# Socioemotional Assessment of Adolescent Risk-Taking:

# The Social Gambling Task

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Abstract

Despite exhibiting cognitive abilities and knowledge similar to those of adults, adolescents take significantly more risks. One way risk-taking has been assessed is with the Iowa Gambling Task (IGT). However, differences between adult and adolescent performance on the IGT, when found, are not of a sufficient magnitude to account for the difference in actual risks taken by both age groups. Furthermore, a monetary task such as the IGT neglects social aspects of adolescent risk-taking. Therefore, better assessment of adolescent risk-taking may be achieved with a socioemotional, adolescent-relevant approach. The present study was designed to validate a Social IGT (SGT) making use of social rewards and punishments, to which adolescents are uniquely sensitive. The SGT involves maximizing "likes" (rather than money), presented with pictures of attractive adolescents. Participants, 14- to 18-year-olds, chose to play or pass from preselected decks of face-down cards. Through playing, participants learned which were good or bad decks, based on the amount won (IGT) or number of "likes" and "dislikes" obtained (SGT). It was predicted that self-reported risk-taking, as assessed by the ARQ and SRTS, would predict SGT performance to a greater degree than IGT performance, after accounting for sex. However, self-reported risk-taking, sex, and gambling task type did not significantly predict IGT and SGT performance. These results suggested that adolescents were equally sensitive to a social reinforcement schedule as to a monetary one. Implications were that both the IGT and the SGT may capture similar risk processing, yet are unrelated to actual adolescent risk-taking propensity.

Résumé

Malgré le fait que les adolescents démontrent des capacités cognitives et des connaissances semblables à celles des adultes, les adolescents prennent considérablement plus de risques. L'Iowa Gambling Task (IGT) est une méthode d'évaluation de la prise de risques. Cependant les différences, mêmes lorsqu'elles sont présentes, de performance en IGT entre adultes et adolescents ne sont pas d'une ampleur suffisante pour expliquer les différences de prise concrètes de risques entre adultes et adolescents. De plus, l'aspect monétaire de l'IGT omet le côté social de la prise de risques chez l'adolescent. Donc, une meilleure évaluation de la prise de risques chez l'adolescent peut être réalisée par une méthode d'évaluation socioémotionelle adaptée aux adolescents. L'étude actuelle a été conçue pour valider un IGT Social (SGT), qui emploie des renforcements et punitions sociaux, auxquels les adolescents sont particulièrement sensibles. Le SGT cible, à la place d'argent, les "j'aimes" (en Anglais "likes") fictifs, présentés avec des photos attrayantes d'adolescents. À chaque tour, un parmi plusieurs jeux de cartes (faces cachées) est présélectionné et les participants, de 14 à 18 ans, doivent choisir de jouer la carte ou passer leur tour. En jouant, les participants ont appris quels étaient les bons ou mauvais jeux, en fonction des gains (IGT) ou le nombre de "j'aimes" et "j'aime pas" ("likes" and "dislikes") obtenus (SGT). Notre hypothèse était que la prise de risque, autoévaluée selon l'échelle de l'ARQ et du SRTS, offrirait une meilleure prévision des résultats du SGT que de ceux de l'IGT, après avoir tenu compte des effets du sexe des participants. Toutefois, l'autoévaluation de la prise de risques, le sexe des participants, et le type de tâche (IGT ou SGT), n'ont pas prédit la performance de l'IGT et du SGT de manière significative. Ces résultats laissent entendre que les adolescents étaient aussi sensibles à un programme de renforcement social que monétaire. Donc,

l'IGT et le SGT semblent capter des processus semblables ayan attrait à la prise de risques, mais sont dissociés de la tendance concrète à prendre des risques chez l'adolescent.

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# CHAPTER 1

## Introduction

Adolescents have been found to demonstrate similar knowledge of, and reasoning about, risks and rewards, in comparison to adults (Cauffman & Steinberg, 2000; Figner, Mackinlay, Wilkening, & Weber, 2009; Moshman, 2005; Reyna, & Farley, 2006; Spear, 2000; Stanovich, Toplak, & West, 2008; Steinberg, 2004; Steinberg, 2005; Steinberg, 2007; Steinberg, 2008; Steinberg & Scott, 2003). As an illustrative example, adolescents and adults both overestimate potential negative consequences of risky behaviors (Cauffman & Steinberg, 2000; Fischhoff, 2008; Reyna & Farley, 2006; Steinberg, 2004; Steinberg, 2008).

Despite cognitive and knowledge similarities, adolescents take many more risks, and more serious risks than adults. Risk-taking and risky decision-making is thought to peak in adolescence (Casey, Jones, & Hare, 2008; Casey, Jones, & Somerville, 2011; Chambers & Potenza, 2003; Crews, He, & Hodge, 2007; Eaton et al., 2008; Figner et al., 2009; Reyna & Farley, 2006; Spear, 2000; Steinberg, 2004; Steinberg, 2005; Steinberg, 2008), especially in mid- to late-adolescence (Essau, 2004; Gullone & Moore, 2000; Gullone, Moore, Moss, & Boyd, 2000; National Research Council, 2007). Adolescent risk-taking is of great practical significance and represents a public health concern (Casey & Jones, 2010; Cauffman et al., 2010; Steinberg, 2008). Given the high prevalence rates of adolescent risk-taking, its often disastrous consequences to oneself and others, and the fact that risk-taking behaviors tend to occur together (including antisocial behaviors), this area has attracted significant research (Abbott-Chapman, Denholm, & Wyld, 2008; Benthin, Slovic, & Severson, 1993; Chambers & Potenza, 2003; Crews et al., 2007; Essau, 2004; Eaton et al., 2008; Spear; 2000). Hence, the high levels of risk-taking

in adolescence are of great concern and cannot be accounted for by knowledge and reasoning abilities, since these are adult-like.

Risk-taking during adolescence has commonly been assessed using self-report measures (e.g., Abbott-Chapman et al., 2008; Essau, 2004; Gullone, Moore, et al., 2000; Hampson, Severson, Burns, Slovic, & Fisher, 2001) or hypothetical scenarios (e.g., Cauffman & Steinberg, 2000; Gardner & Steinberg, 2005; Hampson et al., 2001; Steinberg, 2004; Steinberg, 2005). However, self-report measures have well-known drawbacks, such as: collecting data that may be unreliable but are difficult to verify by other means, as well as contamination of data by social desirability effects, self-enhancement and self-preservation effects, consistency motivation, deception, self-deception, lack of self-directed insight, response styles, and contextual cues in the research setting (Barker, Pistrang, & Elliott, 2002; Fan et al., 2006; Paulhus & Vazire, 2008; Podsakoff & Organ, 1986). Concerns about sensitivity to social desirability (i.e., faking good and faking bad), for example, may be especially relevant to adolescents, who are uniquely sensitive to social influences (e.g., Chein, Albert, O'Brien, Uckert, & Steinberg, 2011; Gardner & Steinberg, 2005) and exhibit the highest levels of social interaction behaviors of any age group (Crews et al., 2007; Garner & Steinberg, 2005; Spears, 2000). Indeed, social desirability has been found to impact self-reported risk-taking results when these are compared to results from other types of risk-taking measures (Brener, Billy, & Grady, 2003). In addition, adolescents confronted with hypothetical situations tend to make less risky decisions than in real-life (Cauffman & Steinberg, 2000; Gardner & Steinberg, 2005; Steinberg, 2004; Steinberg, 2005; Steinberg & Scott, 2003). Finally, both hypothetical scenarios and self-report measures lack the emotional arousal and group setting that real-life risky decisions are associated with (e.g., Chein et al., 2011; Gardner & Steinberg, 2005; Steinberg, 2008). As a result, behavioral measures may be

better suited to assessing adolescent risk-taking (Gardner & Steinberg, 2005; Steinberg, 2004), as they are more likely to trigger emotional arousal (e.g., Buelow & Suhr, 2009), despite typically involving individual decision-making contexts.

The goal of this research is to validate a new, behavioral measure of adolescent risk-taking (the Social Gambling Task; SGT), by examining convergent and divergent factors related to performance on the task. The SGT was modelled on the Iowa Gambling Task (IGT), since the IGT is a well-validated and reliable measure of risk-taking and risky decision-making in adults (e.g., Bechara, Damasio, Damasio, & Anderson, 1994; Bechara & Martin, 2004; Barry & Petry, 2008; Bechara, Dolan, & Hindes, 2002; Grant, Contoreggi, & London, 2000; Mitchell, Colledge, Leonard, & Blair, 2002; Toplak, Liu, MacPherson, Toneatto, & Stanovich, 2007), which has also been used with adolescents (e.g., Cauffman et al., 2010; Crone & Van der Molen, 2004; Crone, Vendel, & Van der Molen, 2003; Ernst et al., 2003; Overman et al., 2004). However, as will be argued in more detail later, the IGT's use of monetary rewards and punishments has not been explicitly connected with the social rewards and punishments tied to risk-taking in adolescence.

