A CROSS-SECTIONAL COMPARISON OF DELAY DISCOUNTING IN SMOKERS AND NON-SMOKERS WITH SCHIZOPHRENIA AND RESPECTIVE CONTROLS

By

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Abstract

Background: Schizophrenia is associated with deficits in decision-making. Aim: To determine the effects of smoking status on delay discounting in schizophrenia in comparison to non-psychiatric controls. Method: Cross-sectional comparison of delay discounting across smoking and psychiatric status. Hypotheses: Individuals with schizophrenia were hypothesized to have higher rates of delay discounting than controls; Non-smokers with schizophrenia would have higher rates of delay discounting than smokers. Control smokers would discount future rewards more than non-smokers. Results: No significant differences in delay discounting were observed between psychiatric groups. Smokers with schizophrenia exhibited more delay discounting than non-smokers. Within the psychiatric group, former smokers discount rates were similar to current smokers. Conclusion: Delay discounting deficits in schizophrenia and modulation by cigarette smoking were not supported; our pattern of results in schizophrenia does suggest that deficits in delay discounting in these patients appears to be a trait rather than a state-dependent phenomenon.
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CHAPTER 1
INTRODUCTION

1.1 Statement of Problem

We are continually faced with the need to make a multitude of decisions. These decisions range in magnitude from buying or renting a home, or simply which foods to consume. The temporal distance of an outcome is associated with the likelihood that it will be preferred. It has been demonstrated that the more a reward is delayed, the less subjective worth it holds (Heerey, Robinson, McMahon, & Gold, 2007; Holt, Green, & Myerson, 2003). The term that has been coined to describe this phenomenon is *Delay Discounting*; a reduction in the subjective worth of a commodity as a function of the amount of and delay to that commodity, or reward (Johnson & Bickel, 2003). Schizophrenia is a psychiatric disorder, which is associated with difficulty in the realm of decision-making (Heerey, et al., 2007; Kester, et al., 2006); a core feature of the illness. Once such example of this impairment is evidenced through their extremely high rates of cigarette smoking (58-88%) when compared to the Canadian general population (~18%) (Le Foll & George, 2007).

1.2 Purpose of the Study

The purpose of the current study was to examine delay discounting across four groups, namely individuals with schizophrenia with and without co-morbid addiction, and their respective non-schizophrenic controls. This would allow us to replicate previous findings that those with schizophrenia (Heerey, et al., 2007; Kester, et al., 2006) and cigarette smokers (Bickel, Odum, & Madden, 1999; Krishnan-Sarin, et al., 2006) delay discount more steeply than comparison controls. The primary aim of this study was to determine the effects of smoking status on delay discounting in patients with schizophrenia in comparisons to non-psychiatric controls. The secondary aim was to determine the relationship between delay discounting and performance on the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994).
and Wisconsin Card Sorting Task (WCST; Heaton, Chelune, Talley, & al., 1993) in individuals with schizophrenia and controls as a function of smoking status. An exploratory element of this study investigated whether impulsivity, as measured through delay discounting, is a state or trait. This would be achieved by analyzing whether former smokers are more similar to never or current smokers.
CHAPTER TWO
LITERATURE REVIEW

2.1 Delay Discounting

Cost, in the form of money, time, or effort, is an essential factor of behavioural economics. Delay discounting focuses on the time component, specifically, it examines how temporally distanced events are discounted (Bickel, Marsch, & Carroll, 2000; Bickel, et al., 2007). The discount rate establishes the steepness of the reduction in the current worth with increase in delay (Petry, Kirby, & Kranzler, 2002). An example of delay discounting includes the extent to which an individual would prefer $500 now (impulsivity), as opposed to waiting six months for $1000 (self-control), with both the length of the delay and magnitude of the reward influencing our choice.

The extent that delayed rewards are discounted has been investigated in animals employing adjusting-delay (Mazur, 1988) and adjusting-amount procedures (Richards, Mitchell, de Wit, & Seiden, 1997). In these trials participants are initially exposed to the forced-choice trials, which involve both small immediate rewards and large delayed rewards. Then the free-choice trials begin where participants are permitted to make a choice between two reward options. If the smaller and more immediate reward is constantly preferred, the larger delayed reward is made more appealing by lessoning the delay or increasing the magnitude, before the series is repeated. The choice-dependent adjusting procedure is continued until participants reach the point of indifference between the small immediate and large delayed rewards, at which time the magnitude of delay discounting can be calculated (Lagorio & Madden, 2005).

An example of this procedure involves a thirsty rat provided with the choice between 100ml of water presented after a brief delay or a smaller amount offered immediately. If that rat picks the delayed reward, the amount of water made available on the next trial is increased by 10%; however, if the smaller immediate reward is chosen, the water reward is decreased by 10%
at the next trial. This procedure is repeated with the amount of water being adjusted until the rat chooses both reward options equally, and the indifference point is reached. The amount of immediate water consumed at the indifference point is used as the measure of the value of the standard, and a series of standards can produce this discounting curve (Richards, et al., 1997).

The extent of discounting can be calculated in humans by using a similar choice procedure in which the reward is also methodically adjusted until the preference for both rewards is equivalent. A discounting curve can be created if this process is repeated at a variety of different time points (e.g., 1 week, 1 month, 1 year; Bickel, et al., 2007; Madden, Petry, Badger, & Bickel, 1997). Behavioural economists have studied delay discounting by measuring the shape and location of these indifference curves (Kagel, Battalio, & Green, 1995; Madden, et al., 1997).

Studies investigating temporal discounting of delayed rewards have demonstrated that subjective value does not decrease in a linear fashion with delay duration. Rather, a hyperbolic association between subjective value and delay has consistently been observed in research involving humans (Madden, et al., 1997). Hyperbolic discounting is a reduction in the value of the delayed reward relative to the delay (Ainslie & Haslam, 1992; Bickel, et al., 2007). This discount rate is quantified by a hyperbolic discounting equation (Mazur, 1987):

$$V_d = \frac{V}{1 + kd}$$

In this equation, the $V_d$ represents the discounted value of an outcome, $V$ the undiscounted value or amount; $k$ is a constant relative to the degree of temporal discounting and $d$ the delay to the reward. The free parameter, $k$, offers a measure of the preference for the smaller reward to the larger delayed reward. The rational theory of addiction (Becker & Murphy, 1988) assumes that delayed rewards are discounted exponentially. This implies that for every unit of time that represents the delay to the reward, the value of that reward decreases, or is discounted by a fixed proportion (Bickel & Marsch, 2001; Kirby, Petry, & Bickel, 1999). In
actual fact, hyperbolic discounting has consistently been observed in which for each unit of time, the reward’s current value decreases by a progressively smaller proportion (see Figure 1) (Bickel & Marsch, 2001; Kirby, et al., 1999). This equation characterizes these findings as a hyperbolic relationship between the subjective value of a reward and time until it occurs (Bickel, et al., 2007).

