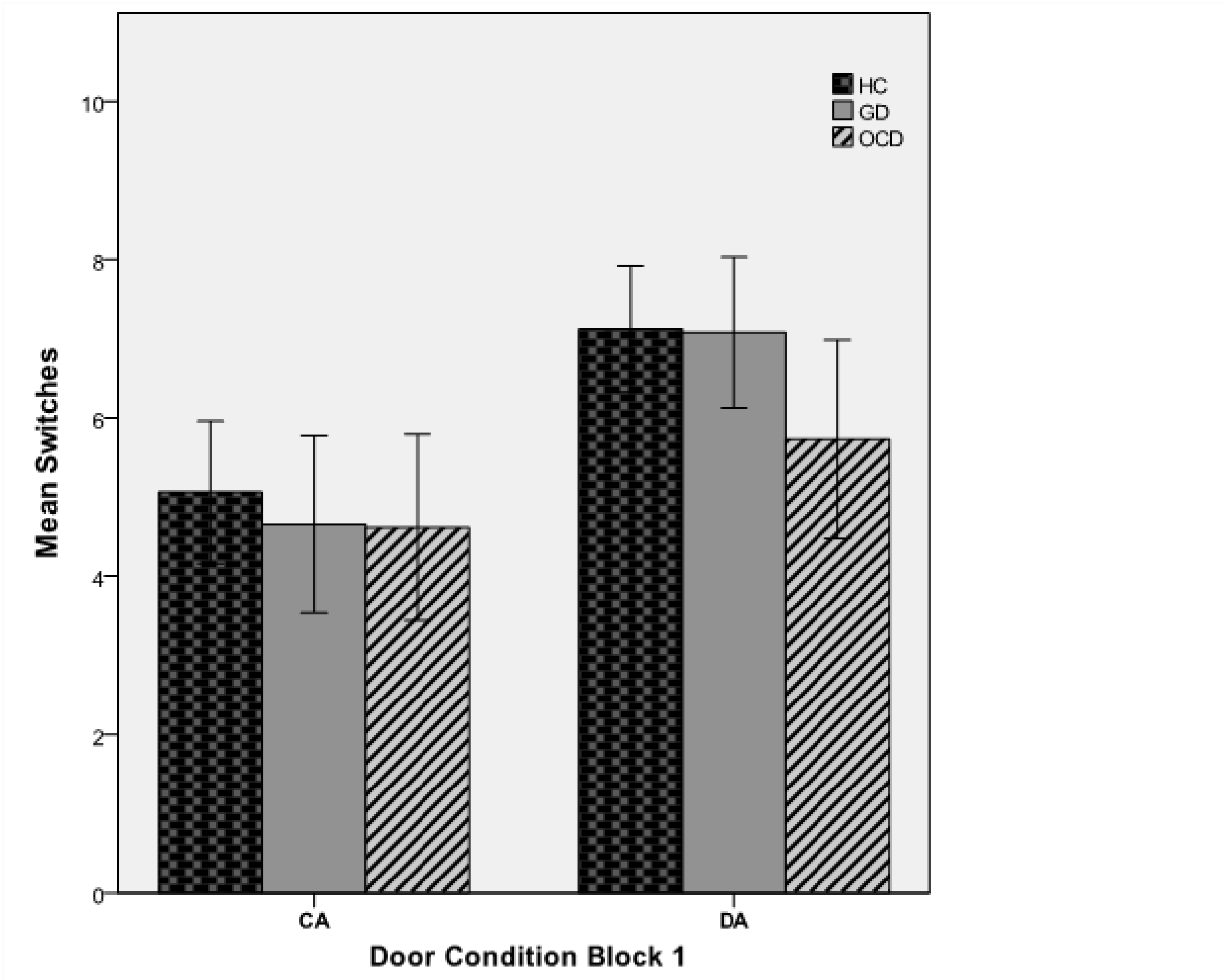


Figure 7. Significant switching differences were observed between the Constant Availability (CA) and Decreasing Availability (DA) conditions of the first block. Although not significant, the OCD group switched less in the DA condition as compared to the GD and HC groups.

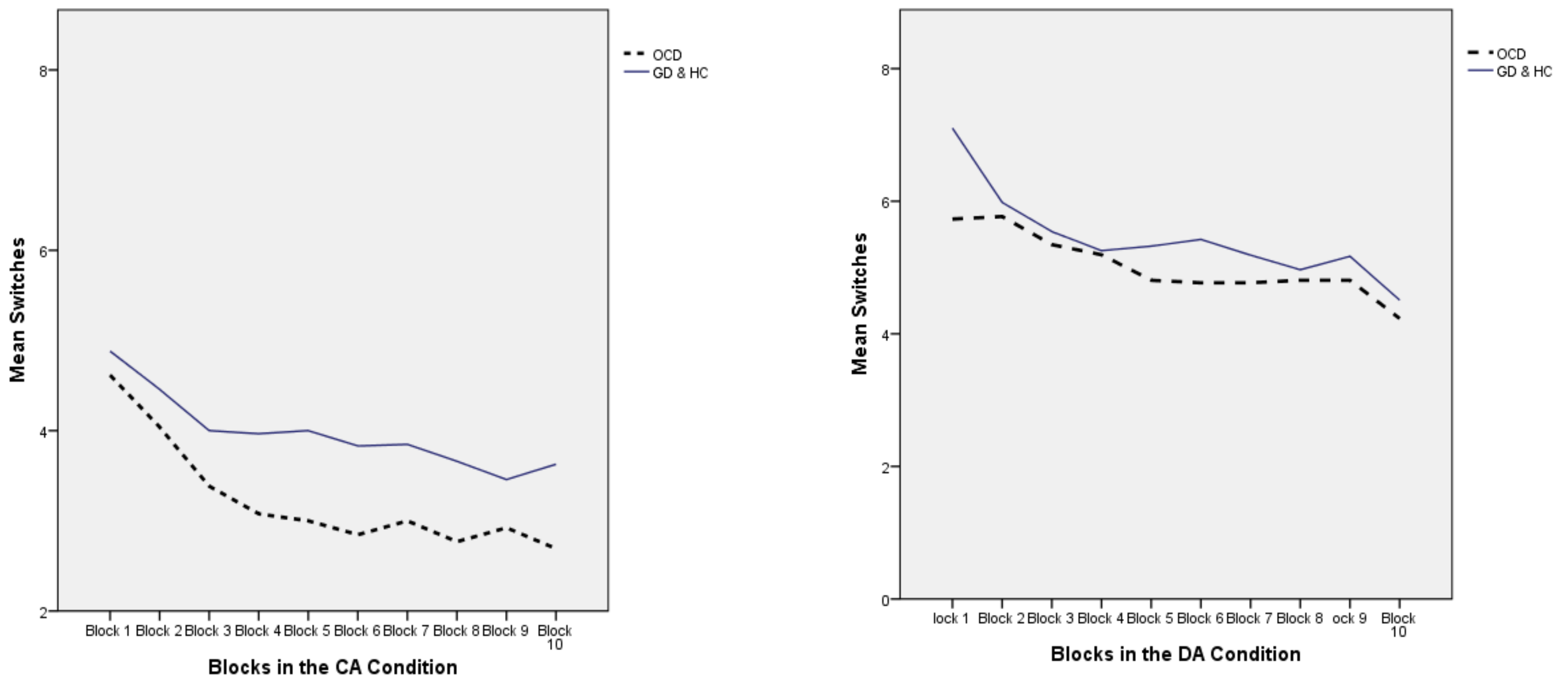


Figure 8. The comparison of switching of the Obsessive-Compulsive Disorder (OCD) group as compared to the combined Gambling Disorder (GD) and Healthy Control (HC) groups.

Psychological Variables and Hedging

Tables 10 and 11 present the mean scores on measures related to motivation (NFC), risky behaviours (SSS), and affective symptoms (STICSA) in each group. Scores on the NFC reveal higher ratings in the OCD group relative to the GD group on all but two subscales (i.e., decisiveness and closed mindedness were similar across groups). The NFC subscales of predictability and ambiguity were marginally significant in favour of higher scores in the OCD group over the HC group. In terms of sensation seeking, gamblers expectedly had significantly higher ratings on the SSS total score as compared to the OCD group and marginally higher as compared to controls. The SSS subscales of disinhibition and susceptibility to boredom and impulsivity were significantly higher in the gambling group than both the OCD and HC groups.

Table 10

Comparison of Mean Scores on Measures Assessing Motivational Factors and Risky Behaviours Across Groups

Measure	GD	OCD	HC	F	Group Contrasts
	M (SD)	*M (SD)*	*M (SD)*		
NFC					
Total	51.65 (15.17)	58.87 (11.86)	53.18 (14.01)	$2.39^{\dagger}$	OCD>GD†
Order	10.18 (4.23)	12.43 (3.57)	11.75 (4.52)	$2.52^{\dagger}$	OCD>GD†
Pred.	9.94 (4.17)	12.53 (3.56)	10.58 (3.80)	3.88^{*}	OCD>GD*, OCD>HC†
Dec	11.38 93.19)	11.33 (3.93)	11.43 (3.07)	0.01	-
Amb.	10.85 (3.97)	12.77 (2.99)	10.90 (3.37)	3.15^{*}	OCD>GD, HC†
CM	9.29 (3.73)	9.80 (2.41)	8.53 (3.69)	1.26	-
SSS					
Total	103.88 (17.10)	86.60 (18.06)	95.43 (17.14)	7.87^{***}	GD>OCD***, GD>HC†, HC >OCD†
TAS	24.24 (6.10)	21.93 (7.07)	23.40 (6.36)	1.02	-
Exp.	27.91 (5.34)	24.87 (5.61)	27.70 (5.13)	3.13^{*}	GD>OCD†, HC >OCD†
Dis.	27.24 (5.23)	21.77 (5.70)	23.80 (5.44)	8.34^{***}	GD>OCD***, GD>HC
BSI	24.50 (4.98)	18.03 (3.94)	20.63 (4.47)	16.88^{***}	GD>OCD, HC**, HC >OCD†

Note. NFC – Need for Cognitive Closure scale; Pred – Predictability; Dec – Decisiveness; Amb – Ambiguity; CM – Closed Mindednesses; SSS – Sensation Seeking Scale; TAS – Thrill & Adventure Seeking; Exp – Experience Seeking; Dis – Disinhibition; BSI – Boredom Susceptibility and Impulsivity

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$; $^{\dagger}.05 < p < .10$

As shown in Table 11, scores on the STICSA were significantly elevated on the cognitive and physical subscales of both state and trait anxiety in the OCD group relative to the GD and HC groups. It was consistently observed that individuals in the OCD group were significantly more anxious than the controls on all subscales and total scores. The OCD and GD groups scored similar to one another on state and trait physical anxiety symptoms, rated physical anxiety symptoms similarly on both state and trait dimensions, and these scores were more elevated than those for the HC group, but the differences between the GD and HC groups were insignificant. Ratings on the BIS BAS indicate that the GD group had higher behavioural approach scores (e.g., fun-seeking, drive) as compared to the OCD and HC groups. The HC group showed significantly lower avoidance behaviour (BIS subscale of the BIS BAS) than the OCD and the GD groups.