## Literature Review

### Adolescent Risk-taking

Adolescent risk-taking has been hypothesized to serve adaptive functions which promote a positive transition to adulthood, such as exploring and testing out new behaviors or environments, developing entrepreneurialism, becoming assertive, and forming social bonds outside of the family, including partner bonds (Chambers & Potenza, 2003; Crews et al, 2007; Gullo & Dawe, 2008; Reyna & Farley, 2006; Somerville, Casey & Jones, 2010; Spear, 2000; Steinberg, 2008). However, adolescent risk-taking can also have a negative side and result in

disastrous consequences, when excessive behaviors such as driving and driving or using drugs are considered (e.g., Eaton et al., 2008; National Research Council, 2007).

Several findings and hypotheses may help account for the difference in risk-taking observed between adolescents and adults, despite similar cognition and knowledge related to this behavior. For instance, the following socioemotional constructs peak in adolescence: motivation to seek out novel experiences (Chambers & Potenza, 2003; Crews et al., 2007; Somerville, Jones, & Casey, 2010; Spear, 2010; Steinberg, 2004), reward sensitivity (Somerville et al., 2010; Somerville, Hare, & Casey, 2011; Steinberg, 2008; Van Leijenhorst et al., 2010)–especially in situations of high reward (Casey & Jones, 2010; Galvan, 2010; Gullo & Dawe, 2008), sensitivity to social or peer influences in general as in situations of risk (Chein et al., 2011; Gardner & Steinberg, 2005; Modecki, 2008; National Research Council, 2007; Somerville et al., 2010; Somerville et al., 2011; Spear 2010; Steinberg, 2004; Steinberg, 2008; Steinberg & Scott, 2003; Yurgelun-Todd, 2007), and orientation towards the present versus the future (Steinberg, 2004). In addition, adolescents have been found to possess immature and limited abilities with regard to impulse control, emotion regulation, delay of gratification, resistance to peer influences, planning, self-monitoring, and inhibitory control in general (Casey & Jones, 2010; Cauffman & Steinberg, 2000; Crews et al., 2007; Reyna & Farley, 2006; Steinberg, 2004; Steinberg, 2007; Steinberg, 2008; Yurgelun-Todd, 2007). It can thus be concluded that adolescence, compared to adulthood, is marked by higher levels of reward-related reactivity, especially in social situations and situations of high reward, a concern with immediate consequences, and lower levels of self-control.

**Dual Systems Models of Adolescent Risk-Taking**

Two contrasting models may help explain why adolescents take more risks and exhibit the socioemotional particularities mentioned above (e.g., higher levels of reward-related reactivity, especially in social situations, and lower levels of self-control), despite cognition and knowledge that are similar to adults. The first model suggests that adolescents' cognitive-computational networks develop fairly rapidly and linearly, resulting in their being fully formed by the ages of 14 to16 (Figner et al., 2009; Klaczynski, 2001; Moshman, 2005; Stanovich et al., 2008; Kokis, Macpherson, Toplak, West, & Stanovich, 2002; Steinberg, 2007). These networks comprise the neurological foundations for intelligence or cognitive ability, and underlie logical, analytical, and computational processing. The rapid, linear course that these networks follow explains why adolescent reasoning about risks is similar to that of adults by mid-adolescence. By contrast, the socioemotional and regulatory networks involved in heuristic information processing and self-regulation develop much more slowly (i.e., well into adulthood), generally in a non-linear fashion, and with significant unevenness among the network components (Crews et al., 2007; Figner et al., 2009; Klaczynski, 2001; Stanovich et al., 2008; Steinberg, 2007). This latter developmental course accounts for the immature self-regulatory abilities demonstrated by adolescents and for part of the difference between knowledge or reasoning and risk-taking behavior. Indeed, the outcomes of decision-making may not be dictated by knowledge and computational or logical processes due to self-regulatory immaturity,

The second model is focused on the unevenness within the socioemotional and regulatory networks, and is comprised of systematic differences in the developmental trajectories of the subcortical and limbic areas of the brain (e.g., amygdala and ventral striatum) compared to top-down control parts of the prefrontal cortex (PFC; e.g., the ventromedial prefrontal cortex). This

second hypothesis leaves out the development of cognitive-computational networks, which are dissociated from socioemotional and regulatory networks, as demonstrated in the first model. The subcortical and limbic systems develop rapidly and along an exponential curve, with a rapid increase in "go or approach systems," while the top-down control parts of the PFC develop in a slow and linear fashion (Chambers & Potenza, 2003; Casey & Jones, 2010; Casey et al., 2008; Casey et al., 2011; Crews et al., 2007; Figner et al., 2009; Gullo & Dawe, 2008; Somerville et al., 2010; Somerville et al., 2011; Steinberg, 2008). The relatively more rapid development of the subcortical and limbic areas, on which reward processing heavily depends, may help account for the peak in reward sensitivity observed in adolescents, whereas the slow development of the top-down control parts of the PFC, which are involved in context-sensitive self-control as well as risk aversion, may account for self-regulation being easily overwhelmed by bottom-up stimulation in situations of high emotional salience (Casey et al., 2008; Casey et al., 2011; Cauffman et al., 2010; Figner et al., 2009; Gullo & Dawe, 2008; Somerville et al., 2010; Somerville et al., 2011). Indeed, increased risk-taking and decreased use of contextual information has been observed among adolescents when affective or "hot" aspects of decision-making aspects are engaged, but not when "cold" cognitive aspects are engaged (Figner et al., 2009). Similarly, linear improvements have been found on a go/no-go task with age (from childhood to adulthood), in the context of neutral cues but not social appetitive cues: with the latter, adolescent performance was significantly reduced (Somerville et al., 2011). In addition, in the context of an immature PFC, the basal ganglia may be relied upon instead when making decisions (Yurgelun-Todd, Killgore, & Clintron, 2003), which could further strengthen the impact of the subcortical areas relative to top-down control areas.

The implication of these two models is that there is empirical support for an explanation of high risk-taking during adolescence which relies on mismatches in the development of distinct neural areas, especially those tied to affective and self-regulatory processing and cognitive-computational processing, instead of simple deficiencies in knowledge or reasoning abilities. Furthermore, these models explain not only why adolescents take more risks than adults, but also why adolescents exhibit socioemotional particularities such as higher levels of reward-related reactivity, especially in social situations and situations of high reward, a concern with immediate consequences, and lower levels of self-control, despite cognition and knowledge that is similar to adults. These models are also consistent with empirical findings in which adolescents have been reported to take more risks than adults because they are more likely to apply cost-benefit analysis with an affective bias towards rewards, rather than applying the risk-averse heuristics that adults adopt when making decisions (Cauffman et al., 2010; Gardner & Steinberg, 2005). This suggests differences between adult and adolescent processing, which cannot be accounted for merely in terms of being more or less analytical or logical.

In conclusion, adolescents exhibit developmental mismatches between cognitive-computational networks versus self-regulatory networks as a whole and between top-down control versus “go or approach” networks, which together account for the higher levels of adolescent risk-taking and higher levels of reward-related reactivity, especially in social situations and situations of high reward, a concern with immediate consequences, and lower levels of self-control, despite cognition and knowledge that is similar to adults. These lines of evidence, in tandem with weaknesses in assessing adolescent risk-taking with self-report or hypothetical vignette measures, suggest that assessing and shedding light on adolescent risk-taking requires using methods which integrate incentives that are particularly relevant or

emotionally arousing to adolescents (e.g., social incentives). One way to do this is by using a behavioral assessment based on social incentives, such as the one created for the current study (the SGT).