![Figure 1](image)

**Fig 1.** An example of a hyperbolic curve created in delay discounting experiments. The y-axis represents the indifference point or the value of the smaller reinforcer at which both reinforcers were chosen equally.

Researchers have questioned the validity of using hypothetical rewards to measure delay discounting (Bickel & Marsch, 2001; Critchfield & Kollins, 2001; Navarick, 2004). Navarick (2004) has suggested that distinctive discounting processes are used for hypothetical rewards and for real rewards that may be immediately consumed, as demonstrated by significant differences in discounting rate across the two options. Kirby (1997) examined the degree of discounting in real versus hypothetical rewards in a survey of the literature. Kirby found that real rewards were often discounted less than hypothetical rewards, but emphasized that the size of the reward was quite influential. Studies that used real rewards tended to use smaller rewards, which may explain the difference noted by Navarick (Kirby, 1997; Lagorio & Madden, 2005). Real versus hypothetical rewards were also examined by Johnson and Bickel (2002) who were careful to
avoid reward type and magnitude confounds. This was achieved by adjusting the amounts procedure within reward type (real or hypothetical), which were manipulated within-participants. No consistent effects of reward type were found, suggesting that hypothetical rewards may often serve as a valid proxy for real rewards in delay discounting research, consistent with majority of research which has failed to find a significant difference between reward type (Baker, Johnson, & Bickel, 2003; Madden, Begotka, Raiff, & Kastern, 2003). Hypothetical rewards, as a measure of delay discounting, is acceptable as demonstrated by previous research failing to find differences in comparison to real rewards. As a result of these findings, hypothetical rewards were examined in the current study.

2.2 Delay Discounting and Schizophrenia

Psychiatric populations have been linked to decision-making impairments (Dunn, Dalgleish, & Lawrence, 2006; Jollant, et al., 2007). Specifically, these impairments have been found in those with obsessive-compulsive disorder (Cavedini, et al., 2002; Lawrence, et al., 2006); anorexia nervosa (Cavedini, et al., 2004); specific mood disorders (Murphy, et al., 2001; Must, et al., 2006); schizophrenia (Heerey, et al., 2007; Kester, et al., 2006); as well as borderline (Bazanis, et al., 2002), antisocial (D. Mitchell, Colledge, Leonard, & Blair, 2002), and impulsive-aggressive (Best, Williams, & Coccaro, 2002) personality disorders. The current study focused on delay discounting in individuals diagnosed with schizophrenia.

The orbital frontal cortex (OFC) (see Figure 2) is a region of the association cortex of the human brain involved in cognitive processes such as decision-making (Rolls, 2000). In healthy adults, damage to the OFC has been linked to decision-making deficits (Salmond, Menon, Chatfield, Pickard, & Sahakian, 2005; Tranel, Bechara, & Denburg, 2002). Structural abnormalities in the OFC have also been observed in the brains of individuals with schizophrenia (Goldstein, et al., 1999; Meador-Woodruff & Watson, 1997), which may explain their disadvantageous decision-making patterns. Compromised white-matter (WM) integrity in
inferior frontal WM has also been associated with social dysfunction and impulsivity in people with schizophrenia (Wolkin, et al., 2003). The Iowa Gambling Task (IGT) (Bechara, et al., 1994) is sensitive to OFC function as it employs decision-making processes including events that have emotionally significant consequences, such as gains and losses (Hongwanishkul, Happaney, Lee, & Zelazo, 2005; Kester, et al., 2006). As a consequence of these structural abnormalities, individuals with schizophrenia do not perform well on tasks specific to OFC function (Moberg, et al., 1999), such as the IGT (Shurman, Horan, & Nuechterlein, 2005).

Memory has been suggested to play a significant role in delay discounting as well. Hinson and colleagues (2003) revealed that when the memory load was increased during delay-discounting tasks, delayed rewards were discounted more steeply. Also, functional imaging results have shown more activity in dorsolateral prefrontal cortex (DLPFC) than ventromedial regions when a delayed reward is chosen and parts of the limbic system associated with the midbrain dopamine system, including paralimbic cortex, are activated when an immediate reward is chosen (McClure, Laibson, Loewenstein, & Cohen, 2004). These findings suggest that
individual differences in the extent of delay discounting may be accounted for by the relative contributions of separate neural and cognitive systems in decision making (Heerey, et al., 2007). Individuals with schizophrenia may discount future rewards more than matched healthy controls as a result of their compromised memory (Lee & Park, 2005), DLPFC function impairments (Cannon, et al., 2005), and abnormal dopamine function (Kapur & Remington, 2001; Knable & Weinberger, 1997).

Heerey and colleagues (2007) investigated delay discounting in schizophrenia by comparing stable outpatients with schizophrenia (n = 42) to healthy controls (n = 29). Delay discounting was assessed using the computerized version of the Kirby Delay Discounting Task (KDDT; Kirby et al., 1999). The hypothesis that individuals with schizophrenia would discount more than healthy controls was confirmed. Also, those psychiatric participants with better memory function and higher levels of negative symptoms were found to discount future rewards less severely. These findings suggest that individuals with schizophrenia may be predisposed to choose immediate rewards while discounting delayed rewards.

2.3 Delay Discounting and Addiction

The discounting model of impulsiveness (Ainslie, 1975) suggests that delay-discounting rates are positively correlated with impulsiveness, which validates using delay discounting as a measure of impulsivity, a common feature among substance abusers (Kirby, et al., 1999). Present-focused behaviour would be represented in this previously mentioned discounting equation by a larger $k$ value (Bickel, et al., 2007). As a result, a smaller $k$ value would represent less impulsivity and more future-directed planning. Impulsivity, acting momentarily, is a factor that largely influences the risk for addiction. It involves a reduced capability to inhibit unsuitable behaviours, the propensity to act without planning ahead and without considering the behavioural consequences of one’s actions (Kreek, Nielsen, Butelman, & LaForge, 2005; Krishnan-Sarin, et al., 2007). These impulsive choices may prevail in chronic substance abusers,
as they often choose immediate and brief drug intoxication over tangible and social rewards.