Table 11

Comparison of State and Trait Anxiety and Approach Avoidance Behaviours Across Groups

Measure	GD *M (SD)*	OCD *M (SD)*	HC *M (SD)*	F	Group Contrasts
STICSA	STATE				
Total	32.12 (10.90)	39.72 (13.71)	27.44 (6.78)	11.49^{***}	OCD>HC**, OCD>GD**
Physical	15.00 (4.82)	17.07 (6.99)	13.46 (2.95)	4.10^{*}	OCD>HC*
Cognitive	17.12 (7.21)	22.65 (8.43)	13.97 (4.43)	14.48^{***}	OCD>HC**, OCD>GD**
STICSA	TRAIT				
Total	33.68 (10.23)	43.3 (13.78)	28.79 (7.51)	16.28^{***}	OCD>HC, GD***
Physical	15.59 (4.97)	18.00 (8.00)	13.38 (2.83)	6.08^{**}	OCD>HC*
Cognitive	18.09 (6.64)	25.30 (7.44)	15.41 (5.20)	21.03^{***}	OCD>HC, GD***
BIS BAS					
Fun	12.77 (2.92)	10.50 (3.09)	11.05 (2.42)	4.89^{**}	GD>OCD**, GD>HC*
Reward	18.38 (1.86)	17.19 (2.22)	17.60 (2.14)	$2.17^{\dagger}$	-
Drive	12.54 (2.28)	10.62 (2.91)	11.54 (2.24)	3.75^{*}	GD>OCD*
BSI	21.65 (3.60)	23.42 (4.08)	19.48 (2.97)	10.38^{***}	GD>HC*, OCD>HC**

Note. STICSA – State Trait Inventory of Cognitive Symptoms of Anxiety; BIS BAS – Behavioural Inhibition and Behavioural Activation Scale; Fun – Fun Seeking; Reward – Reward Responsiveness

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Correlations

Correlations between the psychological variables and switching in the first block for each group are presented in Table 12. As can be seen in this summary table, in the OCD group, the number of switches in the CA condition was significantly negatively associated with the BIS subscale of the BIS BAS and the OCI (obsessing, checking, washing), and positively associated with the SSS (disinhibition, and boredom susceptibility and impulsivity). The number of switches in the DA condition was negatively associated with the NFC subscales (predictability, decisiveness, ambiguity, and total score). These significant findings indicate that less switching is associated with greater affective, clinical, and motivational ratings in OCD.

Although the results were not statistically significant, the HC group relative to the OCD group showed an opposite and trending positive correlation between switching and OCI checking scores, some NFC subscales (e.g., closed mindedness, total score), and a non-significant association with most STICSA subscales. The HC group was the only group to show significant positive correlations with the fun-seeking subscale of the BIS BAS.

Associations of switching in the GD group were discrepant relative to OCD and HC for some variables. For example, switching in the GD group was negatively and marginally significantly associated with the experience seeking subscale of the SSS, while the association was positive for the OCD and HC groups. Similarly, the NFC decisiveness subscale was negatively associated with switching in the CA condition in the GD group, whereas it was positively associated with switching in the HC group. These associations together suggest that hedging behaviour may be associated with different psychological constructs across the three groups, with the behaviour of the clinical groups appearing to be influenced by similar factors (e.g., BIS BAS, NFC), in contrast to the HC group.

Table 12

Pearson Correlations Between Psychological Measures and Number of Switches in the First Block by Group (OCD, GD, HC) and Door Condition (Constant Availability [CA], Decreasing Availability [DA] Conditions)

Measures		Gamblers n = 26		OCD n = 26		HC n = 33	
		CA	DA	CA	DA	CA	DA
BIS BAS	Drive	.01	-.19	-.11	-.28	.18	-.01
	Fun Seeking	-.11	-.12	-.02	.00	**. 40***	**.40***
	BIS	-.33†	-.28	**-.34***	-.26	.10	-.05
OCI	Obsessing	-.14	-.24	**-.43***	-.32†	-.01	.15
	Checking	.02	-.04	**-.42***	-.07	.30†	.31†
	Washing	.01	-.27	**-.37***	-.22	.09	.21
NFC	Predictability	-.05	.15	-.15	**-.54****	-.11	-.07
	Decisiveness	**-.49****	-.05	-.10	-.31†	.26	-.05
	Closedmindedness	.11	**.39***	.07	-.16	.23†	.32†
	Ambiguity	-.09	.21	-.23	**-.39***	-.13	.21
	Total	-.14	.25	-.04	**-.49****	.11	.03
SSS	ExpSeeking	-.32†	-.09	.07	**.34***	.19	.27
	Disinhibition	-.12	-.11	**.39***	.23	.12	.15
	BSI	.06	**-.37***	**.42***	.32†	.07	.28†
	Total	-.14	-.09	.32	.34†	.23	.32†
STICSA	State TOTAL	-.13	-.02	-.18	-.11	.19	.27
	State Physical	.07	.15	-.03	-.05	-.03	.22
	State Cognitive	-.23	-.13	-.28	-.14	.23	.20
	Trait Total	-.09	-.02	-.21	-.18	.20	.14
	Trait Physical	.07	-.05	-.19	-.18	.18	.08
	Trait Cognitive	-.20	.02	-.18	-.15	.16	.14

Note. BIS BAS – Behavioural Inhibition and Behavioural Activation Scale; NFC – Need for Cognitive Closure scale; SSS – Sensation Seeking Scale; ExpSeeking – Experience Seeking; BSI – Boredom Susceptibility & Impulsivity; STICSA – State Trait Inventory of Cognitive Symptoms of Anxiety

* $p < .05$; ** $p < .01$; $^{\dagger}.05 < p < .10$

Regression Analyses

Based on the correlational results, the predictors of switching in the CA condition and hedging in the DA condition of the three groups were examined by regression analyses. Backwards regression analyses were conducted for each group using the significant predictors from the correlation analyses (see Table 12). The variables that were entered in the regressional analyses are listed in Table 13. The final regression models for each group are presented in Tables 14 to 16. The regression analyses indicated that each group's switching is predicted by different factors. For example, hedging was predicted in the clinical groups by clinical and motivational factors (e.g., OCI, NFC), whereas hedging in the HC group was predicted by an affective factor (BIS BAS). For parsimony and to circumvent multicollinearity issues with NFC subscales and the NFC total score, the regression analysis was conducted using the NFC total score.

Table 13

Variables Entered in the Backward Regression for Each Group

Group	CA	DA
OCD	BIS BAS BIS	NFC Total
	OCI Obsessing	OCI Obsessing
	OCI Checking	SSS Experience Seeking
	OCI Washing	
	SSS Disinhibition	
	SSS Boredom Susceptibility & Impulsivity	
GD	NFC Decisiveness	NFC Closed Mindedness
		SSS Boredom Susceptibility & Impulsivity
HC	BIS BAS Fun Seeking	BIS BAS Fun Seeking

Note. GD – Gambling Disorder; OCD – Obsessive-Compulsive Disorder; HC – Healthy Controls; BIS BAS – Behavioural Inhibition and Behavioural Activation Scale; NFC – Need for Cognitive Closure scale; OCI – Obsessive Compulsive Inventory; SSS – Sensation Seeking Scale

Table 14

Regression Analyses of the Predictors of Switching in the First Block for Each Doors Condition in the OCD group (n = 26)

Door Condition	*B*	*SE B*	Β	R^2	*p*
CA Model				.39	.003
Constant	44.54	53.62			
OCI Obsessing	-.38	.13	-.49**		
SSS Disinhibition	.26	.09	.46**		
DA Model				.46	.003
Constant	8.21	3.97			
OCI Obsessing	-.36	.15	-.43*		
NFC Total	-.11	.05	-.34*		
SSS Experience Seeking	.27	.10	.47**		

Note. CA – Constant Availability; DA – Decreasing Availability; OCI – Obsessive Compulsive Inventory; SSS – Sensation Seeking Scale; NFC – Need for Cognitive Closure scale

* $p < .05$; ** $p < .01$

Table 15

Regression Analyses of the Predictors of Switching in the First Block for Each Doors Condition in the GD group (n = 26)

Door Condition	*B*	*SE B*	Β	R^2	*p*
CA Model				.24	.01
Constant	8.62	1.85			
NFC Decisiveness	-.42	.15	-.49**		
DA Model				.15	.05
Constant	4.64	1.27			
NFC Closed Mindedness	.26	.13	.39*		

Note. CA – Constant Availability; DA – Decreasing Availability; NFC – Need for Cognitive Closure scale

* $p < .05$; ** $p < .01$

Table 16

Regression Analyses of the Predictors of Switching in the First Block for Each Doors Condition in the HC group (n = 33)

Door Condition	*B*	*SE B*	β	R^2	*p*
CA Model				.16	.01
Constant	0.51	1.90			
BIS BAS Fun Seeking	.41	.17	.40*		
DA Model				.13	.02
Constant	3.15	1.70			
BIS BAS Fun Seeking	.36	.15	.40*		

Note. CA – Constant Availability; DA – Decreasing Availability; BIS BAS – Behavioural Inhibition and Behavioural Activation Scale;

* $p < .05$; ** $p < .01$

A summary of the factors that significantly predicted hedging by group is presented in Table 17. It appears that clinical, motivational, and risk-taking factors are predominant predictors of hedging in the OCD group; motivational factors in the GD group;, and an affective factor in the HC group.

Table 17

Clinical, Motivational, Affective, and Risk-Taking Predictors of Hedging in Each Group

Door Condition	**GD**	**OCD**	**HC**
CA Switches			
Clinical factors	-	OCI Obsessing	-
Motivational factors	NFC Decisiveness		
Affective factors	-	-	BIS BAS Fun seeking
Risk factors		SSS Disinhibition	-
DA Switches			
Clinical factors	-	OCI Obsessing	-
Motivational factors	NFC Closed Mindedness	NFC Total	
Affective factors	-	-	BIS BAS Fun seeking
Risk-taking factors		SSS Excitement Seeking	-

Note. CA – Constant Availability; DA – Decreasing Availability; BIS BAS – Behavioural Inhibition and Behavioural Activation Scale; NFC – Need for Cognitive Closure scale; OCI – Obsessive Compulsive Inventory; SSS – Sensation Seeking Scale

Discussion

The goal of Study Three was to compare hedging in populations with OCD and GD relative to healthy controls, as well as examine the psychological factors that predict hedging within each group. The results of the hedging analyses replicate previously observed findings in healthy individuals (Pongracic & Farvolden, 2015; Shin & Ariely, 2004) and adds to the literature by demonstrating a possible differential pattern of hedging in the disappearing condition in clinical populations relative to controls. All three groups demonstrated that they were motivated to keep their options available when they were fading. However, in contrast to the apriori hypothesis, there were no observable significant group differences in hedging, although there were some trends suggesting that the OCD group hedged less on average than the GD and HC groups.

Two additional exploratory analyses provided closer examination of switching across blocks across groups (in Appendix C) and a comparison of switching when the order of presentation was varied (in Appendix D). By group, the analyses showed that the hedging profile across blocks of the HC group decreased slightly, but was more or less constant relative to the clinical groups in the CA condition, whose hedging tendency appeared to decrease more significantly (see Figure 8). This was particularly true for the OCD group who showed consistently less hedging in both CA and DA conditions. These finding suggests two possibilities. First, all participants hedged for the purpose of exploring and learning their options, and then adjusted their switching for the purpose of keeping their options open. The change in responding across time may be explained by evidence that down-regulation of early emotional responses occur from 500 ms to minutes following the onset of stimuli (for studies, see Hofmann et al., 2012), which is hypothesized to account for frontal inhibitory regulation of responding. Thus, decreased switching as the task progresses may correspond to executive inhibition of responding following learning. The OCD group showed the least amount of hedging suggesting that other processes or neuropathology (e.g., less sensitive emotional or somatic response) may have further contributed to their pattern of responding. Studies that compare hedging with neuropsychological batteries of executive functioning and IGT performance may corroborate this hypothesis.