**The Iowa Gambling Task as a Measure of Risk-Taking**

The original IGT, developed by Bechara et al. (1994), professed to assess impaired decision-making manifested by patients with lesions in the ventromedial prefrontal cortex (VMPFC), compared to normal comparisons and individuals with other types of prefrontal lesions. Despite displaying largely normal cognitive abilities, reasoning, and knowledge, VMPFC patients performed significantly less well than any of the other groups on the IGT (i.e., took more risky decisions under conditions of uncertain rewards and punishments, and failed to learn from their mistakes over the course of repeated trials), resulting in long-term losses. These findings appear robust, as they were extended to other samples of VMPFC patients in addition to bilateral amygdala patients, who also exhibit deficits in emotional aspects of decision-making compared to patients with other types of lesions and normal comparison groups (Bechara, Tranel, & Damasio, 2000; Bechara, Damasio, & Damasio, 2003; Gupta, Koscik, Bechara, & Tranel, 2011). Moreover, these findings are consistent with theoretical considerations and other empirical findings, since the VMPFC has been implicated as a key structure for decision-making, emotional regulation (including generation and integration of emotions), and social as well as moral judgments (for a review, see: Hernandez, Denburg, & Tranel, 2009).

The pattern of deleterious decision-making exhibited by VMPFC patients on the IGT was well-matched by the same problems in their daily life, and was related to an insensitivity to future consequences as well as an increased sensitivity to immediate rewards but not punishments (Bechara et al., 1994; Bechara, Tranel, & Damasio, 2000). These deficiencies in

real-life and IGT decision-making are similar to the deficiencies exhibited by adolescents in real-life decision-making: high levels of risky decision-making, increased reward sensitivity, and present rather than future orientation. In addition, the brain areas implicated in deleterious IGT decision-making (VMPFC and amygdala) have also been implicated in the second dual-systems model of adolescent development that accounts for adolescent risk-taking. Finally, in the absence of cognitive ability or executive control deficits, these constructs are typically dissociated from IGT performance, making it a fairly pure measure of affective dimensions of risky decision-making (Toplak, Sorge, Benoit, West, & Stanovich, 2010). Importantly, these findings have also been observed in children and adolescents, for whom executive functioning, working memory, inductive reasoning skills, and behavioral response inhibition have been shown to be unrelated to IGT performance and age changes in IGT performance (Crone & Van der Molen, 2004; Hooper, Luciana, Conklin, & Yarger, 2004; Overman et al., 2004). There is therefore ample evidence that the IGT is an appropriate task for the assessment of adolescent risk-taking, since the affective dimensions of adolescent risk-taking appear to be central to adolescent risk-taking.

In addition to the studies with the neurologically impaired patients mentioned, the IGT and the particular response patterns it elicits have been successfully used to study and differentiate other non-adult clinical populations marked by maladaptive or risk-prone decision-making, such as adolescents with multiple school suspensions (Stanovich, Grunewald, & West, 2003), adolescents with behavior and substance use disorders (Ernst et al., 2003), adolescent binge drinkers (Johnson et al., 2008), psychopathic male children and adolescents in special behavioral or emotional education streams (Blair, Colledge, & Mitchell, 2001). Impaired IGT performance has also been empirically tied to theoretically important personality and socioemotional variables in normative adolescent populations, such cognitive disinhibition (but not behavioral

disinhibition; Crone et al., 2003), and neuroticism in males as well as parent-reported externalizing, neuroticism, and extraversion in both females and males (Hooper, Luciana, Wahlstrom, Conklin, & Yarger, 2008). These lines of evidence further indicate the utility of the IGT as an appropriate task for the assessment of adolescent risk-taking.

Despite the apparent appropriateness of the IGT in assessing adolescent risk-taking, there are inconsistencies in the literature comparing adolescent to adult IGT performance, which marks a divergence from the consistent gap in real-life risk-taking between both age groups. In two studies comparing adolescent with adult IGT performance, performance among both age groups was similar as of 14 to15 years of age (Cauffman et al., 2010; Overman et al., 2004). However, despite similar overall performance in both age groups, higher rates of approach behavior were found in adolescents and higher rates of avoidance were found in adults (Cauffman et al., 2010). Although no mention was made of overall IGT performance, Steinberg (2010) extended these approach and avoidance findings by showing that reward-seeking (draws from advantageous decks) was related to age in a curvilinear fashion, peeking in mid-adolescence, while cost-aversion (draws from disadvantageous decks) was related to age in a negative, linear fashion. In another study, IGT performance has also been reported to be similar between normative adult and adolescent participants (12 to14 vs. 21 to 44; Ernst et al., 2003). However, IGT performance was significantly worse for adolescents with behavior disorders compared to healthy adolescents, as well as for adolescents with substance abuse disorders compared to healthy adults (Ernst et al., 2003).

In other studies, IGT performance was found to be slightly worse for adolescents than adults (13 to 15 vs. 18 to 25, Crone & Van der Molen, 2004; 12 to 13 and 15 to 16 vs. undergraduates, Crone et al., 2003; 18 to 25 vs. 26 to $60^{+}$, Icellioglu & Ozden, 2012). However,

caveats are in order for each of these findings. In the Crone and Van der Molen study (2004), adolescents 15 to 18 years of age, for whom risk-taking is highest, were not included. In the Crone et al. study (2003) adolescent groups were not significantly different from each other, finer-grained distinctions among adolescents may have been missed out on since age was not used as a continuous variable, and adolescents 17 to 18 years of age were not included. The Icellioglu and Ozden study (2012) suffered from methodological weaknesses, including certain analyses only being applied to one age group when conclusions were aimed at comparing age groups, and "adolescents" being defined as the 18 to 25 age group.

Regardless of whether adolescents, in fact, perform slightly worse than adults on the IGT, slight developmental differences in performance on this risky decision-making task cannot account for the large developmental differences in *actual* risky behavior. In light of these findings pertaining to adolescent IGT performance, the IGT appears to fail to capture some of the important aspects of the affective processes involved in adolescent risk-taking (e.g., sensitivity to social rewards and punishments), despite performance on this task being related to certain socioemotional variables that are important for adolescent risk-taking (e.g., sensitivity to immediate reward, an orientation towards the present versus the future, emotional aspects of decision-making).

**Sex Differences in Adolescent Risk-Taking and IGT Performance**

Male adolescents typically tend to take more risks overall, and more risks of specific types (e.g., risky driving), compared to female adolescents (e.g., Eaton et al., 2008; Essau, 2004; Gullone & Moore, 2000; Gullone, Moore, et al., 2000; National Research Council, 2007). There is, however, also evidence that the gap between the sexes in risk-taking behaviors (overall or

among specific behaviors) has been diminishing in the last decade (Abbott-Chapman et al., 2008; Figner et al., 2009; National Research Council, 2007).

Findings of sex-related differences on IGT performance in adolescents are mixed. Furthermore, there seems to be a gap in the literature concerning this issue, and some IGT studies have even failed to carry out analyses according to sex (Ernst et al., 2003). The five studies which reported sex effects consistently showed an absence of sex as well as sex and age interaction effects on overall IGT performance, for mixed groups of adolescents and children or adolescents and adults (Cauffman et al., 2010; Crone, Bunge, Latenstein, & Van der Molen, 2005; Hooper et al., 2004; Hooper et al., 2008; Overman et al., 2004). At a more fine-grained level of analysis, however, adolescent and adult males, as a whole, have been reported to play more from both advantageous and disadvantageous, compared to females (Cauffman et al., 2010). By contrast, male children and adolescents, as a whole, have been found to make more selections from only advantageous decks as trials progressed in one study (Crone et al., 2005), and less selections from advantageous decks in another study (Overman et al., 2004). Hence, sex effects pertaining to advantageous and disadvantageous deck selections have been inconsistent.

Male children and adolescents have also been found to make fewer selections from infrequent punishment decks than females across age groups (Hooper et al., 2004; Overman et al., 2004). However, when deck-specific analyses were carried out, males and females only differed on the advantageous and frequent punishment deck (males made more selections from this deck), and on the disadvantageous and infrequent punishment deck (males made fewer selections from this deck; Overman et al., 2004). These findings suggest an overall effect of sex on infrequent punishment deck selection, which is mitigated by deck-specific analyses.

In conclusion, if overall IGT score is used as an index of adolescent risk-taking or risky decision-making, then it is not sensitive to typical sex differences in real-life risk-taking. In addition, findings pertaining to plays from advantageous and disadvantageous decks by sex are inconsistent, so it is not possible to conclude whether these two IGT outcome variables are sensitive to typical sex differences in real-life risk-taking. Finally, when deck-specific analyses are overlooked, it appears that males consistently make fewer selections from infrequent punishment decks compared to females. This suggests that sex should predict infrequent punishment deck selection, and that this IGT outcome variable may be sensitive to typical sex differences in real-life risk-taking. Overall, except for infrequent punishment deck selections, it appears that IGT variables do not adequately capture sex-specific processes pertaining to adolescent risk-taking.