Also, those who abuse substances often experience delayed aversive consequences, including high prevalence of illnesses, loss of employment, and more frequent interpersonal problems with friends and family (Madden, et al., 1997). Intravenous drug users may decide to share hypodermic needles rather than spending the time to disinfect or obtain new needles (Bickel & Marsch, 2001; Normand, Vlahov, & Moses, 1995).

Drugs with addictive properties have been suggested to compel maladaptive decision-making through pharmacological interactions with neurophysiological mechanisms developed for regular learning systems (Berke, 2003; Everitt, Dickinson, & Robbins, 2001; Redish, Jensen, & Johnson, 2008). It is the interaction between the normal learning systems and the reward distribution of specific behaviours that lead to these addictive patterns (Dowling, Smith, & Thomas, 2005; Redish, et al., 2008; Redish, Jensen, Johnson, & Kurth-Nelson, 2007). Substance abusing populations have been found to discount future rewards more than controls. This has been demonstrated by increased temporal discounting rates observed in opioid-dependents (Kirby, et al., 1999; Madden, et al., 1997), cocaine-dependents (Coffey, Gudleski, Saladin, & Brady, 2003), alcoholics (Petry, 2001a), problem and pathological gamblers (Alessi & Petry, 2003; Petry, 2001b), and cigarette smokers (Baker, et al., 2003; Bickel, et al., 1999; S. Mitchell, 1999). These findings suggest that this behavioural process may be a prerequisite for addiction (Bickel, et al., 2007). The present study investigated delay discounting among cigarette smokers with and without schizophrenia.

Madden and colleagues (1997) were the first to explore delay discounting in substance-abusing populations. Their study involved both opioid-dependent and control participants. All involved had a choice between hypothetical monetary rewards, either instantly available or after a delay. Delayed rewards were in the amount of $1000, whereas the immediate reward was adjusted until choices reflected indifference. This step was repeated at 7 different delay periods,
ranging from 1 week to 25 years. Those in the opioid-dependent group were given another series of choices between immediate and delayed heroin. Opioid-dependent individuals discounted delayed monetary rewards significantly more than controls, and discounted delayed heroin significantly more than delayed money. The subjective values of the delayed rewards were discounted more at shorter delays, which left a modest amount of room to further discount at larger delays. In a follow-up study (Kirby et al., 1999), these differences were observed when real rewards were available to participants, rather than hypothetical rewards.

The question has been raised of whether delay discounting is a state or trait dependent phenomenon. There are disparaging findings within the literature regarding discounting status with respect to those with current and former addiction, as well as those who never suffered from an addiction. Previous research on non-psychiatric participants has demonstrated that never and former smokers discounted similarly, with current smokers discounting the most (Bickel, et al., 1999). An investigation among alcoholics revealed they had the highest discounting rates, followed by abstinent alcoholics, and then controls (Petry, 2001a). An unpublished thesis found similar results in psychiatric cocaine users, where current users discounted significantly more than formers users, followed by non-users (Marcello, 2007). Further investigation into whether delay discounting is a state or trait phenomena would facilitate deeper understanding of its stability overtime and post recovery from an addiction.

2.4 Schizophrenia and Cigarette Smoking

People with schizophrenia have smoking rates three times those of the general population (George, et al., 2008; Kalman, Morissette, & George, 2005; Weinberger, Reutenauer, et al., 2007). Research suggests that cigarette smoking can ameliorate clinical and neurocognitive deficits associated with this illness (Dolan, et al., 2004; George, et al., 2008; George, Vessicchio, Termine, Bregartner, et al., 2002; Smith, Singh, Infante, Khandat, & Kloos, 2002). This is achieved though nicotine which may decrease or normalize attentional and haloperidol-induced
working memory deficits (Dolan, et al., 2004; Freedman, et al., 1997; Levin, Wilson, Rose, & McEvoy, 1996). Visuospatial Working Memory (VSWM) is partially mediated by DA function in the PFC, which is known to be dysregulated in schizophrenia. Smoking abstinence has been found to worsen VSWM deficits in smokers with schizophrenia, but not in control smokers (George, Vessicchio, Termine, Bregartner, et al., 2002). This may provide a partial explanation for the higher prevalence of tobacco smoking among these patients compared to the general population.

2.5 Current Study

The current study was a cross-sectional design that defined comparison groups on the basis of current smoking and psychiatric status. These four conditions include the following groups: smokers with schizophrenia (SS), non-smokers with schizophrenia (SNS), healthy control smokers (CS) and healthy control non-smokers (CNS). To our knowledge, no cross-sectional studies examining delay discounting among these comparison groups have previously been conducted.

2.6 Hypotheses

To summarize, our primary goal of this study was to determine the effects of smoking status on delay discounting in patients with schizophrenia in comparisons to non-psychiatric controls. As a consequence of brain abnormalities among individuals with schizophrenia, and consistent with previous research (Heerey, et al., 2007; Kester, et al., 2006), it was hypothesized that:

1. Individuals with schizophrenia would discount rewards to a greater extent than control comparison groups.

2. Among the non-schizophrenic group, those with a smoking addiction were hypothesized to discount future rewards more than those without an addiction, which is also inline with previous findings (Bickel, et al., 1999; Madden, et al., 2003).
3. The opposite prediction was made for the group with schizophrenia, as those with a co-morbid smoking addiction were hypothesized to delay discount less than non-smokers, as a result of the neurocognitive benefits of nicotine in this population (Dolan, et al., 2004; George, et al., 2008; George, et al., 2002; Smith, Singh, Infante, Khandat, & Kloos, 2002).

The secondary aim of this study was to determine the relationship between delay discounting and performance on tasks of executive function, IGT and the WCST, in individuals with schizophrenia and controls as a function of smoking status. We hypothesized that:

3. Delay discounting would be positively correlated with performance on the IGT and WCST in those with schizophrenia, and negatively correlated with performance in controls.