The second suggestion from the findings is that clinical groups, particularly OCD, may actually be less sensitive to loss aversion given that they showed the least amount of hedging in the DA condition relative to the other groups. This idea was supported by examining decision-making when order of presentation of condition was varied in Appendix D. When the order of presentation was considered within groups, an interesting finding emerged in the first block (first 10 trials) when the CA condition preceded the DA condition. The OCD group did not increase their hedging tendency from the CA condition to the DA condition as the other two groups did. In fact, the OCD group hedged marginally less in the DA than the CA condition (See Table D1). This finding suggests a muted response in OCD to threat of loss, which is in line with research suggesting abnormal activation of areas associated with loss aversion, specifically, the OFC and VMPFC, and the ability to detect somatosensory information (Bechara et al., 1996; Denys, van der Wee, Janssen, De Geus, & Westenberg, 2004; Pogarell et al., 2003; Rolls, 2000; Simpson et al., 2003; Starcke, Tuschen-Caffier, Markowitsch, & Brand, 2010; Zohar & Insel, 1987). For example, hypoactivation of the frontal striatal and OFC regions have been reported in OCD that correlate with diminished cognitive functioning relative to controls (Britton et al., 2010; Chamberlain et al., 2008; Gu et al., 2008; Harrison et al., 2009; Page et al., 2009; van den Heuvel et al., 2005). The insensitivity of these neural regions may reflect a diminished behavioural response that is captured by the hedging task and adds another line of evidence for a decision making impairment in OCD. Some have called for using cognitive or neural responses as endophenotypes as a proxy for underlying genetic pathophysiology (Chamberlain & Menzies, 2009; Gottesman II, 2003). Task such as the Doors Game (Shin & Ariely, 2004) that measure decision making arising from behavioural loss aversion provide promising avenues for advancing endophenotypic theories of decision making.

The Association of Psychological Factors With Hedging

Several psychological factors and hedging were significantly associated in the OCD group as compared to the GD or HC groups. Namely, NFC total was negatively associated with hedging in OCD. While obsessiveness showed marginal correlations with hedging in the DA condition, obsessiveness, checking, and washing subscales of the OCI were significantly correlated with switching (in the CA condition) in OCD. Only the experience seeking subscale was positively significantly associated with hedging in OCD. The lack of significant findings with OCI and NFC in GD and HC highlight that decision making in OCD is likely influenced by OCD- relevant constructs.

The regression model supports the idea that higher ratings of obsessiveness and the need to make immediate decisions predicts less hedging. In fact, obsessiveness, as measured by the OCI, significantly predicted less hedging in both the CA and DA conditions in the OCD group. People who exhibit obsessiveness are characterized by having the need to perfectly control their environment and and postpone or avoid decisions to minimize risk (Salzman, 1980). In a study involving low and high-risk situations, OCD participants requested more information and time deliberating before making decisions only in the low-risk scenario (Foa et al., 2003). These findings from past research were in line with the a priori thinking in this work where the hypothesis was that individuals with OCD would hedge more in the face of uncertainty. However, the actual results obtained in this study indicate that people with OCD may have a preference for staying with the familiar choices when faced with multiple fading options. It is possible that the unique characteristics of individuals with OCD prevented them from adapting their strategy when faced with disappearing doors (i.e., by increasing hedging, which was observed in the GD and HC groups). This tendency in OCD may indicate that decision making deficits may be mediated by their elevated scores on clinical and motivational factors (as measured by the OCI and NFC) that impeded the OCD participants' flexibility to switch doors.

Obsessiveness has also been associated with perseveration on switching tasks such as the Wisconsin Card Sorting Task (WCST; Berg, 1948) and reversal learning tasks with binary choices (Chamberlain et al., 2008; Huizinga & van der Molen, 2007; Miyake et al., 2000; Remijnse et al., 2006; Valerius, Lumpp, Kuelz, Freyer, & Voderholzer, 2008). Individuals with OCD are reported to have difficulty switching to alternate options even when their actions elicit punishment and when they were provided with feedback, and the absence of learning such reversal strategies was related to reduced OFC-striatal and PFC activity (Chamberlain et al., 2008; Remijnse et al., 2006; Valerius et al., 2008). This deficit of switching in reversal tasks appears to fit with the finding of less frequent hedging in OCD. However, the Doors Game is fundamentally different in the structure of reward and punishment as compared to the WCST and reversal tasks. While the WCST and reversal tasks provide continual feedback until an opposite target behaviour is elicited (i.e., a reversal), the distribution of punishment (losses) and rewards (gains) in the Doors Game is independent of participant response.

The OFC is implicated in impaired performance on reversal tasks (Morein-Zamir et al., 2014; Remijnse et al., 2006; Valerius et al., 2008) while the dorsolateral prefrontal cortex drives impaired WCST performance (Huizinga & van der Molen, 2007; Miyake et al., 2000). Because all options pay the same in the Doors Game, decision making behaviour is hypothesized to be motivated by the reaction to loss aversion rather than switching for monetary incentives. Hence, the Doors Game potentially opens avenues to test convergent/divergent validity of the above and related tasks. On the convergence side, performance on the Doors Game and reversal tasks should be similar given the shared OFC underpinnings. Performance on the WCST is related to executive dysfunction, thus should not show significant relations with performance on the initial trials of the Doors Game, but may show associations in the latter half. Processes involved in the latter half of the task may include inhibition, planning, and goal-oriented behaviour (i.e., executive functioning). Given the common neural structures involved in decision making, future studies should tease apart the relation between reversal learning and loss aversion (OFC circuitry) and executive processes could be a fruitful area for future research.

The regression model for the OCD group highlighted the potential effect of NFC on reducing hedging. A perusal of item content on the NFC decisiveness subscale indicates that the motivation to hedge less in the OCD group may be due to receiving a reinforcing affective reward for making quick decisions. Items of the NFC decisiveness scale include, "When I have made a decision, I feel relieved," "When I am confronted with a problem, I'm dying to reach a solution very quickly," and "I would quickly become impatient and irritated if I would not find a solution to a problem immediately." These statements imply that decision closure helps individuals with OCD reduce negative affect, which is also in line with the significantly elevated BIS scores reported in OCD relative to GD and HC groups. High BIS scores correspond to avoidance behaviours that are driven by conflict between incompatible decisions with unknown consequences and are potentially dangerous (Wytykowska & Lewicka, 2011). The NFC items suggest that committing to a decision helps individuals resolve emotional conflict. Thus, hedging less and reducing the number of options may effectively reduce conflicting feelings of indecision.

For the GD group, NFC closed-mindedness predicted increased hedging. Closed-mindedness is defined as being unwilling to have one's knowledge challenged by alternative opinions or inconsistent evidence (Roets & Hiel, 2011). In other words, being more closed minded was associated with keeping options available in the GD group. This finding is surprising given that the items of this subscale suggest a preference for low deliberation and consultation of alternate options. For example, the items include, "I dislike questions that could be answered in different ways," "I do not usually consult many different opinions before forming my own views," and "I feel irritated when one person disagrees with what everyone else in a group believes." On the face of it, it would appear that hedging (i.e., keeping options available) is inversely related to the first item (i.e., the more one dislikes answering questions in multiple ways should lead to less hedging). It is noteworthy that the three groups did not significantly differ on this dimension of the NFC subscale. The lack of variability or range of responses may explain this unexpected finding. In fact, NFC total scores were not associated with hedging in the GD and HC groups, but total NFC predicted less hedging in the OCD group. Independent replication verification of this finding may shed more light on the closed-mindedness factor of NFC.

The finding that the OCD group did not display the same overall pattern of hedging as the GD and HC groups may also be due to other characteristics and constructs related to OCD such as higher doubt, perfectionism, and harm avoidance (Ecker & Gönner, 2008; Frost & Shows, 1993; Rassin, Muris, Franken, Smit, & Wong, 2007). Individuals with OCD tend to be doubtful of their actions and therefore are more cautious about decisions and actions in order to avoid making mistakes (e.g., perfectionistic) and to avoid harm (Summerfeldt, 2000). Perhaps the motivation for participants with OCD to choose similar options quickly is to remove doubt and uncertainty, thereby reducing the probability of potential harm. Sticking with past decisions that have not resulted in significant harm may be reinforcing to the extent of biasing future decision making that avoids considering other potentially harmful possibilities.

Harm avoidance is an affective factor that was not directly measured in this study; however, the BIS (behavioural inhibition) factor of the BIS BAS could be considered as a proxy for behavioural avoidance and was indeed found to be more significantly elevated in the OCD group relative to the other two groups. However, the regression analyses removed the BIS factor as a significant predictor of hedging, suggesting that harm avoidance plays a minor role in hedging in OCD. Rather, clinical constructs more directly related to OCD (i.e., obsessiveness) and motivational factors appear to drive hedging behaviour in OCD.

Hedging in the HC group was uniquely predicted by the BIS BAS fun-seeking subscale. In both the CA and DA conditions, higher fun-seeking scores predicted more hedging. This finding suggests that HC may perceive keeping options available as a fun and exciting experience. Such views may explain the observed data that showed relatively stable hedging across the blocks. Thus, HC may view hedging as a positive and adaptive strategy that may be related to rewards relative to individuals with OCD, whose obsessiveness and urgent need for certainty and reduction of emotional conflict prevents them from considering all possibilities.

As compared to the OCD and GD groups, the HC group uniquely showed a positive association between hedging in the CA and DA conditions and the BIS BAS fun-seeking subscale. According to Carver and White (1994), the neural basis of the BAS system motivates goal directed actions that lead to positive feelings when exposed to cues of impending reward. This finding implies that switching and hedging are indirectly associated with positive affect in HC, which appears counterintuitive. In the validation of the BIS BAS scale, partial correlations showed that only fun seeking was initially significantly positively correlated with initial feedback of success, whereas drive and reward responsiveness both significantly predicted initial and latter happiness (Carver & White, 1994). Applying this understanding to the current findings, the observed significant positive association of fun seeking in both CA and DA condition may reflect initial responses to reward incentives, novelty, and goal-directed behaviour in the first 10 taps. Notably, this reward responsiveness of the BAS system significantly predicted hedging only in the HC group, suggesting a muted reward sensitivity in the OCD and GD groups, which is consistent with past literature (Abe et al., 2015; Bergh, Eklund, Södersten, & Nordin, 1997; Chamberlain et al., 2008; Goudriaan et al., 2006; Hollander et al., 2005; Potenza et al., 2013; Rasmussen, Eisen, & Greenberg, 2013; Reuter et al., 2005; Velikova et al., 2010). Additionally, significant negative associations with the avoidant BIS system in the CA condition was indeed observed suggesting shared neural hypersensitivity of avoidance behaviours is shared in the clinical groups. These parallel findings of BIS BAS provide support that 1) initial decision making in clinical groups may be more influenced by the BIS system, 2) elevations on the BIS is associated with less switching, and 3) the BAS system plays a significant role in switching in HC. Replication is needed to establish that these findings are not artefactual.

This research did not show significant associations between anxiety and hedging despite having a sample with anxiety severity ratings that ranged from mild to severe. These results stand in contrast to past studies that have reported a significant association between higher anxiety and cautious decision making (Maner et al., 2007). One possible explanation is that the construct of hedging is principally different from scenario-based decision making paradigms, which require one decision point, whereas hedging measures a series of decision points which provide feedback for future decisions. Hence, a global self-report of symptoms on the STICSA obtained at a discrete point in time may have little correlation with multiple decision points. This issue may be resolved by a time-series design that tracks anxiety and hedging over time. Findings in the literature suggests that anxiety affects outcomes of decisions where poor choices result in net losses (Einhorn & Hogarth, 1981). The reward incentive of the Doors Game is based on an equal net gain of $3.00 in all the conditions for a relatively small cost (loss). Further, loss is typically made more salient in scenario-based paradigms that explicitly show loss probabilities than in the Doors Game. Hence, a stronger saliency of loss (i.e., the magnitude of loss in conscious awareness) may be necessary to establish links between anxiety and decision making. Relatedly, a future study examining loss anticipation which is typically associated with activity in the anterior insula (Choi, 2012) may complement behavioural studies. Across the three studies of this dissertation, the absence of consistent associations between hedging and anxiety suggests that loss aversion may influence hedging independent of anxiety. Future research examining the role of anxiety in decision making may yield more consistent results by using paradigms with variable financial outcomes. For example, anxious individuals may hedge differently based on the net payout of each door (i.e., low, medium, high net winnings).