**Summary**

Risk-taking peaks during adolescence, with both positive and negative outcomes. The negative outcomes are serious enough to make the prevalence of this behavior in adolescents a great concern for society as a whole. Adolescents exhibit similar knowledge of, and reasoning about, risks compared to adults, yet take significantly more risks. Hence, purely cognitive and computational accounts of adolescent risk-taking cannot be empirically supported. Dual-systems models of adolescent development, however, have been empirically supported, and can explain not only why adolescents take more risks than adults, but also why adolescents exhibit socioemotional particularities such as higher levels of reward-related reactivity–especially in social situations and situations of high reward–a concern with immediate consequences, and lower levels of self-control, despite cognition and knowledge that is similar to adults. These models focus on developmental mismatches between cognitive-computational networks versus

self-regulatory networks as a whole and between top-down control versus “go or approach” networks. The IGT could be an appropriate tool to assess adolescent risk-taking, because it has been deemed a fairly pure measure of the affective dimensions of risky decision-making (of central interest in adolescent risk-taking); poor IGT performance has been linked to many variables that are correlated with risk-taking or risk-prone decision-making in a wide variety of populations; deficiencies in real-life and IGT decision-making in lesion patients are similar to the deficiencies exhibited by adolescents in real-life decision-making; the brain areas associated with deleterious IGT decision-making (VMPFC and amygdala) have also been implicated in the second dual-systems model of adolescent development that accounts for adolescent risk-taking. However, overall adolescent performance on the IGT has either been found to be similar to that of adults, or the difference in overall performance between both age groups has been too small in magnitude to account for the differences in observed real-life risk-taking between both age groups. In addition, only one IGT outcome variable (plays from infrequent punishment decks) has been consistently linked to sex, indicating that only this outcome variable is sensitive to sex-specific risk-taking processes in adolescence. In light of these findings, and findings pertaining to weaknesses in assessing adolescent risk-taking with self-report or hypothetical vignette instruments, a novel, behavioral task was proposed to assess adolescent risk-taking: the Social Gambling Task (SGT). This task was modelled on the IGT, but replaced monetary rewards and punishment (IGT) with social ones (SGT). The rationale for making this modification was that replacing monetary rewards and punishments with social ones would make the task more sensitive to processes involved in adolescent risk-taking, by increasing the emotional salience of the incentives.

## Present Study

The present study addressed several gaps in the literature, by contributing data pertaining to: (a) the ecological validity of the IGT or its relation to other measures of risk-taking (a need identified by Buelow & Suhr, 2009); (b) IGT performance in adolescents from 14 to 18 years of age, which few studies have investigated (Cauffman et al., 2010; Overman et al., 2004; Weller, Levin, & Bechara, 2010), and which has yielded mixed results; (c) to the effect of sex on adolescent IGT performance, which has also yielded mixed results; and (d) proposing and validating a new behavioral measure of adolescent risk-taking, based on adolescent sensitivity to social influences. To address these issues, the SGT was developed. The present study was designed to validate the SGT by examining the relation between performance on the task, IGT performance, risk-taking variables, sex, and age.

The SGT was modelled on the IGT in terms of visual presentation, how it is played, and reward or reinforcement schedules. The specific rewards and reinforcements, however, were changed to be social ("likes" and "dislikes") instead of monetary. In addition, a picture of an adolescent's face was added to each card, above feedback about gains and losses. These changes were aimed at making the task more emotionally arousing, as adolescents are more sensitive to social rewards and punishments than any other age group. The SGT would therefore tap the socioemotional and "go or approach" systems to a greater degree than the IGT, making it harder for adolescents to perform well on the SGT compared to the IGT, and capturing sex differences in the affective dimensions of risky decision-making. Poorer SGT performance would then be more closely related to high levels of risk-taking and poor decision-making seen in adolescents, compared to the IGT. In addition, poor SGT performance in males would be related to the higher levels of risk-taking typically observed in males.

The population studied was comprised of 14- to 18-year-olds as our participants because: (a) adults do not show the same peak of risk-taking behaviors as adolescents, and we therefore wanted to obtain adolescents who had not yet assumed more socially adult roles or were not yet treated legally as adults; and (b) 14 is the earliest age for which IGT performance, as well as reasoning and knowledge, have been previously reported to be similar between adolescents and adults. So, imposing this lower age limit meant that IGT and SGT performance could be interpreted as indicative of affective decision-making ability instead of cognitive impairment or immaturity.

**Aims and Hypotheses**

The aim of the present study was to develop and then validate the SGT by examining whether self-reported adolescent risk-taking and risk-perception were better predicted by the SGT compared to the IGT, accounting for sex differences. If risk-taking was predicted to a greater degree with the SGT compared to IGT, our central hypothesis would be supported: social incentives are more sensitive to psychological processes involved in adolescent risk-taking compared to monetary incentives. In addition, preliminary evidence for the validity of the SGT would also be found.

The following hypotheses were proposed: (a) adolescents would perform well on the IGT, such that participants would learn to play more from advantageous decks and less from disadvantageous decks as the task progressed; (b) adolescents would perform better on the IGT than the SGT, indexed in the same way, since the social rewards and punishments would be more sensitive to the deleterious decision-making underlying adolescent risk-taking; (c) females would show a preference for infrequent punishment decks on both tasks, showing an increased sensitivity to punishment frequency and a different IGT and SGT playing strategy; (d) females

would outperform males on the SGT, mirroring differences in actual risk-taking; and (e) most importantly, the SGT would predict self-reported risk-taking to a greater degree than the IGT after sex was accounted for.

# CHAPTER 2

## Methods

### Participants

The sample for the current study was drawn from the Queen's Developmental Psychology database, and was comprised of adolescents who had participated in a previous longitudinal study. Families were initially recruited to the database through diverse methods, from use of birth records to snowball sampling. They resided, and attended public schools, in the wider Kingston area. There were no exclusion criteria for the current study, in order to obtain a representative sample of the general adolescent population.

Three participants were dropped from the initial sample ($N$ = 79) due a technological malfunction. With the exception of those three participants, there were no missing data. Participants in the remaining sample ($N$ = 76) were between 14 and 18 years of age ($M$ = 16.29, $SD$ = .85), with males accounting for 45% of the sample. Additional sample characteristics are available in Table 1.

Participants were divided into two groups through random assignment: one that completed the IGT task first (49%) and one that completed the SGT task first (51%). Initially, a within-subject analysis had been planned, but initial analyses revealed that performing the first task impacted performance on the second task. Hence, only the performance on the task presented first was retained, and analyses were carried out with a between-subjects procedure.

Finally, chi-squared tests indicated that the IGT and the SGT groups did not differ significantly in terms of sex or ethnicity, and independent samples $t$-tests indicated that the two groups did not differ significantly in terms of age or any of the other predictor variables (i.e., risk-taking behavior and perception variables; see Table 1).

Table 1

*Sample Characteristics for Total Sample and by Group*

| Variable | Total Sample ($N$ = 76) | Group 1: IGT First ($N$ = 37) | Group 2: SGT First ($N$ = 39) |
|---|---|---|---|
| *Mean* Age (*SD*) | 16.29 (.85) | 16.21 (.81) | 16.37 (.88) |
| Sex, % (*n*) | | | |
| Males | 44.7 (34) | 45.9 (17) | 43.6 (17) |
| Females | 55.3 (42) | 54.1 (20) | 56.4 (22) |
| Race or Ethnicity, % (*n*) | | | |
| Chinese | 1.3 (1) | 0 (0) | 2.6 (1) |
| Don't Know | 1.3 (1) | 2.7 (1) | 0 (0) |
| Other | 1.3 (1) | 2.7 (1) | 0 (0) |
| "White" | 92.1 (70) | 91.9 (34) | 92.3 (36) |
| "White" and Chinese | 2.6 (2) | 2.7 (1) | 2.6 (1) |
| "White" and Filipino | 1.3 (1) | 0 (0) | 2.6 (1) |
| Mother Tongue, % (*n*) | | | |
| English | 94.7 (72) | 94.6 (35) | 94.9 (37) |
| French | 5.3 (4) | 5.4 (2) | 5.1 (2) |
| Risk Aversion *M* (*SD*) | 1.69 (.37) | 1.65 (.40) | 1.73 (.34) |
| Risk-Taking Perception *M* (*SD*) | 2.54 (.76) | 2.51 (.85) | 2.56 (.68) |
| Risk-Taking Behavior *M* (*SD*) | .52 (.50) | .58 (.60) | .47 (.39) |
| Social Risk-Taking *M* (*SD*) | | | |
| Comfort with Situation | 1.40 (.58) | 1.41 (.51) | 1.39 (.65) |

| | | | |
|---|---|---|---|
| Frequency of Activity | 1.31 (.43) | 1.31 (.37) | 1.31 (.48) |

**Procedure**

Potential participants who had participated in the previous longitudinal study and met the age requirement were contacted by telephone. Parents were required to provide consent for the younger adolescents. Younger adolescents visited the lab with a parent while older adolescents had the option of visiting with or without a parent. All adolescents completed assent forms (for letters of information, see Appendix A; for consent and assent forms, see Appendix B).