2.7 Significance

This research is of significant value as it is the first cross-sectional comparison of delay discounting in dually diagnosed smokers and non-smokers with schizophrenia and their respective non-schizophrenic controls. This research facilitates a deeper understanding of the modulating role that nicotine plays in decision making for individuals with schizophrenia who are already vulnerable to decision-making impairments. This study generates clinical suggestions for understanding why psychiatric patients struggle with smoking cessation and how interventions can focus on developing enhanced behavioural inhibitory processes, target impulsive decision making in therapy, and use medications which decrease impulsive behaviours (Krishnan-Sarin, et al., 2007).
CHAPTER THREE

METHODS

3.1 Participants

Ninety-one individuals between the ages of 18 and 55 were recruited over a 6-month period. Six outliers were not included in the analyses, as their responding on the delay-discounting task was inconsistent (see Appendix A). Excluding these outliers, our final sample ($N=85$) included $n=47$ psychiatric participants (SS & SNS) and $n=38$ non-psychiatric controls (CNS & CS). Recruitment procedures of non-psychiatric participants, involving newspaper advertisements and Internet postings, were aimed at community members within the Greater Toronto Area. Stable outpatients at the Centre for Addiction and Mental Health (CAMH) were recruited through mean of flyers, word-of-mouth, and referrals. Psychiatric participants met diagnostic criteria for either schizophrenia or schizoaffective disorder based on the Fourth Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) (American Psychiatric Association, 2000) and were capable of providing consent. These subjects were all psychiatrically stable at the time of interview with a score < 70 on the Positive and Negative Syndrome Scale for Schizophrenia (PANSS; (Kay, Fiszbein, & Opler, 1987), and if on medication, been on a stable dose of medication for at least one month prior to the study assessments. Control participants did not meet criteria for any current Axis I disorders assessed by the Structural Clinical Interview for DSM-IV-TR (SCID; First, Spitzer, Robert, Gibbon, & Williams, 1996).

Medtox urine toxicology screens were used to screen for illicit drugs (Cannabinoids, Opiates, Amphetamine, Phencyclidine, Barbiturates, Benzodiazepines). Participants in both groups were excluded if they have abused or were dependent on alcohol or illicit drugs in the past six months prior to study enrollment.

Smoking status was assessed via self-report (cigarettes smoked per day) and
biochemically verified with expired breath carbon monoxide levels $\geq 10$ parts per million (ppm). Level of nicotine dependence was measured with the Fagerstrom Test of Nicotine Dependence (FNTD) (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). Eligible smokers reported smoking $\geq 10$ cigarettes per day on average, with expired CO levels $\geq 10$ ppm, and FTND scores $\geq 4$. Non-smokers were included with CO levels $< 10$ ppm and were either abstinent from cigarettes for $\geq 6$ months (former smokers) or never smoked in their lifetime, and were not currently using any nicotine replacement products.

3.2 Measures

3.2.1 Estimates of pre-morbid intelligence and clinical stability

All participants were administered the National Adult Reading Test (Nelson & Willison, 1991) in order to obtain an estimate of premorbid intelligence. Also, the Positive and Negative Syndrome Scale for Schizophrenia (Kay, et al., 1987) interview was administered to the psychiatric participants during the screening interview in order to confirm clinical stability. Participants were deemed clinically stable if their score on the PANSS was less than 70.

*National Adult Reading Test (Nelson & Willison, 1991)*. The NART is a list of 50 words presented in order of escalating reading difficulty. The words are unusual with respect to the common rules of pronunciation, which reduces the likelihood of the subject reading by phonemic decoding rather than by word recognition. The NART is one of the most commonly used tests of word-reading ability. This measure is extensively used in schizophrenia research and is presented as both a method of estimating premorbid IQ and a quick way of assessing current IQ (Russell, et al., 2000).

*Positive and Negative Syndrome Scale for Schizophrenia (Kay, et al., 1987)*. The PANSS is a widely used medical scale that measures symptoms severity of patients with schizophrenia. This 30-item rating instrument evaluates the presence or absence and severity of positive, negative and general psychopathology of schizophrenia. All items are rated on a 7-point scale
(1=absent; 7=extreme). The PANSS has good inter-rater reliability (Kay, Opler, & Lindenmayer, 1988), adequate construct validity (Kay, et al., 1987; Kay, et al., 1988), and high internal reliability (Kay, et al., 1987). Internal reliability of the PANSS for the positive, negative, and general psychopathology scales have Cronbach’s alpha of .80, .82, and .82, respectively.

3.2.2. Smoking Dependence

*Fagerstrom Test of Nicotine Dependence (Heatherton, et al., 1991)*  The FTND is a brief, 6-item scale that yields a score between 0 and 10, assessing smokers’ level of nicotine dependence. Individuals respond to multiple-choice type questions, with each answer corresponding to a score and higher scores indicating higher levels of dependence. Examples of items include “How many cigarettes do you smoke per day?” and “Do you smoke if you are so ill that you are in bed most of the day?” The FTND is one of the most commonly used measures to assess nicotine dependence, and has acceptable reliability for use among smokers with and without schizophrenia (Weinberger, Reutenauer, et al., 2007). Weinberger et al. (2007) report the internal consistency of the FTND to be equal to Cronbach’s alpha of .74 and test-retest reliability equal to .65 in the psychiatric smokers. These researchers report similar findings in control smokers, with Cronbach’s alpha of .72 and test-retest reliability of .82.

3.2.3. Decision-making measures

*The Kirby Delay Discounting Task (KDDT; Kirby, et al., 1999)*  The KDDT is a 27-item questionnaire that assesses discounting of hypothetical monetary amounts across three different delayed-reward magnitudes: small ($25 - $35), medium ($50 - $60), and large ($75 - $85). Examples of items include “Would you prefer $100 today, or $101 in 300 days?” and “Would you prefer $20 today, or $55 in 7 days?” K-values are calculated and are based on the extent to which the respondents choose smaller immediate rewards rather than larger delayed rewards. The KDDT has decent internal consistency among discount rates for the three different reward magnitudes, and adequate test-retest reliability ($r = .71$) (Kirby, 2009).
3.2.4. Executive Function

**Iowa Gambling Task - Computerized** (IGT; Bechara, et al., 1994). The IGT is a widely used measure that is highly sensitive to measuring impaired decision-making in a variety of neurological and psychiatric conditions, including schizophrenia (Bechara, et al., 1994). All participants sat facing a computer screen which displayed four decks of cards (A, B, C, and D) and were told to pick a card from the decks one at a time. They were informed they would receive a monetary reward or penalty for every card they choose, and that the goal of the game is to maximize profits on a $2000 loan they will receive before they begin the task. The subjects were permitted to pick from any deck and to switch decks at any time. Subjects were allowed to take as much time as they needed to complete this task.