Summary

In summary, Study Three contributes to the literature by demonstrating associations between hedging decisions and clinical, motivational, and risk-taking factors. Individuals with OCD and GD are similar in that they appear less motivated to explore their options as demonstrated by lower hedging, whereas HC appear to take a fun-seeking, exploratory stance in situations even when there is a threat of loss of options.

An important contribution to the OCD literature on decision making is the novel construct of hedging to examine decision making that is related to loss aversion. The findings suggest that impaired decision making corresponds to behavioural deficits that map onto the OFC and VMPFC (e.g., hedging that is putatively motivated by loss aversion). Another contribution of this study is the identification of significant motivational factors such as NFC that influence decision making. Much of the extant research has focused on anxiety and decision making involving risk probability, but in this study, there was some indication that anxiety may possibly be associated with hedging. Moreover, for OCD participants in this sample, the dimension of obsessiveness appears to explain the reluctance to hedge, which could lead to less optimal decision making outcomes.

The findings and generalizability of these results may be limited by the nature of the sample and modest sample size. Challenges with recruiting a genuine clinical sample from the community continue to pose difficulties for research studies (Gioia, Sobell, Sobell, & Agrawal, 2016; Hysong et al., 2013; Moscovitch et al., 2015) and this study was not exempt from such challenges. Given that no significant hedging differences were detected between groups in the overall hedging score (although the regression analyses suggest group differences in hedging motivations), a replication of this study with a more stringent screening of clinical groups may provide a clearer picture. The statistical trends identified in the exploratory post-hoc analyses also support the need for additional research with a larger sample size. Moreover, the sample size in the current study was not conducive to analyzing hedging among OCD subtypes. OCD is a heterogenous disorder with various subtypes (i.e., checking, washing, obsessing) (Mataix-Cols, Rosario-Campos, & Leckman, 2005). The correlational findings from Study Three suggest that obsessiveness and checking are negatively associated with switching and hedging, but only obsessiveness significantly predicted hedging. Given these findings, OCD subtypes analyses would be worthy of inclusion in future studies.

Study Three provides some ideas for future exploration, such as the need to include other affective, cognitive and risk-taking measures, such as harm avoidance and loss aversion, as well as other validated decision making tasks (e.g., IGT or the BART). Although the IGT design has been recently criticized (Lin et al, 2007; Steingroever et al., 2013, 2014), given that it has been the most prevalent decision making experimental task used, comparing hedging that accounts for loss frequency on the IGT (Steingroever et al., 2013) may be insightful. There appears to be considerable promise for future studies to tease apart the psychological constructs that may differentially motivate hedging across diagnostic groups. Even though hedging behaviour did not differ significantly across groups, this finding may be attributed in part to the relatively modest sample sizes of the groups and possibly the severity of clinical presentation. Issues of bonafide clinical symptoms were noted during the recruitment process; thus future studies that include clinical groups should set stricter inclusion criteria. One very consistent result across all three studies was the moderate to large effect size of hedging.

This study supports future examination of the hedging construct using the Doors Game to better understand decision making not only in OCD but also in other clinical groups. An examination of the neural correlates of hedging would help to advance this area of research in the future. Shin and Ariely (2004) proposed that loss aversion is the underlying process of hedging on the Doors Game, thus associations would be expected between hedging and activation in frontal-striatal circuits and related structures. In light of evidence of hedging in all three groups, it would be interesting to see how neural activation or modulation occurs in these groups.

Chapter 5: General Discussion

Contributions to the Literature

The overall purpose of this dissertation was to better understand a new facet of decision making called hedging. Two overarching objectives were set: first, to explore hedging in individuals with OCD and a normative sample; and second, to compare hedging in individuals with OCD and GD. The dissertation was organized in three studies with the sub-goals of i) replicating the options availability effect (Shin & Ariely, 2004) using the Doors Game; and ii) examining some of the psychological factors likely to be related to hedging. The results of this research replicated the hedging effect with the Doors Game in a healthy control sample, and demonstrated that psychological constructs of obsessiveness, NFC, and sensation seeking predict hedging in OCD. The results of this research also demonstrated that hedging patterns in OCD relative to a clinical group of gamblers is similar, but the motivations underlying decision making within the groups likely differs. Each of these main results is discussed below and future lines of research are suggested to develop this area of study further.

Replication of the Hedging Effect

The replication of a novel paradigm that purportedly reflects decision making that is motivated by loss aversion was demonstrated in three studies with participants from three samples of healthy controls, one sample of individuals with OCD, and one sample of individuals with GD. A conclusion based on the consistency of the findings reported here is that hedging is a human trait that falls along a continuum and likely reflects individual differences in sensitivity to loss aversion threats. This finding is in line with empirical findings of the pervasive influence of aversion to loss in decision making (Boyce et al., 2016).

The replication of the hedging effect provides strong evidence that may explain Steingroever et al.'s (2013) conclusion that high switching variability in the IGT in healthy individuals may indeed be due to an aversion to loss of options. Loss aversion is not specifically measured by the IGT, although the underlying neural substrates (e.g., OFC, striatum) may be shared with loss aversion (Tom et al., 2007). The evidence presented herein supports the recommendation for the use of measures other than (or in addition to) the IGT to better understand decision making.

The results reported here support the use of the Doors Game as an alternate and possibly more fitting task relative to the IGT for exploring loss aversion characteristics. The Doors Game was designed to measure real-life decision making behaviour that was demonstrated to be motivated by loss aversion rather than the need for information or future flexibility of choice (Shin & Ariely, 2004). Even with practice and adverse monetary penalties, people continued to hedge, suggesting a robust and stable phenomenon. The Doors Game has the advantage of illustrating observable decision making behaviours (i.e., switching), that apply to real-world situations. For example, hedging illustrates the pseudo-endowment effect where individuals overweigh the value of keeping options when they are at risk of losing them. The pseudo-endowment effect is the corollary of the endowment effect that states that people put more value on the loss of objects (e.g., the sale of an item) and therefore demand more value for it than people who wish to purchase the item (van Dijk & van Knippenberg, 1996). More specifically related to this dissertation, the clinical groups potentially showed attenuated responses to the pseudo-endowment effect relative to controls, who placed greater effort at keeping more options available. Hence, controls possibly showed a stronger pseudo-endowment effect than the OCD and GD groups.

A strength of the Doors Game over the IGT is the ability to isolate behaviours that are independent of the value of the financial rewards. Recall that the expected values on the IGT varied by deck. However, in the current version of the Doors Game, the fluctuating reward incentives and punishment confounds are removed while leaving intact the sense of future uncertainty and potential loss, in a way that mimics real life decision making. Such a design provides the possibility to detect behavioural loss aversion (i.e., hedging) and corresponding neural activation. The field of neuroeconomics is currently focused on encoding loss aversion at the neural level (Canessa et al., 2013), and this task may help capture and isolate such processes. A potential argument against using the Doors Game pertains to the possibility of multi-factorial processes that plague existing decision making tasks. It is difficult to circumvent this issue given that there were potential signs of task learning, and it was not possible to rule out the potential influence of other executive processes (e.g., perseveration, set shifting) on decision making that may have influenced hedging responding after several blocks of trials. To rule out other processes, perseveration could be tested by providing participants with salient feedback during the task and examining whether the same degree of hedging persists. Future research that uses advanced computational models and neurophysiological methods would be required to further knowledge in this area. For example, additional research support is needed to determine the extent of other neuropsychological processes (e.g., executive functioning) that may be operating at different stages of the task. Based on the results presented here, the initial response to loss aversion is best captured in the first few trials of the task, and decisions that occur later in the task may correspond to other facets of executive control. Similar to past experiments, early and later stages of performance on the Doors Game can be compared with tasks that correspond with executive functioning (e.g., Game of Dice) (Brand, Franke-Sievert, Jacoby, Markowitsch, &

Tuschen-Caffier, 2007).

It is worthy of mention that even though individuals hedged more when the threat of loss was present in the Doors Game, significant hedging variability was observed in hedging within groups. In the non-clinical control groups, the U-shaped distribution of hedgers in the CA condition suggests the existence of two groups with naturally high and low hedging tendency. In contrast, the profile of the clinical groups suggests that they have low hedging traits that may reflect an insensitivity to loss aversion that only applied to some individuals in the control group. These findings align with similarly heterogeneous reactions in other experimental tasks that elicit loss aversion behaviourally and neurally (Canessa et al., 2013; Dreher, 2007; Tom et al., 2007). However, additional research is needed to further examine the link between hedging variability and neural responses to loss aversion. The Doors Game has face validity and theoretical support as a real-world task; thus additional empirical research is warranted to examine its validity and reliability.

Psychological Correlates of Hedging in Non-Clinical Participants

The second contribution of this dissertation is an increased understanding of the psychological correlates of hedging. The results from the three studies add to the literature by showing that clinical, affective, motivational, and risk-taking traits are associated with hedging. The association between certain personality factors (e.g., neuroticism, extraversion, sensation seeking) and loss aversion is gaining empirical support (Boyce et al., 2016; Disatnik & Steinhart, 2015; Wong & Carducci, 2013). Personality factors may in fact prove useful in identifying individual reactions to economic decision making (Boyce et al., 2016). An important point made by Filbeck, Hatfield, and Horvath (2005) is that the relationship between personality traits and facets and decisions involving risky behaviours are not likely linear; rather they are likely highly curvilinear and complex. Further, personality traits reliably predict choice behaviours independent of perceived outcome (i.e., losses and gains) (Soane, Dewberry, & Narendran, 2010). For example, individuals high in conscientiousness were found to be more sensitive to loss as compared to individuals who were moderately conscientious (Boyce et al., 2016). Related to this research, conscientiousness is associated with rigidity and obsessiveness (Carter, Guan, Maples, Williamson, & Miller, 2015; Nettle, 2006) and individuals who are high in conscientiousness (as many with OCD are) may also show less hedging. In Study Three, obsessiveness indeed was a significant predictor of hedging. Associations between hedging and impulsivity, sensation seeking, and perhaps neuroticism (e.g., some aspects of anxiety) suggest potential avenues for further personality research.

Data from individuals in the control group were used to approximate the relations among affective and personality traits and hedging. The results showed a few relationships between hedging tendency and elevated levels of anxiety and extraversion. In terms of extraversion, higher levels of sensation seeking were related to less hedging in an undergraduate sample, suggesting that those with the highest levels of sensation seeking should hedge the least. This similar negative association between sensation seeking and hedging was somewhat corroborated in the GD group in Study Three (albeit at a marginally significant level due to the modest sample size). Sensation seeking was also significantly related to hedging in the general population and will be discussed in the next section.