A stratified sampling method was used to obtain an equal number of males and females in each study condition during recruitment. A small compensation ($10) was offered to each participant at completion of the study. All participants completed a demographics questionnaire, followed by the gambling tasks, and the self-report measures. Counterbalancing was used for the gambling tasks, to ensure that order effects could be evaluated. Questionnaires were administered after gambling tasks, so that participants would not be suspicious that the two gambling tasks–presented as games–measured risky decision-making. Research assistants were in the next room while participants completed tasks and questionnaires, to provide assistance or answer questions, as needed. At the end of this process, participants were debriefed, and compensation was provided.

**Measures**

**Demographic information.** Participants were asked to provide their birth date, current grade level, sex, mother tongue, and ethnicity or race with which they identified. The demographics questionnaire was computer-administered.

**Play or Pass Iowa Gambling Task (IGT; Cauffman et al., 2010; Steinberg, 2010).** In this computerized version of the IGT, as in the original task (Bechara, Damasio, & Damasio, 1994), the goal is to maximize monetary gains. The task was presented as a game, and participants were not told beforehand that it specifically assessed risky decision-making, as this could influence their behavior (for debriefing forms, see Appendix C). There were a total of 120 trials, divided into 6 blocks of 20. Dividing the task, and task performance, into blocks of 20 is custom to evaluate the within-subject progression of performance, or learning, which occur as the task progresses (e.g., Bechara et al., 2001; Bechara et al., 2002; Cauffman et al., 2010; Hooper et al., 2004; Hooper et al., 2008; Overman et al., 2004; Weller et al., 2010).

Participants started with a $2,000 pretend loan. They were instructed to maximize their gains on that loan by choosing whether to play or pass from one of four preselected card decks within four seconds (for a screen shot of the beginning of a turn, see Figure 1; for IGT instructions, see Appendix D). If they did not make a choice in time or chose to pass, the turn counted as a pass and the amount of money did not change. Participants had to make play or pass decisions based on their experience with each deck, as cards were face down, and were only turned face up one at a time at the end of each play. The play or pass modification by Cauffman et al. (2010), Peters & Slovic (2000), and Steinberg (2010), enables researchers to identify independent effects of rewards and punishments on following card selections by deck (i.e., approach or avoidance behavior) and minimizes chances that participants use different reasoning or strategies to play a card in any given deck. Indeed, in the original IGT (Bechara et al., 1994), participants can play from any of the four decks at any time, so picking a card in one deck may reflect approach toward that deck, avoidance of the other decks, or even the simple strategy of ignoring all decks but one (Peters & Slovic, 2000).


*Figure 1.* Screenshot of the beginning of a turn for the IGT.

At the end of each turn, participants received feedback as to how much they won or lost as well as their new cumulative total (see Figure 2). The four decks have systematic reward and punishment schedules such that two of the decks offer high rewards but are considered disadvantageous (i.e., result in net loss over repeated trials), while the other offer low rewards but are considered advantageous (i.e., result in net gains over repeated trials; Cauffman et al., 2012; Steinberg, 2010). The systematic reward and punishment schedules are also set up so that two decks yield frequent punishments and two decks yield infrequent punishments. The resulting structure is: *Deck A*: disadvantageous and frequent punishment; *Deck B*: disadvantageous and infrequent punishment; *Deck C*: advantageous and frequent punishment; *Deck D*: advantageous and infrequent punishment. In contrast to Cauffman et al.'s (2010) modified IGT, however, the present version of the IGT does not involve asking participants which decks they think are "good" and which decks they think are "bad" at the end of each block. For a summary of the reinforcement schedule by deck, see Table 2.

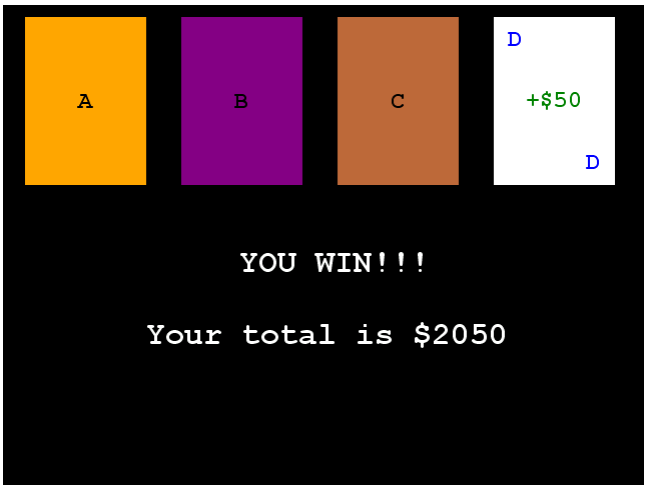


*Figure 2.* Screenshot of the end or feedback part of a turn for the IGT.

***IGT Measures.*** The type of data collected from the IGT was based on Cauffman et al.'s (2010) procedure: Percentage Advantageous Plays (Decks C and D), Percentage Disadvantageous Plays (Decks A and B), and Net Score Plays (Percentage Advantageous Plays minus Percentage Disadvantageous Plays). The Percentage of Plays variables were calculated for each block by dividing the number times participants chose to play from the relevant decks (e.g., A and B) by the number of times those same decks were presented or preselected, and then multiplying the resulting quotient by 100. Net Score Plays represents an estimation of IGT performance which is sensitive to both approach and avoidance behavior, with positive scores indicating a preference for the advantageous decks. With the play or pass option, play ratios are more appropriate than the conventional approach of using simple counts of plays (e.g., as in Bechara et al., 1994; Crone & Van der Molen, 2004; Hooper et al., 2008).

However, several variables relating to punishment frequency were added, since punishment frequency has been found to be predictive of patterns of play and IGT performance (Crone & Van der Molen, 2004; Hooper et al., 2004; Overman et al., 2004). The punishment frequency

Table 2

*Play or Pass IGT Reinforcement Schedule by Deck*

| | Deck | | | |
|---|---|---|---|---|
| Payoff Variable | A | B | C | D |
| Reward and Punishment Range | -$250 to $100 | -$1'150 to $100 | -$25 to $50 | -$200 to $50 |
| Probability of Reward | .50 | .90 | .50 | .90 |
| Probability of Punishment | .50 | .10 | .25 | .10 |
| Probability of $0 Reward | .00 | .00 | .25 | .00 |
| Expected Value* | -$25 | -$25 | $18.75 | $25 |

* Expected value is the average reward or punishment, defined by the total amount of money that it is possible to gain or lose over 40 possible trials, divided by the 40 possible trials.

variables were: Percentage Plays from High Frequency Punishment Decks (A and C), Percentage Plays from Low Frequency Punishment decks (B and D), and Net Score Punishment (Percentage Plays from High Frequency Punishment Decks minus Percentage of Plays from Low Punishment Frequency Decks). Net Score Punishment represents an estimate of IGT Strategy and Punishment Sensitivity, with positive scores indicating a preference for low frequency punishment decks.

**Play or Pass Social Gambling Task (SGT).** The SGT was created for the current study and was formatted in the exact same way as the Play or Pass IGT, except: (a) the goal was to maximize pretend "likes" as can be seen in social networking websites, instead of pretend money, (b) the participants started with zero "likes" instead of a baseline of 2000, and (c) individual cards presented the picture of an adolescent's face on the same side as rewards, punishments ("dislikes"), and "no change" cards (see Figure 3). In addition, (d) the reward and

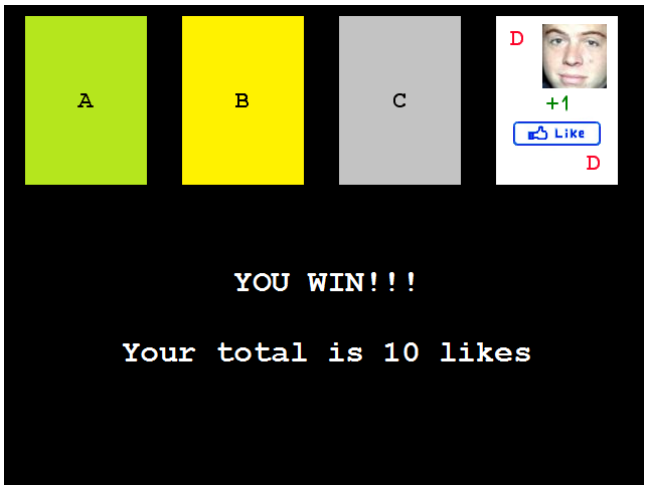


*Figure 3.* Screenshot of the end or feedback part of a turn for the SGT.

punishment schedule for the IGT was adjusted, since the high values used in the IGT would be unrealistic when applied to "likes" (e.g., 1150 dislikes is typically unheard of). So, the SGT reinforcement schedule consisted of IGT rewards and punishments divided by 50 for each trial and each deck. With this procedure, however, some deck C reward values were turned into non-integers (.5 "likes"). Since "likes" are only meaningful and only exist on social networking sites as integers, these deck C reward values were rounded up to one "like."