The four decks in the IGT vary in the amount and ratio of reward to penalty that each provides. Decks A and B initially offer large monetary rewards, but are disadvantageous because some selections from these decks are accompanied by large monetary penalties. Decks C and D offer smaller monetary rewards, but also involve smaller penalties. Previous research has suggested that individuals with schizophrenia are significantly impaired on IGT in comparison to healthy controls, as they earn significantly lower scores and make more disadvantageous picks (Beninger, et al., 2003; Kester, et al., 2006), resulting in less hypothetical monetary winnings by the end of the task.

**Wisconsin Card Sorting Task** (WCST; Heaton, Chelune, Talley, & al., 1993). The WCST is an extensively used measure that assesses executive functions, including planning and set-shifting. Outcome measures include number of categories completed, percent total errors, percent perseverative errors, percent non-perseverative errors, and number of trials to complete first category. Performance on this task has been linked with activation of the dorsolateral prefrontal cortex (Egan, et al., 2001). Reliability of the WCST, interscorer and intrascorer agreements have
been found to be excellent. Since this task assesses decision-making ability, poor performance on this task should be consistent with high levels of delay discounting.

3.3 Procedure

At the screening visit, the consent forms were reviewed and signed, and eligibility was determined using the SCID-IV, Medtox™ urine toxicology screen, Expired Breath Carbon Monoxide (CO) monitoring, and the PANSS for the psychiatric participants. These assessments were conducted by specially trained Bachelor’s- and Master’s-level psychology students. Participants whom met eligibility criteria were invited back for a cognitive-testing session. This cognitive session involved the KDDT, the IGT, and then the WCST. During both visits, participants were permitted breaks as often as they required. Smokers were asked to notify the research staff of how many cigarettes they smoked on their break. After the sessions were completed, participants were compensated for their time at a rate of $10 per hour. Completion time was approximately three hours for the screening visit and an additional two hours for the cognitive session, totaling five hours. Those who completed this study received a total of $50. This protocol was reviewed and approved by the Centre for Addiction and Mental Health Research Ethics Board (CAMH-REB).
CHAPTER 4

RESULTS

4.1 Demographic Characteristics of Study Sample

As noted, once outliers were excluded (see Appendix A), the study population consisted of 85 subjects, including 47 psychiatric participants (SS; $n = 25$ & SNS; $n = 22$) and 38 non-psychiatric control comparisons (CS; $n = 17$ & CNS; $n = 21$). The study adopted the conventional 0.05 alpha level as evidence of statistical significance. The demographic and clinical characteristics of the four groups are presented in Table 1. A one-way analysis of variance (ANOVA) was utilized in order to compare continuous demographic and clinical variables and Chi Square analyses for categorical variables across the four groups. There were no significant differences between the four diagnostic groups (SS, SNS, CS, or CNS) in terms of race ($ns$); however, there was for gender, $X^2 (3) = 1.88, p < .001$. There was also a significant difference in level of education completed, $F (3, 81) = 26.7 (p < .001)$, and full scale IQ $F, (3, 80) = 11.7 (p < .001)$ across groups (CNS > CS > SNS > SS). Furthermore, a significant age difference across the four groups was observed, $F (3, 81) = 3.4 (p < .05)$. Independent-samples $t$-tests revealed that both psychiatric and non-psychiatric smokers had comparable levels of nicotine dependence as measured on the FTND, and similar numbers of cigarettes smoked per day ($ns$). Smoking behaviors defined by CO levels were significantly higher in the psychiatric smoker group as compared to the non-psychiatric control smokers, $t (40) = -2.06, p = .046$, consistent with previous research (Weinberger, Sacco, et al., 2007).
Table 1.

Clinical and demographic means and standard deviations of the sample

<table>
<thead>
<tr>
<th></th>
<th>Schizophrenia</th>
<th>Controls</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smoker (n = 25)</td>
<td>Non-Smoker (n = 22)</td>
<td>Smoker (n = 17)</td>
</tr>
<tr>
<td>Age M (SD)</td>
<td>39.6 (9.2)</td>
<td>34.6 (9.9)</td>
<td>38.3 (8.0)</td>
</tr>
<tr>
<td>Sex (% male)</td>
<td>88% (22)</td>
<td>64% (14)</td>
<td>59% (10)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>18</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>African-American</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Asian</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Education</td>
<td>11.8 (1.7)</td>
<td>14.0 (1.9)</td>
<td>14.9 (1.6)</td>
</tr>
<tr>
<td>Estimated Full-Scale IQ</td>
<td>104.5 (7.7)</td>
<td>110.2 (7.6)</td>
<td>112.9 (4.9)</td>
</tr>
<tr>
<td># Cigs per day</td>
<td>20.5 (6.0)</td>
<td>-</td>
<td>18.4 (6.0)</td>
</tr>
<tr>
<td>Baseline Carbon Monoxide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level (ppm)</td>
<td>21.9 (10.9)</td>
<td>.73 (1.1)</td>
<td>15.9 (6.2)</td>
</tr>
<tr>
<td>FTND</td>
<td>6.3 (1.5)</td>
<td>-</td>
<td>5.7 (1.9)</td>
</tr>
<tr>
<td>PANSS Positive</td>
<td>13.5 (3.2)</td>
<td>15.5 (4.0)</td>
<td>-</td>
</tr>
<tr>
<td>PANSS Negative</td>
<td>13.2 (4.0)</td>
<td>11.2 (3.3)</td>
<td>-</td>
</tr>
<tr>
<td>PANSS General</td>
<td>24.5 (6.4)</td>
<td>25.3 (4.3)</td>
<td>-</td>
</tr>
<tr>
<td>PANSS Total</td>
<td>51.7 (10.0)</td>
<td>52.0 (7.9)</td>
<td>-</td>
</tr>
</tbody>
</table>
Medication