The studies conducted in this dissertation did not find strong evidence for the relationships between hedging and emotional factors such as anxiety and depression. The findings regarding the association between anxiety and hedging were mixed in the undergraduate samples recruited in Studies One and Two. The post-hoc analysis in Study One that divided the levels of anxiety into quartiles was driven by the theoretical hypothesis that higher anxiety was related to greater hedging. However, the earlier findings were not replicated in the comparisons of discrete groups with a range of anxiety severity in Study Three. Study One generated mixed findings, with anxiety sensitivity showing a negative association with hedging that was contrary to the hypothesis. However, individuals with the highest quartile of cognitive state anxiety showed a greater tendency to hedge, which was in line with the initial hypothesis. Although the results of Study Two concurred with the finding of a negative association between hedging in the DA condition and state physical anxiety, but not the cognitive factor of anxiety, there was no association between hedging and anxiety in Study Three. It is possible that the significant variability of hedging scores from non-normal distributions in all three studies did not provide evidence of consistent correlates. For example, in Study One, anxiety sensitivity was the only measure that was normally distributed, and it showed significant overall negative associations with hedging in the first 10 taps of the task. State or trait anxiety may have some associations with hedging, depending on the nature and heterogeneity of the sample. Taken together, these results suggest that that the relationship between hedging and different components of state and trait anxiety is unclear and warrants further research.

Impaired Decision Making in Obsessive-Compulsive Disorder

This dissertation produced new knowledge on the trends in differential patterns of hedging between individuals with OCD as compared to to GD and HC. The overall hedging tendency in the CA and DA conditions were not significantly different across groups; however, closer examination of switching in Block 1 indicates potentially less switching in the CA condition in the OCD group than the GD and HC groups. This finding was most pronounced in the first 10 trials of the task and showed significant differences when order of presentation of the conditions was considered. Evidence for this assertion is most clearly observed in the first block, where the GD and HC groups increased switching whereas the OCD group did not. Another finding that supports a diminished response to loss aversion in OCD is that hedging decreased more across the trial blocks in OCD than in HC. These findings suggest that individuals with OCD may be less sensitive to simulated loss aversion as compared to controls; however, additional research is needed to replicate the results in this work.

The lack of response to loss aversion has been reported in other clinical groups such as in patients with schizophrenia (Trémeau et al., 2008). A study by Tom et al. (2007) highlighted that changes in loss aversion responsiveness may involve dopaminergic systems, which are implicated as the underlying etiological basis of schizophrenia (i.e., mesolimbic and mesocortical pathways) (Davis, Kahn, Ko, & Davidson, 1991). The combined results of the studies described here suggest a deficit in behavioural loss aversion that likely has a different underlying etiology or mechanism in OCD than that for other clinical groups such as GD and schizophrenia. OCD pathophysiology is more related to the cortico-striatal circuitry, particularly the involvement of lateral and medial orbitofrontal cortices, the dorsal anterior cingulate cortex, and the amygdala-cortical circuitry (Milad & Rauch, 2012). Pathology models of GD implicate the interplay of underactive mesolimbic prefrontal circuits, reinforcement mechanisms, serotonergic system underlying impulsive control (Gobet & Schiller, 2011; Reuter et al., 2005), and vulnerabilities to cognitive biases (Gobet & Schiller, 2011). Schizophrenia pathophysiological models include gray-white matter volume abnormalities, reduced volume of lateral and medial temporal lobe structures, thalamic volume, cortical thinning, and abnormal shape of subcortical structures such as the hippocampus and thalamus (Isobe, 2016; Woodward & Heckers, 2016).

A tendency to hedge less may become problematic when decisions lead to less than optimal outcomes. The inflexibility to consider options may constrain future behaviours and consequences. The absence of behavioural loss aversion (i.e., hedging) may reflect deficits in the integration or differentiation of affective information during cognitive processes, which is a deficit reported in clinical populations (Herbener, Song, Khine, & Sweeney, 2008; Trémeau et al., 2008). The evidence from this dissertation adds some initial support for the convergence of involvement of brain structures of loss aversion that are also implicated in the pathophysiology of individuals with OCD (i.e., OFC). Neuropsychological evidence and the results of recent technologically-advanced imaging studies provide more recent consensus that the OFC and VMPFC implicate decision making deficits in OCD (Abe et al., 2015; Bokor & Anderson, 2014; Milad & Rauch, 2012). While it is assumed that hedging is motivated by loss aversion and related circuits of the OFC, this assumption needs direct validation by future neuroimaging research.

Although it was initially hypothesized that anxiety would be associated with cautious decision making, the findings of the current research generally did not support the a priori hypothesis. Given that controls hedged more in the DA condition, it was assumed this behaviour is adaptive. Hedging on either extremes of this normative benchmark might suggest maladaptive decision making. Anxiety, for example, was hypothesized to be associated with more hedging. However, the findings regarding anxiety were mixed across the three studies suggesting that sample selection may explain the results of the first two studies. In fact, other affective variables were more strongly associated with hedging in the healthy controls and two clinical populations. For example, the neurobiologically-based affective traits underlying approach and avoidance behaviours BIS BAS (Gray, 1987; Gray & McNaughton, 2000) had better predictive power in hedging decisions. These findings suggest that individuals with anxiety may be less sensitive to reward and punishment cues than constructs such as the BIS BAS, at least in predicting hedging. This claim is further supported by two results from Study Three. First, there was a positive association between BIS BAS and the NFC scales, supporting past findings (Colbert, Peters, & Garety, 2006; Corr, Hargreaves-Heap, Tsutsui, Russell, & Seger, 2013; Czernatowicz-Kukuczka et al., 2014) and indicating that anxiety is associated with avoidance behaviour. Second, the NFC was a significant predictor of hedging in the two clinical groups, whereas the BIS BAS was not. Future research should further examine the role of motivational and affective factors in decision making in clinical groups.

From a cognitive perspective, Dittrich et al., (2011) reported that OCD patients with symmetry/order and sexual/religious concerns were impaired on a gambling task. The authors argued that impaired information processing is due to obsessional fears or deficits in directing attention to relevant contingencies. The distress experienced during obsessions may have a similar effect to that of anxiety in the disruption of attention control (M. W. Eysenck et al., 2007). More specifically, distress may cause the allocation of attentional resources to the internal threat-related distress and shift attention away from goal-oriented and on-going task demands. In terms of decision making, choosing the same option or as few options as possible requires less attentional load than continual hedging, which requires constant updating of information. If the locus of attention is internally focused in individuals with OCD, then a lesser amount of hedging suggests a lack of cognitive resources to process the available contingencies and choices.

No specific a priori hypothesis was proposed regarding the relations among hedging and OCD symptom subtypes. However, correlational results from the current study suggest moderate associations with washing, checking, and obsession subscales of the OCI (Foa et al., 2002). No significant associations were observed between hedging and the ordering, neutralizing, and hoarding subscales. Given that the face-validity of hoarding appears to be related to loss aversion in the sense that hoarders are reluctant to discard their belongings as it may be viewed as a loss, it was surprising to see no relations with hedging. Hoarding in some individuals however, is related to the need to perform checking rituals and mental compulsions before discarding any item (Morein-Zamir et al., 2008). It thus appears that acts of checking and mental compulsions are more prominent in hoarding than perhaps loss aversion of items. Other OCD-related themes of reassurance seeking, repeating, mental reviewing, and hypochondriacal concerns are not captured in the OCI scale (Huppert et al., 2007; Mataix-Cols, Rosario-Campos, & Leckman, 2005) and could potentially be associated with hedging and provide alternate areas of investigation.

Obsessiveness contributed significant variance as a predictor of less hedging in both CA and DA conditions in the OCD group. Interestingly obsessiveness is also considered more sensitive than washing and checking subscales for identifying individuals with a diagnosis of OCD (Huppert et al., 2007). Reactive obsessions triggered by environmental cues, such as contamination concerns or doubts about checking, are less distressing than spontaneously generated intrusive obsessions of harm, which are typically more ego-dystonic (Foa et al., 2002; H. J. Lee & Kwon, 2003). Hence, the level of distress that is associated with obsessiveness appears to be a better predictor of hedging than anxiety, although there are established relations between obsessing, checking, washing, and ordering with measures of trait anxiety (Deacon & Abramowitz, 2005). Relatedly, some evidence suggests a positive correlation between obsessiveness and indecision (Summerfeldt, 2000). While indecision was not explicitly measured, the current finding that high obsessiveness is related to and predicts less hedging suggests that individuals with OCD may have a stronger motivation to commit to decisions (possibly to achieve cognitive closure) and therefore appear less indecisive.

Another perspective that may help explain the observed findings relates to the constructs of harm avoidance and incompleteness in OCD. Two distinct symptom profiles exist; namely incompleteness is associated with tension/discomfort while harm avoidance is related to anxiety/nervousness, respectively (Pietrefesa & Coles, 2009). Reportedly, people with stronger ratings of incompleteness report a ‘difficult to describe’ subjective experience of “not just right feeling” that is unassociated with the desire to prevent harm (Rasmussen & Zohar, 1991). From this finding, behaviours that are motivated to reduce harm do not appear to satisify the feeling of incompleteness. Typical harm reduction behaviours such as checking and washing (i.e., neutralizing behaviours) are performed to alleviate anxious apprehension and serve to avoid harm (Abramowitz et al., 2009; Rasmussen & Zohar, 1991; Summerfeldt, 2000; Szechtman & Woody, 2006), which suggests that harm avoidance behaviours may be influenced by affective information as postulated by the risk-as-feelings model (Loewenstein, 2001). In contrast, for individuals with OCD who do not report sensitivity to anticipatory anxiety or potential threat, OCD compulsions may be motivated by the urge to correct feelings of incompleteness (Ecker & Gönner, 2008; Pietrefesa & Coles, 2009; Summerfeldt, 2004).

The findings in Study Three suggest potential associations of hedging with both harm avoidance and incompleteness; however, neither harm avoidance nor incompleteness were directly measured. Although speculative, the proxies for harm avoidance could be postulated to have been captured by the affective measures (i.e., STICSA and BIS BAS), whereas the motivational measure (i.e., NFC) may have been most related to sense of incompleteness. The results of Study Three thus suggests that hedging may be more related to incompleteness than harm avoidance in OCD. It is also possible to conceive that aberrant decision making may in part be influenced by two factors: the motivation to reduce self-perceived threats of harm and the desire to improve one's sense of completeness. These two constructs as they relate to decision making are understudied and are potential factors that may lead to better understanding of motivators of decision making.

Perhaps the most significant clinically-related finding was the power of NFC to predict less hedging. One possible connection that is yet to be studied is the relation between NFC and the feeling of incompleteness in OCD. It is conceivable that a low tendency to hedge financial decisions parallels the perseverative nature of checking to satisfy the feeling of incompleteness. The finding that NFC, obsessiveness, and checking are related to less hedging suggests a plausible decision making model whereby the need for closure is satisfied by committing to fewer options and foreclosing on more possibilities than healthy individuals in order to achieve a sense of completeness. Feeling compelled to exclude options is perhaps one way for individuals with OCD to achieve "closure" for "not just right experiences" (Ecker & Gönner, 2008). These findings are in line with Ecker's (2008) report of a positive relation between the sense of failure to achieve closure and obsessions, which together act as motivational decisional forces. However, this hypothesis awaits empirical validation.

Comparison of Decision Making in Obsessive-Compulsive Disorder and Gambling Disorder

Another major objective of this dissertation was to compare individuals with OCD and GD and examine whether or not there were similar deficits in decision making as has been previously suggested (Anholt et al., 2004; Frost et al., 2001; J.W. Hur et al., 2012). For example, patients with GD have been reported to manifest lower signals of somatic responses (i.e., skin conductance and heart rate changes) on the IGT (Goudriaan et al., 2006). The results of Study Three do not provide behavioural evidence of differences in hedging decisions between OCD and GD when the total average switching was analyzed. A more fine-grained analysis of initial responses to stimuli in the first 10 trials support the view that individuals with GD reacted to initial loss aversion in the DA condition similar to HC by increasing their hedging, in contrast to individuals with OCD who decreased their hedging. However, across the blocks in the CA condition, the GD and OCD groups possibly hedged less than controls (non-significant). Perhaps the reduced hedging in GD and OCD reflect similar perseveration difficulties (Choi et al., 2012; de Ruiter et al., 2009; Leeman & Potenza, 2012; van den Hout, Kindt, Luigjes, & Marck, 2007). It may also be the case that individuals with GD use exploitation of options (i.e., repeatedly choosing to maximize outcome) (Linnet, Røjskjær, Nygaard, & Maher, 2006).