In order to minimize carryover effects from first presentation (IGT or SGT) to second presentation (SGT or IGT), the decks were in different positions in each game. For the IGT and the SGT, they were laid out from left to right as A, B, C, and D. So the SGT's deck A was the IGT's deck D (advantageous, infrequent punishment); the SGT's deck B was the IGT's deck C (advantageous, frequent punishment); the SGT's deck C was the IGT's deck B (disadvantageous, infrequent punishment); and the SGT's deck D was the IGT's deck A (disadvantageous, frequent punishment). Essentially, A and D reversed positions, and B and C reversed positions (for a full description of decks and their reinforcement schedules, see Table 3).

Pictures of smiling adolescents' faces were purchased from www.canstockphoto.com (for a full list of credits, see Appendix E). A total of 180 pictures were purchased, along with an individual usage license, in order to obtain a set that looked like profile pictures from a social media site. Pictures were cropped (including pictures of multiple adolescents), to obtain small pictures of fairly equivalent sizes with only faces of smiling adolescents and 0-.3 cm of background. The final selection consisted of 60 females and 60 males of diverse racial or ethnic origins, with various backgrounds behind them, various types of lighting, and various facial orientations (a maximum angle of approximately 45° was decided upon as a cut-off for how tilted a face could be). All pictures were of adolescents facing the camera and looking into the lens.

The IGT instructions were also modified to suit the nature of the SGT, which is based on social instead of monetary rewards and punishments. However, preserving similarity between both types of instructions was a priority, since the SGT is aimed at exclusively being a modification of the types of rewards and punishments, but not other aspects of the task (for SGT instructions, see Appendix F).

***SGT measures.*** The measures derived from the SGT were the same as that analyzed for the IGT: Percentage Advantageous Plays (A and B), Percentage Disadvantageous Plays (C and D), Net Score for Plays (Percentage Advantageous Plays minus Percentage Disadvantageous Plays), Percentage Plays from High Frequency Punishment Decks (B and D), Percentage Plays from Low Frequency Punishment Decks (A and C), and Net Score for Punishment (Percentage Plays from High Frequency Punishment Decks minus Percentage of Plays from Low Punishment Frequency Decks).

**Adolescent Risk-Taking Questionnaire (ARQ; Gullone, Moore, et al., 2000).** The ARQ assessed perception of risk-taking behaviors and risk-taking behaviors. A shortened version of

Table 3

*Play or Pass SGT Reinforcement Schedule by Deck*

| | Deck | | | |
|---|---|---|---|---|
| Payoff Variable | A | B | C | D |
| Reward and Punishment Range | -4 to 1 likes | -1 to 1 likes | -23 to 2 likes | -5 to 2 likes |
| Probability of Reward | .90 | .50 | .90 | .50 |
| Probability of Punishment | .10 | .25 | .10 | .50 |
| Probability of 0 Likes | .00 | .25 | .00 | .00 |
| Expected Value* | .5 likes | .25 likes | -.5 likes | -.5 likes |

* Expected value is the average reward or punishment, defined by the total amount of money that it is possible to gain or lose over 40 possible trials, divided by the 40 possible trials.

this self-report questionnaire, comprising 12 items instead of 22 was used (all thrill-seeking items and three antisocial behavior items were dropped). The items were rated twice: once in terms of frequency of behavior (behavior subscale) and once in terms of perception of how risky these behaviors are (perception subscale). Participants thus rated each item or behavior with regard to how risky they perceived it to be, on a 5-point Likert scale (0 = not at all risky, 4 = extremely risky), as well as how often they engaged in the behavior, on a 5-point Likert scale (0 = never done, 4 = done very often; Gullone, Moore, et al., 2000). The current version of the ARQ comprised three factors: rebellious behaviors (e.g., taking drugs or smoking), reckless behaviors (e.g., drinking and driving or having unprotected sex), and antisocial behaviors (e.g., cheating or sniffing gas or glue).

For each of the two subscales (perception and behavior), a mean score was calculated by adding ratings and dividing the sum by the total number of items. Higher scores indicated perceptions of behaviors as being riskier (Risk Perception subscale) and greater engagement in risky behaviors (Risk Behavior subscale). Internal consistency of the four ARQ factors, for each subscale, have been found to be acceptable ($\alpha$ = .70-.89; Gullone, Moore, et al., 2000; Gullone, Paul, & Moore, 2000). Consistently, in the current study, internal consistency was found to be acceptable for the ARQ-B ($\alpha$ = .85) and ARQ-P ($\alpha$ = .90) total scores.

**Social Risk-Taking Scale (SRTS; adapted from Liebowitz, 1987).** The Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987) consists of 24 items which assess social anxiety. Participants are asked to rate each item, describing a situation (e.g., telephoning in public, or going to a party) in terms of two aspects, both on a 4-point Likert scale: how much fear or anxiety that situation would trigger (0 = none, 3 = severe; fear and anxiety subscale), and how much that situation is avoided (0 = never or 0% of the time, 3 = usually or 67-100% of the time; avoidance subscale). Items are divided into two subscales: 13 performance items (e.g., telephoning in public, or participating in small groups) and 11 social interaction items (e.g., going to a party, or returning goods to a store). Higher scores indicate greater dysfunction.

For the present study, it was considered that the LSAS assesses situations that socially anxious individuals find anxiety provoking, and thus avoid, due to their risky nature (e.g., risk of disapproval of others or being rejected). So, a social risk-taker may find these types of situations to be comfortable and have no trouble engaging in them. Therefore, the same 24 situation items were used and the 4-point Likert response format was retained, but the content of the ratings and the two subscales were altered to create the SRTS. The two SRTS subscales were: comfort with the situation (the counterpart of fear and anxiety) and frequency with which the behavior or

activity has been engaged in (the counterpart of avoidance of the situations). The 4-point Likert-type responses were thus adjusted to fit the new subscales: comfort (0 = none, 3 = complete) and behavior frequency (0 = never, 3 = usually). Mean scores were calculated for both subscales by taking the mean of all items, with higher scores indicating higher social risk-taking ability or comfort, and behavior.

Internal consistency for LSAS scores has been deemed good to excellent ($\alpha$ = .71-.98; Beard et al., 2011; Beard, Rodriguez, Weisberg, Perry, & Keller, 2012; Fresco et al., 2001; Heimberg et al., 1999; Heimberg & Holaway, 2007). Consistent with these findings, internal consistency was high in the present study, for the comfort ($\alpha$ = .94) and the frequency ($\alpha$ = .90) subscales of the SRTS.

# CHAPTER 3

# Results

## Plan for Analysis

All analyses were carried out with IBM SPSS software package, version 20. Due to the moderate sample size and the number of variables, as well as deviations from normality in the distribution of some variables, bootstrapping was used for all analyses except RM ANOVAs. Block 6 data for the IGT and the SGT was used for t-tests, bivariate correlations and regressions, based established procedure (e.g., Cauffman et al., 2010; Steinberg, 2010), and because findings from the second half of trials overall are considered more representative of decision-making under conditions of risk instead of trial-and-error, uncertainty, or at best, ambiguity (e.g., Buelow & Suhr, 2009; Stanovich et al., 2003; Weller et al., 2010).

First, an independent samples t-test was used to examine IGT and SGT group differences on IGT and SGT overall performance (Net Score Plays). This analysis indicated whether participants had performed well on both tasks (evidenced by positive scores), and whether IGT performance exceeded SGT performance.