<table>
<thead>
<tr>
<th>Medication Name</th>
<th>Atypical</th>
<th>Typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clozapine</td>
<td>92% (23)</td>
<td>91% (20)</td>
</tr>
<tr>
<td>Risperdone</td>
<td>8% (2)</td>
<td>9% (2)</td>
</tr>
<tr>
<td>Loxapine</td>
<td>4% (1)</td>
<td>5% (1)</td>
</tr>
<tr>
<td>Quetiapine</td>
<td>4% (1)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>Olanzapine</td>
<td>20% (5)</td>
<td>18% (4)</td>
</tr>
<tr>
<td>Fluphenazine</td>
<td>0% (0)</td>
<td>5% (1)</td>
</tr>
</tbody>
</table>

\( p = .90 \)

Medication Name

<table>
<thead>
<tr>
<th>Medication Name</th>
<th>Clozapine</th>
<th>Risperdone</th>
<th>Loxapine</th>
<th>Quetiapine</th>
<th>Olanzapine</th>
<th>Fluphenazine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40% (10)</td>
<td>36% (8)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>28% (7)</td>
<td>23% (5)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>4% (1)</td>
<td>5% (1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>4% (1)</td>
<td>0% (0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>20% (5)</td>
<td>18% (4)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>0% (0)</td>
<td>5% (1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note. * \( p < .05 \), two-tailed. ** \( p < .01 \) two tailed.

4.2 Cognitive Testing

The means and standard deviations for the outcomes on the cognitive tasks are provided in Table 2. An independent-samples \( t \)-test was conducted in order to compare IGT performance in psychiatric patients and control comparisons. On average, psychiatric participants performed significantly worse on the IGT (net score) than did controls, \( t (82) = 3.6, p = .001 \). A similar pattern was observed in the WCST, with the psychiatric participants displaying poorer performance on the WCST, with more perseverative errors, \( t (83) = -4.3, p < .001 \) and fewer categories completed, \( t (83) = 4.0, p = .001 \).

Bivariate correlations were conducted in order to investigate the relationship between IGT net scores and delay discounting. When examined separately (controls versus patients), no
significant correlations were observed. However, when psychiatric status was collapsed across
groups, IGT net scores were negatively correlated with overall discounting rates, \( r (85) = -0.22, p < .05 \). Additional bivariate correlations were run to examine the relationship between the WCST
and delay discounting. Both perseverative responses and errors were positively associated with
delay discounting in controls, \( r (38) = .42 \), and patients, \( r (47) = .37, ps < .01 \).

A one-way ANOVA was employed to examine differences on IGT and WCST
performance across the four groups (SNS, SS, CNS, CS). A significant effect of group on IGT
net total scores was observed, \( F (3, 81) = 4.5, p = .006 \). Bonferonni post hoc tests revealed that
SS performed significantly worse than CS \( (p < .05) \). No other groups were significantly different.
As well, there was a significant group effect on the WCST perseverative responses, \( F (3, 81) = 9.1 \) and errors, \( F (3, 81) = 8.5, ps = .000 \), and categories completed \( F (3, 81) = 5.8, p = .001 \).
Bonferonni post hoc tests revealed that for perseverative responses and errors, SS had
significantly higher scores than CNS and CS \( (ps < .001) \). CNS and CS completed significantly
more categories than SS \( (ps < .05) \). SNS were not statistically different from the other groups,
and responded similarly to SS on all WCST categories.
Table 2.

**Means and Standard Deviations of Cognitive Tasks**

<table>
<thead>
<tr>
<th></th>
<th>Schizophrenia</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smoker (n = 25)</td>
<td>Non-Smoker (n = 22)</td>
</tr>
<tr>
<td>Small log k</td>
<td>-3.81 (1.4)</td>
<td>-4.57 (1.5)</td>
</tr>
<tr>
<td>Medium log k</td>
<td>-4.44 (1.7)</td>
<td>-4.99 (1.3)</td>
</tr>
<tr>
<td>Large log k</td>
<td>-5.20 (1.6)</td>
<td>-5.28 (1.1)</td>
</tr>
<tr>
<td>Geometric k</td>
<td>1.96 (1.9)</td>
<td>1.12 (1.0)</td>
</tr>
<tr>
<td>IGT Net</td>
<td>-4.40 (25)</td>
<td>-1.27 (22.3)</td>
</tr>
<tr>
<td>WCST – Categories Completed</td>
<td>3.12 (2.4)</td>
<td>3.63 (2.6)</td>
</tr>
<tr>
<td>WCST – Perseverative Responses</td>
<td>38.88 (27.4)</td>
<td>25.36 (23.0)</td>
</tr>
<tr>
<td>WCST – Perseverative Errors</td>
<td>32.16 (21.2)</td>
<td>22.05 (18.2)</td>
</tr>
</tbody>
</table>

*Note.* **p < .01 two tailed.

A two-way between-subjects ANOVA was conducted in order to evaluate the effect of psychiatric (schizophrenia, control) and smoking (smoker, non-smoker) status on delay discounting (see Figure 3). The covariate, years of education, was significantly related to delay discounting, $F(1, 80) = 4.0, p = .005$. There was a significant main effect of psychiatric status on overall delay discounting score after controlling for the effect of education, $F(1, 80) = 3.9, p = .05$, partial $\eta^2 = .05$, with controls discounting future rewards more than patients. No significant results were observed for the main effect of smoking status (ns).
An additional between-subjects ANOVA was employed in order to examine the effects of psychiatric status and smoking history (former, never, current smoker) on delay discounting, while controlling for years of education, see Table 3 for means and standard deviations. No significant main effects of psychiatric status or smoking history were observed (ns); however, there was a trend towards an interaction effect between these variables on delay discounting $F(2, 77) = 7.1$ ($p = .05$), $\text{partial } \eta^2 = .07$. *Post hoc* analyses (Bonferroni) revealed significant differences between psychiatric current smokers and never smokers ($p < .05$), all other differences were non-significant (former > current > never) (see Figure 4). Interestingly, there were no observable significant differences between groups among the control participants (never > current > former).
Table 3: Delay Discounting Across Smoking History