Individuals with GD have shown a deficit in searching and evaluating information prior to deciding (Kagan, 1966; A. J. Lawrence et al., 2009b). For example, they requested to open fewer boxes and tolerated more uncertainty than controls on an information sampling task. Such impulsivity is associated with more task errors (Evenden, 1999) and negative real-life decision making errors. On balance, the results of this dissertation suggest that decision making processes in GD are less consistent than they are for OCD and control groups. In support of this finding, regression analyses identified unique clinical factors in each group that motivate hedging, but not the typical constructs, such as risk-taking or extraversion that are expected in GD. For example, it is somewhat surprising that hedging in the GD group was not predicted by risk-taking or higher ratings of sensation seeking, as has been found in many studies on risky decision making (Barrault & Varescon, 2013; S. W. Kim & Grant, 2001; McDaniel & Zuckerman, 2003). Rather, two factors of NFC predicted hedging in opposite directions, making it difficult to draw conclusions from the findings. In contrast, hedging in OCD was negatively influenced by NFC and obsessiveness and therefore presents a more coherent picture of the motivations driving hedging. Together, these findings give strength to the idea that decision making as an etiological endophenotype of OCD should be further explored as suggested by others (Cavedini et al., 2006; Sachdev & Malhi, 2005).

Future Directions

The current research provides a foundation for disciplines within and outside of psychology to further knowledge on decision making. The scientific community stands to benefit from learning more about hedging and daily functioning in order to devise treatment interventions and strategies. For example, the discovery of specific maladaptive cognitions related to the NFC in individuals with OCD could be discussed and challenged in cognitive therapy. It appears from this research that obsessiveness predicts less hedging more so than checking, washing, hoarding, and neutralizing symptoms, thus treatment may best focus on psychoeducation and cognitive restructuring beliefs about closing out options. Exposure exercises for tolerating distress related to non-closure and sensation seeking experiences may help patients become aware when their tendency to hedge less may preclude the discovery of other options that can lead to overall advantageous decision making.

The current study focused on hedging behaviour in OCD and GD, and future research should examine whether other clinical groups potentially show aberrant hedging behaviour (e.g., poverty of hedging or excessive hedging). Deficits in decision making performance have previously been identified in individuals with schizophrenia, (Trémeau et al., 2008), eating disorders (I. H. A. Franken & Muris, 2005), anxiety disorders (Lorian & Grisham, 2010; Volans, 1976), and substance use disorders (Lemenager et al., 2011; von Ranson, Wallace, Holub, & Hodgins, 2013). In a study of patients with schizophrenia, it was anecdotally reported that the absence of loss aversion might lead to the non-optimal decision making of inpatients. For example, patients with schizophrenia in state hospitals have been known to easily sell their personal belongings to patients and then later repurchase them (Trémeau et al., 2008). This behaviour suggests that some patients are motivated to close out their options when there are clear incentives, such as receiving money to buy items (e.g., cigarettes). Whether patients with schizophrenia hedge when the outcomes are more or less similar as in the Doors Game remains to be explored. Further knowledge of hedging characteristics of other clinical populations could help clarify whether loss aversion deficits could be specific to OCD and the corresponding neuropathophysiology of the disorder, or a shared etiology among mental health disorders.

Given that hedging manifests in everyday behaviours, descriptive or direct observation of such behaviours in other domains, such as financial and investment decisions may provide information that is externally valid and practical. Research may be able to answer questions related to the utility and boundary conditions (e.g., exceptions) that limit and enhance hedging and optimal decision making. Behavioural studies using the Doors Game that are accompanied by neuropsychological testing and neuroimaging could significantly contribute to the neuroeconomics literature and further map the neural correlates of loss aversion.

Appendix A

Quartile Analyses

To examine hedging behaviour at various levels of self-reported anxiety symptoms on the STICSA, the data were divided into quartiles. Higher quartiles indicate more severe symptoms. Subscales of each measure by quartiles can be viewed in Table A1. In this sample, mean Q4 levels of state and trait anxiety are in the clinical ranges. Mixed ANOVAs were conducted on the subscales and four planned comparisons accounting for family-wise error rates with a p-value <.01 was set as significant.

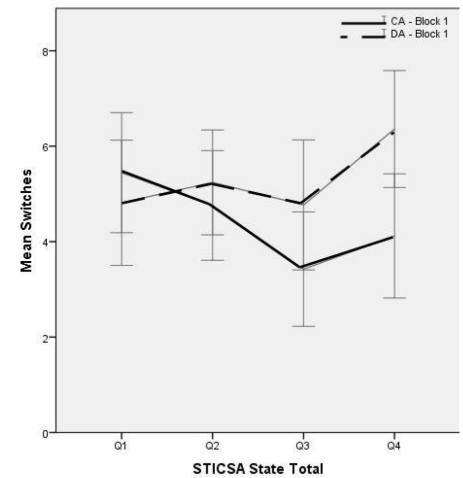
Table A1

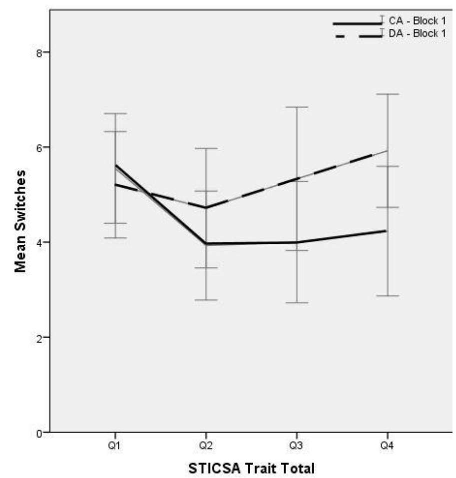
Quartile Means of State Trait Inventory of Cognitive Anxiety (STICSA) composite and subscales

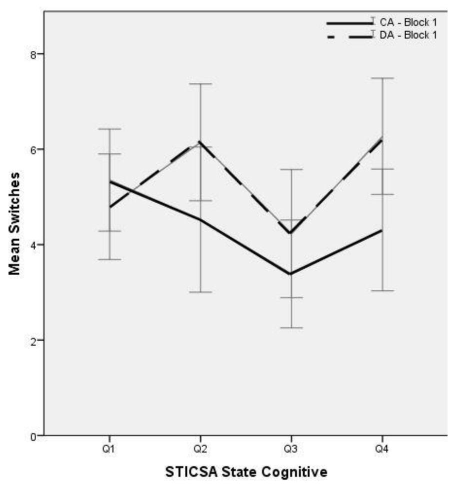
Mean (SD)				
Variable	Q1	Q2	Q3	Q4
State Total	24.1 (1.5)	29.3 (1.5)	34.4 (2.3)	47.7 (6.7)
State Cognitive	12.4 (1.4)	16.0 (0.8)	19.6 (1.1)	26.7 (3.8)
State Physical	11.5 (0.5)	13.0 (0)	15.2 (1.2)	21.9 (3.6)
Trait Total	26.8 (2.1)	32.5 (1.1)	39.0 (2.7)	49.6 (4.0)
Trait Cognitive	13.9 (1.4)	18.7 (1.1)	22.7 (1.5)	29.7 (3.4)
Trait Physical	11.6 (0.5)	13.5 (0.5)	16.0 (1.2)	22.7 (3.1)

Figure A1 shows the overall hedging and search trends of Block 1 of the CA and DA conditions across quartiles of self-rated state and trait cognitive and physical anxiety. Hedging in the fourth quartile of STICSA State and Trait cognitive anxiety appear to increase in the DA conditions while hedging slightly decreased in the CA conditions. Mixed ANOVA analyses indicate a significant interaction between the doors conditions and quartiles of STICSA state cognitive anxiety *F*(3, 103) = 3.28, $p = .02$). Follow-up analyses focused on Q4 as an analogue of hedging in individuals with higher rated levels of anxiety. Significantly more hedging was observed in the DA than the CA condition in Q4 ($M_{CA} = 4.31$, *SD* = 3.16; $M_{DA} = 6.27$, *SD* = 3.01, *t*(25) = - 2.10, $p = .007$, d = 0.64) in contrast to non-significant differences in Q1, Q2, and Q3 (i.e., Bonferroni-corrected family wise error was set at $p < .01$). The physical component of the STICSA yielded non-significant findings. There was a significant interaction effect of the STICSA State Total composite *F*(3, 103) = .46, $p = .02$) with significantly more hedging in Q4 in the DA condition relative to the CA condition ($M_{CA} = 4.12$, *SD* = 3.15; $M_{DA} = 6.36$, *SD* = 2.97, *t*(25) = - 3.58, $p = .002$, d = 0.73) than Q1, Q2, and Q3.

Similar interaction effects were observed only in the STICSA Trait Cognitive subscale *F*(3, 103) = 2.64, $p = .05$) with significantly more hedging in Q4 in the DA condition as compared to the CA condition ($M_{CA} = 4.17$, *SD* = 3.35; $M_{DA} = 6.29$, *SD* = 2.91, *t*(24) = - 2.98, $p = .007$, d = 0.68) than Q1, Q2, and Q3.


CA - Block 1
DA - Block 1
Mean Switches
0
2
4
6
8
Q1
Q2
Q3
Q4
STICSA State Total


CA - Block 1
DA - Block 1
Mean Switches
0
2
4
6
8
Q1
Q2
Q3
Q4
STICSA Trait Total


CA - Block 1
DA - Block 1
Mean Switches
0
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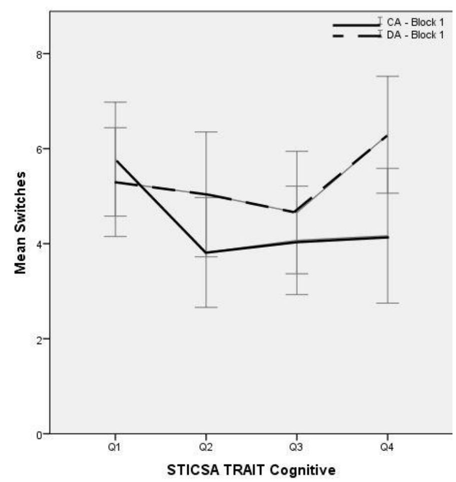
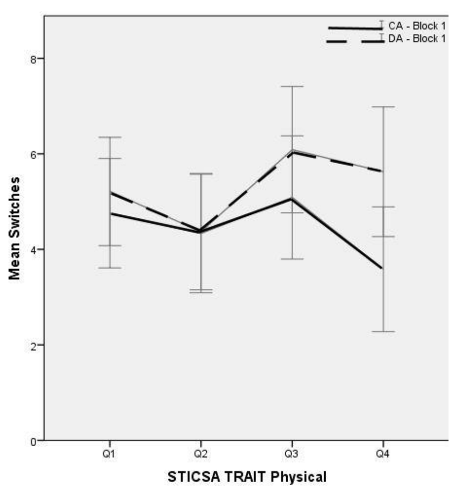
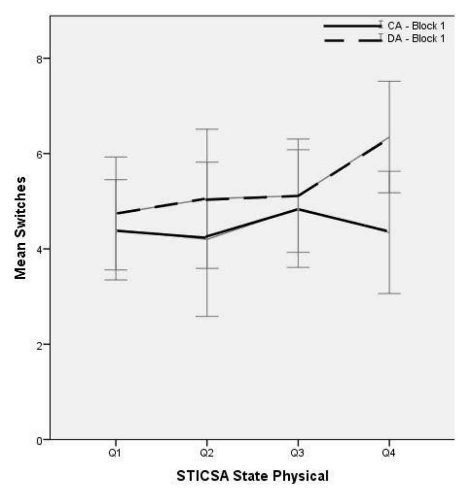
Q1
Q2
Q3
Q4
STICSA State Cognitive


CA - Block 1
DA - Block 1
Mean Switches
0
2
4
6
8
Q1
Q2
Q3
Q4
STICSA TRAIT Cognitive


CA - Block 1
DA - Block 1
Mean Switches
0
2
4
6
8
Q1
Q2
Q3
Q4
STICSA TRAIT Physical


CA - Block 1
DA - Block 1
Mean Switches
0
2
4
6
8
Q1
Q2
Q3
Q4
STICSA State Physical

Appendix B

Descriptive Statistics and Hedging Analyses of Study Two

Descriptive statistics of hedging are listed in Table B1. Mean switching per block in the CA and DA conditions, SD, paired *t* score differences, and Kolmogorov-Smirnof (D) of normality are presented. Statistical significance was evaluated at an alpha level of .05.