Second, repeated-measures analyses of variance (RM ANOVAs) were used to examine the pattern of plays (IGT and SGT) across blocks for: Net Score Plays, Net Score Punishment, and Percentage of Plays in individual decks, advantageous decks, disadvantageous decks, infrequent punishment decks, and frequent punishment decks (RM ANOVA procedure as in Weller et al., 2010). The purpose of this first stage of analyses was to test whether there were learning effects on each of these variables for both gambling tasks, whether these learning effects looked different between both tasks, and whether collapsing individual decks into broader categories

such as advantageous and disadvantageous for subsequent analyses was justifiable (for the latter, see Cauffman et al., 2010). RM ANOVAs were carried out separately for the SGT and the IGT.

Third, bivariate correlations were used to examine the relations between the two main IGT and SGT outcome variables (Net Score Plays and Net Score Punishment), and other variables (age, Risk-Taking Perception, Risk-Taking Behavior, Social Risk-Taking Comfort, and Social Risk-Taking Frequency; as in Cauffman et al., 2010). These analyses indicated whether overall IGT and SGT performance as well as punishment sensitivity or playing strategy were associated with age and risk-taking variables, and which of these potential predictor variables were to be used in the next step of the analyses.

Fourth, hierarchical regression analyses were carried out to examine which of these other variables (age, Risk-Taking Perception, Risk-Taking Behavior, Social Risk-Taking Comfort, and Social Risk-Taking Frequency), identified as important in the third step of the analyses, predicted IGT and SGT outcome variables (Net scores Plays or Punishment, Percentage Advantageous or Disadvantageous Plays, and Percentage Plays from Infrequent or Frequent Punishment Decks), and to what degree (hierarchical regression as in: Hooper et al., 2004; Hooper et al., 2008; Steinberg, 2010). Game type was also included in the models, to test whether the SGT was more closely associated with risk-taking variables than the IGT was. Since findings have been mixed and a gap in the literature has been identified with regard to sex, sex was included in the first step of the regressions for both tasks. Thus, one hierarchical regression was carried out per gambling task dependent variable: sex was entered in the first step, risk-taking variables and game type in the second step (according to bivariate correlation results), and game X risk-taking variable interactions in the final step.

**Mean Net Score Plays by Task and *T*-Test**

The bootstrapped mean for IGT Net Score Plays at block 6 was positive, indicating that participants performed well on the IGT, as expected ($M$ = 16.49, $SE$ = 4.72, 95% CI [7.43, 26.19]). This finding offered partial support for our first hypothesis that adolescents would perform well on the IGT. The bootstrapped mean for SGT Net Score Plays at block 6 was also positive, indicating that participants performed well on the SGT ($M$ = 20.51, $SE$ = 4.17, 95% CI [12.36, 29.33]). The independent samples t-test indicated that the difference in means was not significant, $t(74) = .64$, $p = .523$, 95% CI [-8.49, 16.54]. This finding failed to support our second hypothesis: in terms of overall performance, participants did not perform worse on the SGT compared to the IGT.

**RM ANOVAs**

This section of results is divided into two subsections based on separate sets of analyses: IGT subgroup and SGT subgroup. Within these subsections, results are presented in three parts: (a) analyses by deck, (b) analyses pertaining to Percentage Plays from Advantageous or Disadvantageous Decks and Net score Plays, and (c) analyses pertaining to Percentage Plays from Infrequent or Frequent punishment deck plays and Net Score Punishment.

**IGT subgroup.** The first four RM ANOVAs examined percentage of plays by block, for each deck (see Figure 4). There was no linear effect of blocks on Percentage Plays from Deck A, $F(1, 36) = 1.18$, $p = .285$, and no linear effect of blocks on Percentage Plays from Deck B, $F(1, 36) = .03$, $p = .873$. Hence, participants in the IGT subgroup did not learn to play less from both disadvantageous decks as trials progressed. With regard to the advantageous decks, there was no linear effect of blocks on Percentage Plays from Deck C, $F(1, 36) = 1.36$, $p = .252$. However, a significant linear effect of blocks on Percentage Plays from Deck D was observed, $F(1, 36) =$

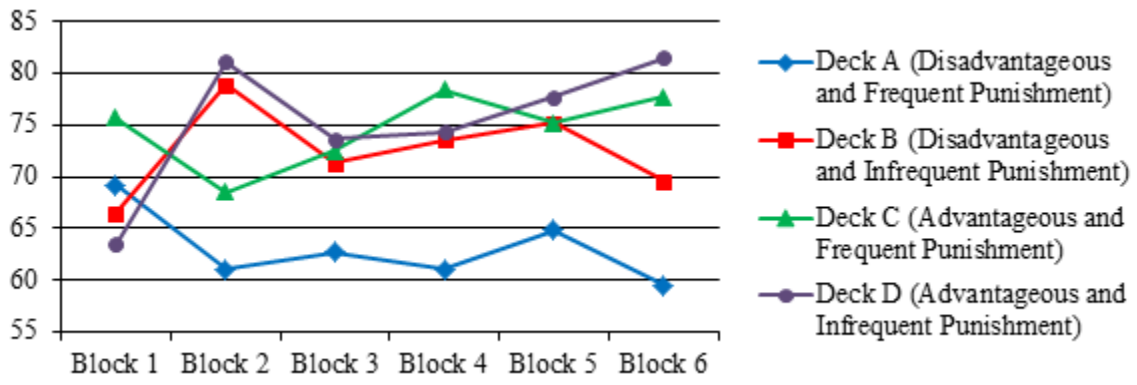


*Figure 4.* Percentage of plays by block and by deck (IGT).

9.23, $p$ = .004. As such, participants in the IGT subgroup only learned to play more from the latter advantageous with infrequent punishment deck.

Following these analyses, decks were aggregated according to being advantageous (C+D) or disadvantageous (A+B), and analyzed with two separate RM ANOVAs (see Figure 5). Percentage Advantageous Plays across blocks linearly increased, $F(1, 36) = 8.48$, $p = .006$. However, there was no linear effect of blocks on Percentage Disadvantageous plays, $F(1, 36) = .35$, $p = .560$. Thus, overall, participants learned to play more from advantageous decks as trials progressed, but did not learn to play less from bad decks, as trials progressed.

The RM ANOVA conducted on Net Score Plays (see Figure 6), which indexes overall IGT performance, revealed a significant linear effect of blocks, $F(1, 36) = 7.16$, $p = .011$. Hence, as participants progressed through the task, they showed a preference for advantageous decks, when both advantageous and disadvantageous decks were considered together.

The last series of RM ANOVAs were conducted on Percentage Plays from Infrequent Punishment Decks (see Figure 7), Percentage Plays from Frequent Punishment Decks (see Figure 7), and Net Score Punishment (see Figure 8). No linear effect of blocks on Percentage Plays from

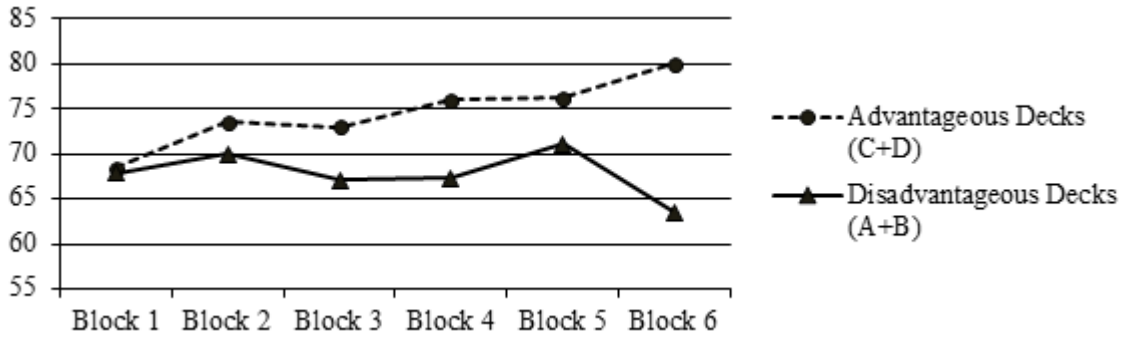


*Figure 5.* Percentage Advantageous and Disadvantageous Plays by block (IGT).