<table>
<thead>
<tr>
<th>Smoking History</th>
<th>Small log $k$</th>
<th>Medium log $k$</th>
<th>Large log $k$</th>
<th>Geometric $k$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychiatrist Group (n = 45)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never (n = 15)</td>
<td>-5.0 (1.5)</td>
<td>-5.4 (1.2)</td>
<td>-5.47 (1.2)</td>
<td>0.75 (0.6)</td>
</tr>
<tr>
<td>Former (n = 6)</td>
<td>-3.5 (1.1)</td>
<td>-3.8 (0.7)</td>
<td>-4.77 (0.7)</td>
<td>2.10 (1.1)</td>
</tr>
<tr>
<td>Current (n = 24)</td>
<td>-3.8 (1.4)</td>
<td>-4.44 (1.5)</td>
<td>-5.20 (1.6)</td>
<td>2.00 (1.9)</td>
</tr>
<tr>
<td>Controls (n = 38)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never (n = 18)</td>
<td>-3.7 (1.2)</td>
<td>-4.41 (1.3)</td>
<td>-4.91 (1.2)</td>
<td>2.03 (1.7)</td>
</tr>
<tr>
<td>Former (n = 3)</td>
<td>-4.3 (0.6)</td>
<td>-4.63 (.00)</td>
<td>-4.93 (0.5)</td>
<td>1.01 (0.3)</td>
</tr>
<tr>
<td>Current (n = 17)</td>
<td>-4.0 (1.0)</td>
<td>-4.39 (1.3)</td>
<td>-4.89 (1.0)</td>
<td>1.81 (1.7)</td>
</tr>
</tbody>
</table>

Fig 4. Comparison of delay discounting between psychiatric and controls participants across smoking history.

An independent samples $t$-test was conducted in order to examine differences between
smoking cessation treatment seeking (TS) psychiatric participants versus non-treatment seeking (NTS) individuals, on delay discounting. Those who were considered treatment seeking were recruited from an ongoing smoking-cessation clinical trial within the same laboratory. These individuals were motivated to quit smoking, as demonstrated by their self-enrollment in the smoking-cessation trial. Interestingly, no significant differences were observed between the TS ($M = 1.38, SD = 1.4$) and NTS ($M = 2.59, SD = 2.2$), $t (18) = -1.45$ (ns).

Additional bivariate correlations were run in order to examine relationships between individual characteristics (FTND, cigarettes smoked per day, age, years of education, and IQ) and delay discounting. No significant relationships were observed. However, when psychiatric symptoms were examined, a positive significant correlation was found between negative symptoms within schizophrenia, and delay discounting of medium reward sizes, $r (47) = .42, p < .01$. No other significant correlations were observed with the other reward sizes, or positive symptoms of schizophrenia.

A mixed factorial ANOVA was employed to examine differences in delay discounting across the three reward magnitudes (small, medium, large), between the controls and patients. A main effect of reward size was observed, small ($M = -4.05, SD = 1.3$), medium ($M = -4.58, SD = 1.4$), and large ($M = -5.09, SD = 1.2$), $F (2, 166) = 34.3, p < .001$, partial $\eta^2 = .29$, but not of psychiatric status (ns).
CHAPTER 5

DISCUSSION

5.1 Executive Function

There are conflicting findings examining psychiatric patients' performance on the IGT. Although some studies have found no significant deficits (Cavallaro, et al., 2003; Evans, Bowman, & Turnbull, 2005; Martino, Bucay, Butman, & Allegri, 2007; Turnbull, Evans, Kemish, Park, & Bowman, 2006), our findings are consistent with those studies that found that psychiatric participants exhibit deficits in decision-making, as evidenced by their poor performance on the IGT (Beninger, et al., 2003; Kester, et al., 2006; Shurman, et al., 2005; Yip, Sacco, George, & Potenza, 2009). These findings suggest a considerable diagnostic-group effect on risk/reward decision-making (Yip, et al., 2009).

Within both the psychiatric and control group, there were no significant differences in decision-making deficits between smokers and non-smokers, although smokers in both groups demonstrated poorer performance (lower IGT net total scores). While several studies suggest that nicotine effects of cigarette smoking can ameliorate performance deficits on neuropsychological tasks in individuals with schizophrenia (Depatie, et al., 2002; George, et al., 2006; George, Vessicchio, Termine, Sahady, et al., 2002; Sacco, et al., 2006; Sacco, et al., 2005), our hypothesis that smokers with schizophrenia would perform better on the IGT was not confirmed. Yip et al. (2009) also found no significant differences between psychiatric smokers and non-smokers; however, they did find that female smokers with schizophrenia outperformed their male counterparts. Interestingly, the smokers with schizophrenia in the present study displayed (non-significantly) poorer performance than the non-smokers.

The hypotheses that delay discounting would be positively correlated with performance on the IGT in those with schizophrenia and negatively correlated with IGT scores in controls were not confirmed. Rather, IGT performance was negatively correlated with delay discounting
when combining the psychiatric and control participants scores. This suggests that for both
groups, those who demonstrate superior risk/reward decisions are more inclined to consider to
long-term consequences.

The WCST assesses tactical planning, utilizing environmental feedback to shift cognitive
sets, directing behavior toward achieving a goal, and adjusting impulsive responding, all
implicated in the realm of executive functioning and ultimately decision-making. The controls
outperformed the patients, as evidenced through their lower scores on perseverative responses
and errors, and higher numbers of categories completed on the WCST. This further supports the
notion that psychiatric patients suffer from deficits in decision-making, and may explain some of
the poor choices they make (e.g., high rates of cigarette smoking). Also, performance on the
WCST was associated with delay discounting for both the controls and patients, such that as
perseverative errors increased on the WCST, so did the $k$ value on the delay discounting task,
meaning higher rates of delay discounting. Similar to our findings on the IGT, performance on
these tasks of executive functioning is related to the magnitude of delay discounting. Although
we had hypothesized this finding for controls but not for psychiatric participants, this finding is
logical since both of these groups had similar patterns of delay discounting.

5.2 Delay Discounting

Although we have already demonstrated decision-making deficits in those with
schizophrenia (poor performance on measures of executive function), we further analyzed these
deficits by looking at the degree to which small immediate rewards were chosen over larger
delayed rewards. While patients did not respond to questions of delay discounting differently
than the controls, they demonstrated lower levels of delay discounting [after educational level
was covaried out], which is opposite to what was hypothesized and inconsistent with previous
findings (Heerey, et al., 2007). The control non-smokers in the present study responded
similarly to the control smokers, which is surprising since numerous studies have reported that
smokers discount the future more than non-smokers (Baker, et al., 2003; Reynolds, 2004). This may have contributed to the atypical findings that controls are more impulsive than the patients.