Table B1

Mean Switches in Blocks of 10 taps for Both the Constant Availability (CA) and Decreasing Availability (DA) Conditions of the whole sample

	CA		DA			
Switches by Block	Mean	SD	Mean	SD	*t-value*	*D*
Block 1	5.48	2.85	6.79	2.44	-2.79*	0.50
Block 2	5.22	3.70	6.49	3.33	-2.03*	0.36
Block 3	4.87	3.89	6.16	3.83	-1.87†	0.33
Block 4	4.52	4.03	5.87	3.57	-1.99*	0.35
Block 5	4.67	3.75	5.78	3.83	-1.75†	0.29
Block 6	4.06	3.78	5.08	3.64	-1.54	0.27
Block 7	4.10	3.80	5.10	3.84	-1.47	0.26
Block 8	4.29	3.86	5.19	3.81	-1.33	0.24
Block 9	4.63	3.84	4.97	3.76	-0.49	0.09
Block 10	4.38	3.38	4.43	3.31	-0.08	0.01
Sum of Blocks	46.22	32.53	55.86	31.77	-1.68†	0.30

*$p < .05$; † $.05 < p < .10$

In order to establish hedging tendency of the whole group (n=63), an independent *t*-test revealed a marginally significant difference between the CA (*M* = 46.2, SD = 32.5) and DA groups (*M* = 55.9, SD = 31.8; $t_{(62)} = -1.68$, $p = .10$, d = 0.30). Analysis of the groups of ten blocks of switching revealed significant differences in mean switching in three of the first four blocks, with the third block registering as marginally significant. Switching tendency appears to decrease over time in both conditions as depicted in Figure B1 with more significant switching occurring in the DA condition across the first five blocks and similar amount of switching in both conditions in the last five blocks. This suggests that differences in hedging may be best captured in the initial responses, whereas responses occurring in the latter half of the blocks may indicate learning effects or executive functioning-related adjustment to the task.

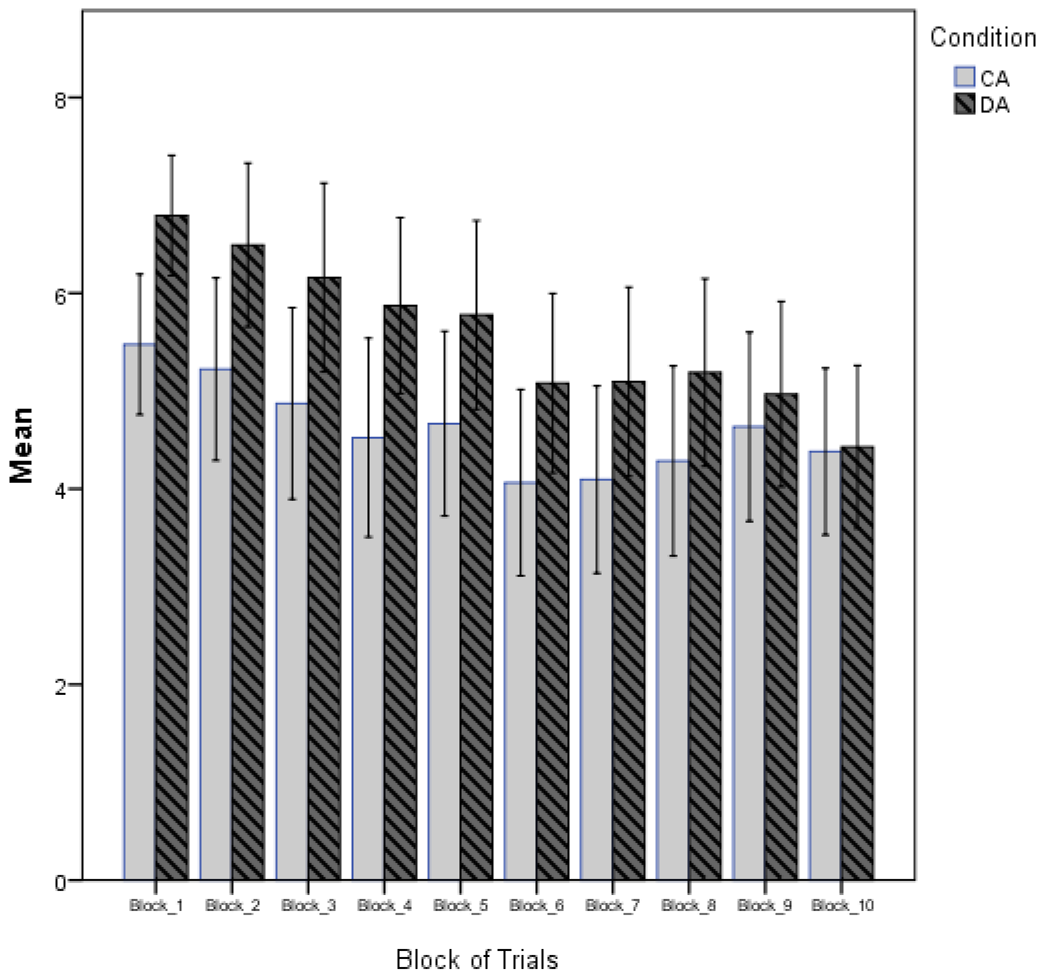


Figure B1. Switching average in blocks of 10 taps of the whole sample.

The histogram illustrated in Figure B2 of total switches in the CA illustrates a U-shape pattern of switching, while the histogram of the DA condition shows a flatter distribution with a preponderance of people switching at the highest levels. In fact, an increase of more than double the number of individuals is observed at the highest level of possible switches (i.e., 95^{th} – 99^{th} switches) in the DA condition. Bimodal distributions for CA and DA conditions failed the Kolmogorov-Smirnof assumptions of normality, $D(63) = .12$, $p < .05$ and $D(63) = .17$, $p < .001$ respectively. The data suggest that two types of hedgers may be present in the population (high and low hedgers).

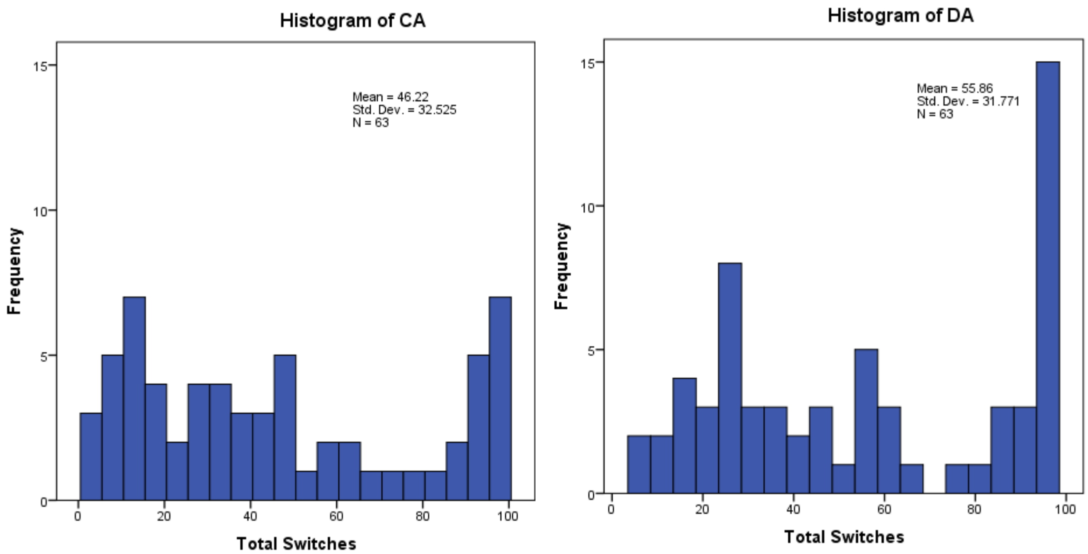


Figure B2. Bi-modal distributions are apparent in both Constant Availability (CA) and Decreasing Availability (DA) conditions.

Appendix C

Block by Block Analyses of Clinical and Healthy Control groups

Based on prior analyses in Studies One and Two, and the observed link between initial behaviours and automatic and affective reactions (Slovic et al., 2004), switching was examined in the first block and subsequent individual blocks to provide more insight into hedging over time. A repeated measures ANOVA (2 Doors x 10 Block x 3 Group) did not indicate significant interactions between the variables; however, main effects were observed for Doors ($F(1, 82) = 26.09$, $p < .001$) and Blocks ($F(9, 738) = 18.20$, $p < .001$). Regarding the main effect of blocks, except for Block 2, pairwise comparisons yielded significantly more switching in Block 1 relative to all of the blocks (all *p*-values were less than .001), supporting the rationale to examine switching of the first Block.

Visual inspection of trends across blocks in the CA condition (see Figure C1) shows that the clinical groups gradually decreased switching similarly to controls. However, the rate of decrease of switching in the first three blocks appears steeper in the clinical groups relative to the controls but all groups tend to stabilize their switching thereafter. In the DA condition, less hedging in the OCD group appears in the first block, while the GD and HC group switched similarly.

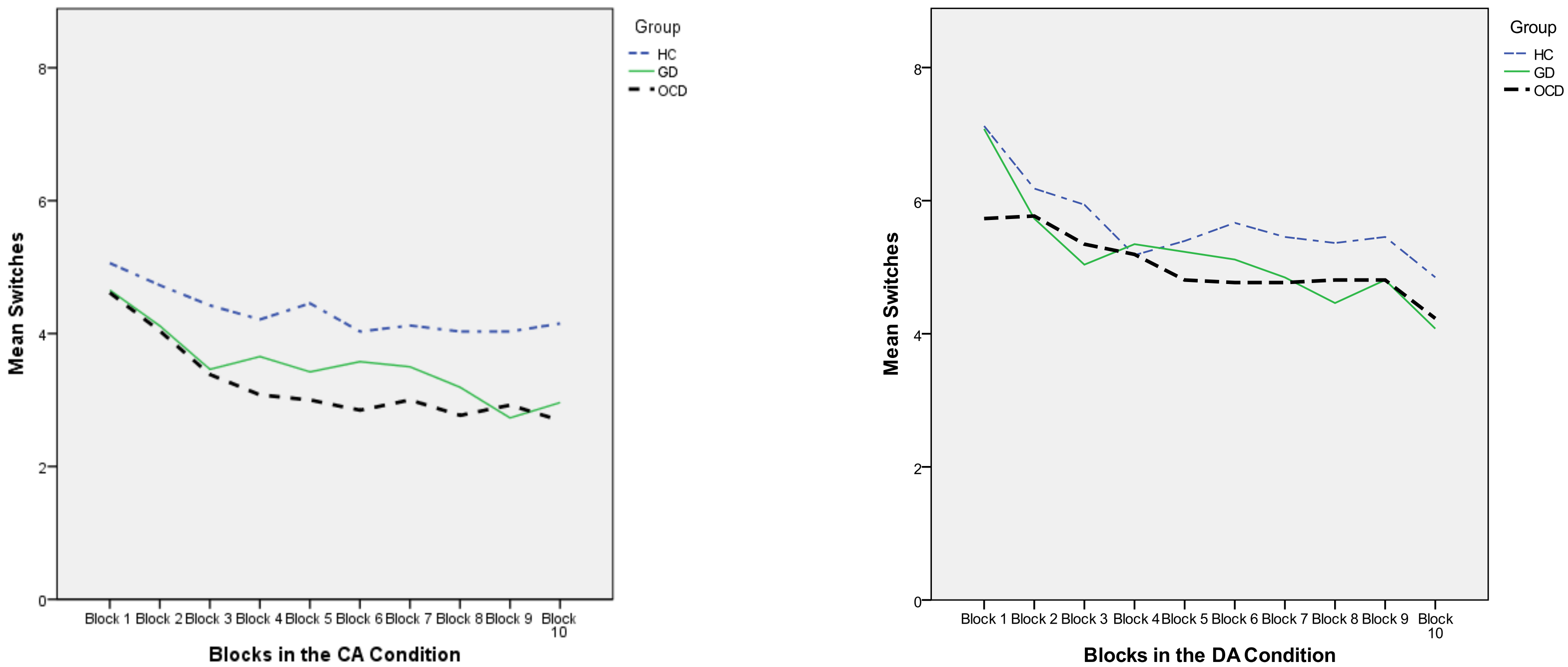


Figure C1. Block by block switching of groups in the Constant Availability (CA) and Decreasing Availability (DA) conditions.

Appendix D

Order of Presentation Effects

In Studies One and Two, order of presentation was shown to affect hedging behaviour, suggesting that higher hedging tendency occurs when participants least expect the doors to disappear (i.e., when the DA condition is presented first). Thus, examination of the first block was conducted with a mixed ANOVA (2 Doors x 2 Order x 3 Group) that resulted in a significant interaction between Doors and Order ($F(1, 79) = 3.94$, $p = .05$), and a main effect for Doors ($F(1, 79) = 34.80$, $p < .001$). Means are listed in Table D1. Figure D1 displays the interaction effect.

Table D1

Mean Switches When Order of Presentation was Varied

	GD	OCD	HC
	M (SD)	*M* (SD)	*M* (SD)
CA was presented first	n = 13	n = 14	n = 14
CA condition	4.85 (2.19)	4.86 (2.25)	5.07 (2.02)
DA condition	6.69 (2.39)	4.79 (3.22)	7.07 (5.67)
DA was presented first			
DA condition	7.46 (2.37)	6.83 (2.69)	7.16 (1.98)
CA condition	4.46 (3.33)	4.33 (3.63)	5.05 (2.92)

Note. CA – Constant Availability; DA – Decreasing Availability; GD – Gambling Disorder; HC – Healthy Controls; OCD – Obsessive-Compulsive Disorder

Additional exploratory post-hoc analyses of switching with each condition that was presented first were conducted. When the CA condition was presented first, a mixed ANOVA (3 Groups x 2 Doors) yielded a significant main effect for Doors ($F(1, 38) = 7.98$, $p = .007$), a trend appearing in the interaction between Doors and Groups ($F(2, 38) = 2.27$, $p = .12$), and no significant difference in hedging between groups ($F(2, 38) = 1.42$, $p = .26$). Planned contrasts revealed that a marginally significant difference is observed between the OCD and the HC group, $p = .09$. A follow-up mixed ANOVA between the OCD and HC group yielded a marginally significant interaction between Doors and Group, $F(1, 26) = 3.77$, $p = .06$. The trend suggests that individuals in the OCD group switched consistently less across both door conditions than the HC group in Block 1.

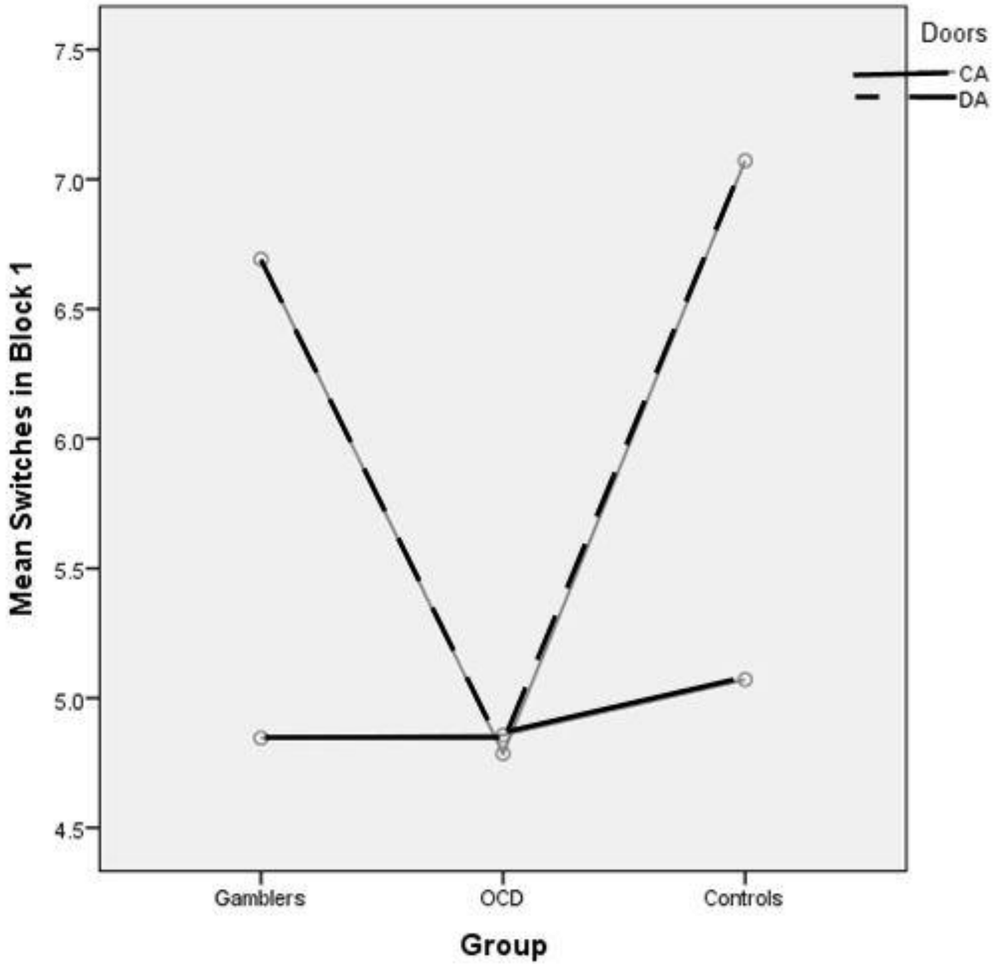


Figure D1. Mean switches of groups in the first block when the Constant Availability (CA) condition was presented first, followed by the Decreasing Availability (DA) condition.

When the DA condition was presented first, as depicted in the bar graphs of Figure D2, little variability was observed across conditions and groups in the DA condition. When the threat of loss of options was presented first, all groups similarly switched more than they did in the second CA condition. These results indicate that loss aversion affects all groups comparably and was fairly consistent across blocks when the threat of loss was first encountered.

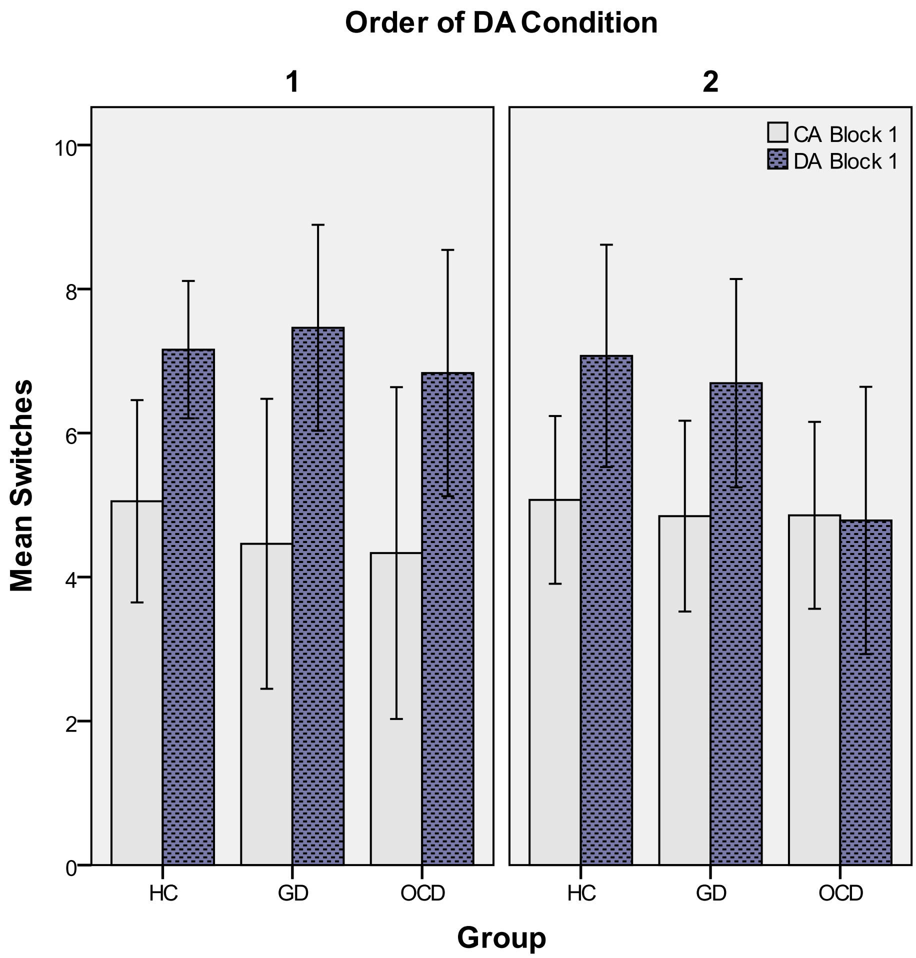


Figure D2. Group switching when order of presentation of considered. When Decreasing Availability (DA) was first presented, all groups switched similarly.

Appendix E

List of Abbreviations

ASI	Anxiety sensitivity index
BART	Balloon analogue risk task
BIS	Barratt's impulsivity scale
BIS BAS	Behavioural inhibition scale behavioural activation scale
BDI	Beck depression inventory
CA	Constant availability
DA	Decreasing availability
fMRI	Functional magnetic resonance imaging
GD	Gambling disorder
HC	Healthy Controls
IGT	Iowa gambling task
NFC	Need for cognitive closure
OCD	Obsessive-compulsive disorder
OCI	Obsessive compulsive inventory
OFC	Orbital frontal cortex
SSS	Sensation seeking scale
SUD	Substance use disorder
STICSA	State trait inventory of cognitive symptoms of anxiety
VMPFC	Ventromedial prefrontal cortex

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