When delay discounting was compared across the groups defined on smoking history (never, former, and current smoker), a trend towards significance was observed between patients and controls. Within the psychiatric participants, current and former smokers have comparable levels of delay discounting, but current smokers significantly discounted future rewards more when compared with never smokers. This parallels previous research examining controls with addiction that suggests that current abusers are more impulsive than non-users (Bickel, et al., 1999; Coffey, et al., 2003; Kirby, et al., 1999; Madden, et al., 1997). The opposite pattern of delay discounting was demonstrated in the controls, although differences were non-significant. This finding in controls was surprising, once it again it may be a result of the unusually impulsive control non-smokers in this sample, or the small sample size of the control former smokers ($n = 3$). The present findings suggest that within psychiatric individuals, delay discounting may be a trait, rather than a state marker, since former and current smokers responded similarly. Also, when treatment-seeking psychiatric participants were compared to non-treatment seeking individuals, no significant differences in delay discounting were observed, which further supports the notion that delay discounting is a trait.

A relationship between negative symptoms of schizophrenia and delay discounting of medium reward sizes was observed, such that those with more intense negative symptoms had higher delay-discounting scores, meaning that they are more present-orientated. Heerey and colleagues (2007) also investigated the relationship between psychiatric symptoms and delay discounting, and consistent with the present study, found a significant relationship only between medium reward sizes and negative symptoms. In contrast to the present findings, they found an inverse relationship, with more intense negative symptoms being associated with less delay
discounting. Although these two studies demonstrated contrasting findings, both confirm a relationship between symptom severity and delay discounting.

Both controls and patients similarly discount small rewards the most, followed by medium and large reward sizes. This suggests that within delay discounting, the size of the reward does play a role. Although someone may choose an immediate small reward over delayed small or medium rewards, a majority of people will wait if the payoff is large enough. This would have treatment implications because the focus should be on the smaller immediate rewards, but when focusing on the future, the emphasis should be on larger rewards, as they are more influential in the decision-making process.

5.3 Limitations & Future Directions

This study is not without its limitations. First, power was inadequate as a result of our small sample. Each subgroup (SNS, SS, CS, CNS) had relatively small sample sizes (with $ns < 25$), which prevented further sub-analyses. Future studies would benefit from increasing the sample size within each comparison group, and controlling for an equal spread of current, former, and never smokers in order to further investigate whether impulsivity is a state versus a trait marker. Another constraint to this study was the measurement of expired breath carbon monoxide (CO) levels, which occurred only at the screening visit, rather than again on the day of cognitive testing. Also, smoke breaks were offered but not required for subjects participating in these assessments. As a result, we were not able to ensure that the smokers were satiated with nicotine at the time of testing. Furthermore, there were no measures of craving and withdrawal, which would have informed us about tobacco satiation/deprivation. Although these limitations were recognized while recruitment was still ongoing, the second half of psychiatric-smoker sample was satiated, because they were required to smoke immediately before the cognitive-testing session. Although no significant differences were observed between the first half and second half of psychiatric smokers, enforcing smoke breaks and measuring CO levels on the day
of testing would ensure that all smokers are satiated, and would significantly improve the methodology of this study.

The psychiatric participants in this study were all medicated and demonstrated relatively low to moderate levels of psychosis, as demonstrated by their PANSS scores. As well, their IQ level and education are quite high for this specific population, which may have contributed to our non-significant findings. Enforcing a minimal PANSS total score as an inclusion criteria could ensure more chronic patients, and should be considered for future research.

This present study focused on cigarette dependence rather than other types of substance dependence. Although cigarette smokers have demonstrated greater impulsivity when compared with non-smokers (Geist & Herrmann, 1990; Waldeck & Miller, 1997), they do not experience major life disruptions (e.g., loss of employment) as a result of their nicotine dependence, whereas someone with a drug or alcohol addiction may (Bickel, et al., 1999). Therefore, our findings might have been different had we explored other substances. Substance abuse or dependence, other than cigarettes, was an exclusion criterion for this study. It would be interesting for future studies to examine differences between psychiatric and controls participants who suffer from alternate addictions, as well as poly-substance use.

5.4 General Conclusions

Although this study reconfirms that psychiatric patients make disadvantageous decisions in comparison to controls, this difference may not be reflected in abnormalities in delay discounting. This is, to our knowledge, the first cross-sectional studies to attempt to elucidate the relationship between delay discounting in smokers and non-smokers, with and without co-morbid schizophrenia. Results were unanticipated, inasmuch as smokers with schizophrenia responded similarly to control smokers of previous studies (Baker, et al., 2003; Bickel, et al., 1999). This finding is incongruent with our hypothesis that smokers would discount less because of the neurocognitive benefits of nicotine. However, our results suggest that delay discounting is
a trait rather than a state marker, which might explain this finding, as former and current smokers may be more impulsive, regardless of current smoking status.

This study may have clinical implications for providing a deeper understanding for why psychiatric patients have a predisposition to higher rates of smoking compared to the general population, and more difficulties with quitting smoking. Smokers with schizophrenia focus on immediate gratification (i.e., smoking), rather than the long-term risks (i.e., health problems, death). Findings from the present study suggest that smoking-cessation treatments should focus on the small immediate rewards of cessation (i.e., becoming more socially acceptable, avoiding the unpleasant smell of smoke), while highlighting the profound long-term benefits of cessation, such as longer life expectancy and financial savings, for a group of patients with significant socioeconomic disadvantages, and medical morbidity and mortality due to tobacco-related disease burden.


Gur, R. E., Cowell, P. E., Latshaw, A., Turetsky, B. I., Grossman, R. I., Arnold, S. E., et al. (2000). Reduced dorsal and orbital prefrontal gray matter volumes in schizophrenia. *Arch Gen Psychiatry, 57*(8), 761-768.


APPENDICES

Appendix A

Outliers

SS – 16 removed
SNS – 27, 18, 03 removed

CS – 29 & 32 removed
* No CNS were excluded from the analyses.