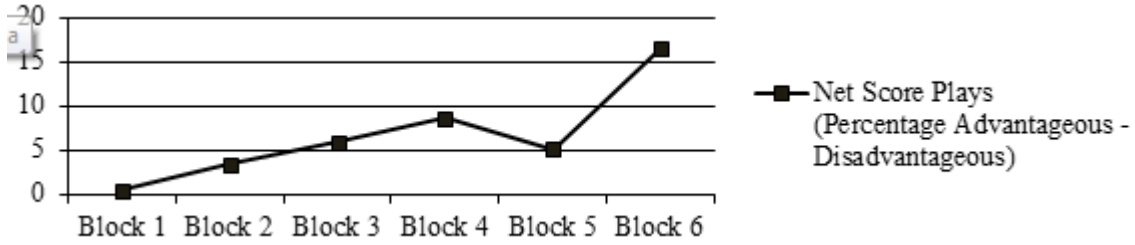


*Figure 6.* Net Score Plays by block (IGT).

Infrequent Punishment Decks was found, $F(1, 36) = 3.55$, $p = .068$. No linear effect of blocks on Percentage Plays from Frequent Punishment Decks was found either, $F(1, 36) = .11$, $p = .748$. Finally, a significant linear effect of blocks on Net Score Punishment was observed, $F(1, 36) = 4.82$, $p = .035$. Participants in the IGT subgroup therefore showed a preference for infrequent punishment decks when both infrequent and frequent punishment deck plays were considered together.

From all of these analyses, it was indeed empirically justified to use Net Score Plays and Punishment at block 6 as dependent variables in the subsequent hierarchical regressions. The adolescents in the current study learned to play more from good decks (approach behavior), but not less from bad decks (avoidance behavior), as trials progressed.

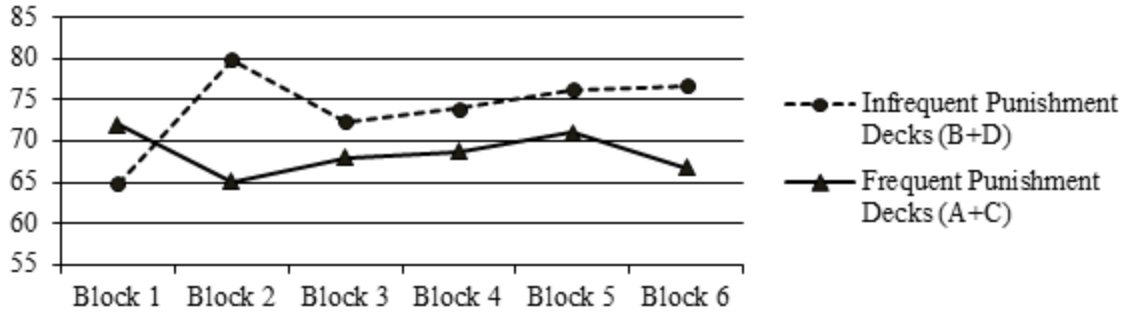


*Figure 7.* Percentage Plays from Infrequent and Frequent Punishment Decks by block (IGT).

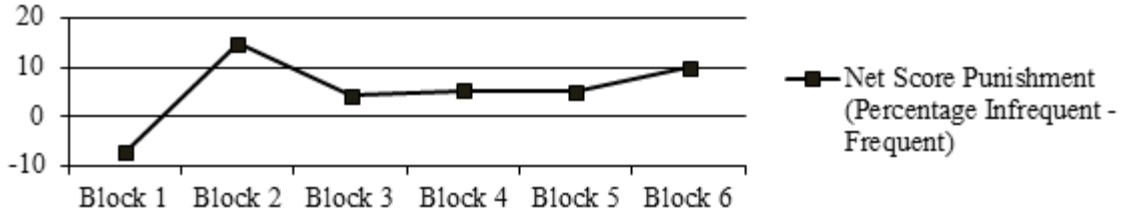


*Figure 8.* Net Score Punishment by block (IGT).

**SGT subgroup.** The first four RM ANOVAs examined percentage of plays by block, for each deck (see Figure 9). A significant linear effect of blocks on Percentage Plays from Deck A was observed, $F(1, 38) = 8.99$, $p = .005$. Hence, participants in the SGT subgroup learned to play more from this advantageous deck as trials progressed, as IGT subgroup participants did–since deck A in SGT is deck D in IGT. No linear effect of blocks on Percentage Plays from Deck B was found, $F(1, 38) = 1.75$, $p = .194$. Thus, similarly to the IGT subgroup results, participants in the SGT subgroup did not learn to play more from the advantageous and frequent punishment deck as trials progressed. For disadvantageous decks, a significant linear effect of blocks on Percentage Plays from Deck C was found, $F(1, 38) = 6.63$, $p = .014$. Hence, participants in the SGT subgroup learned to play less from this disadvantageous deck as trials progressed, while participants in the IGT subgroup did not (deck C in SGT is deck B in IGT). Finally, no linear effect of blocks on Percentage Plays from Deck D was observed, $F(1, 38) = .02$, $p = .881$. Hence,

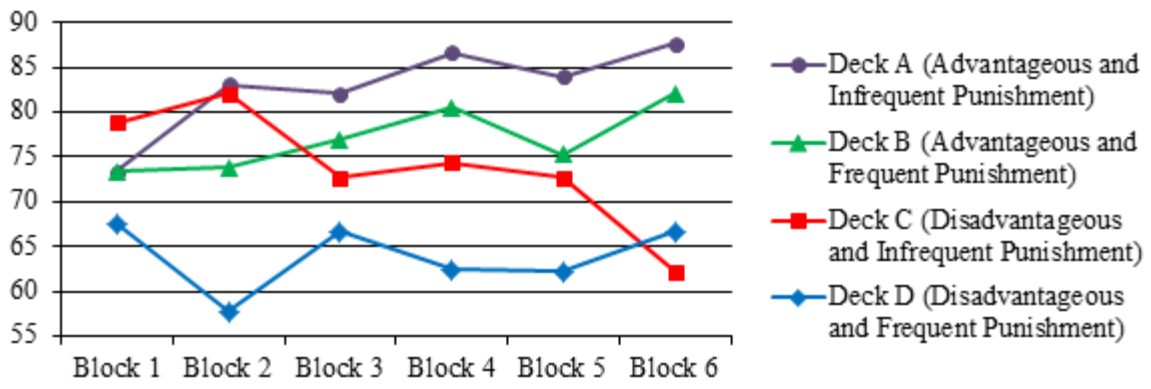


*Figure 9.* Percentage of plays by block and by deck (SGT).

similarly to participants in the IGT subgroup, participants in the SGT subgroup did not learn to play less from this disadvantageous deck (deck D in SGT is deck A in IGT).

Following these analyses, decks were aggregated according to being advantageous (A+B) or disadvantageous (C+D), and analyzed with two separate RM ANOVAs (see Figure 10). A significant linear effect of blocks on Percentage Advantageous Plays was found, $F(1, 38) = 6.73$, $p = .013$. However, no linear effect of blocks on Percentage Disadvantageous plays was observed, $F(1, 38) = 2.88$, $p = .098$. Thus, overall, participants learned to play more from advantageous decks as trials progressed, but did not learn to play less from bad decks (except deck C), as trials progressed.

The RM ANOVA conducted on Net Score Plays (see Figure 11), which indexes overall SGT performance, revealed a significant linear effect of blocks, $F(1, 38) = 17.78$, $p < .001$. Hence, just as in the IGT subgroup, as participants showed a preference for advantageous decks as they progressed through the SGT, when both advantageous and disadvantageous decks were considered together.

The last series of RM ANOVAs were conducted on Percentage Plays from Infrequent

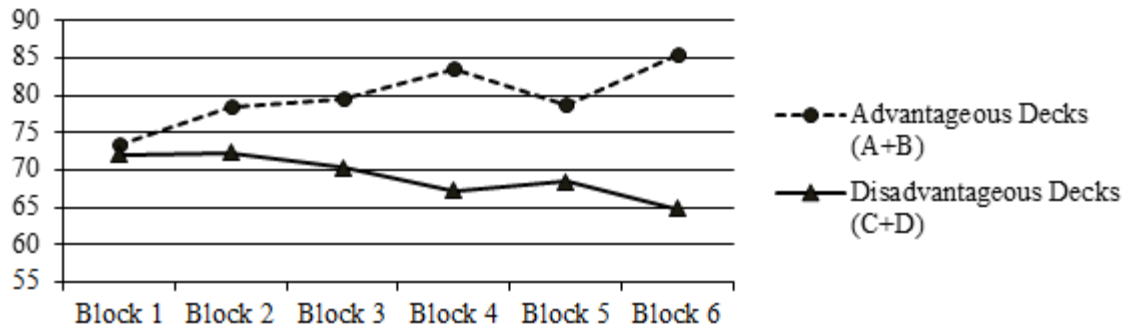


*Figure 10.* Percentage Advantageous and Disadvantageous Plays by block (SGT).

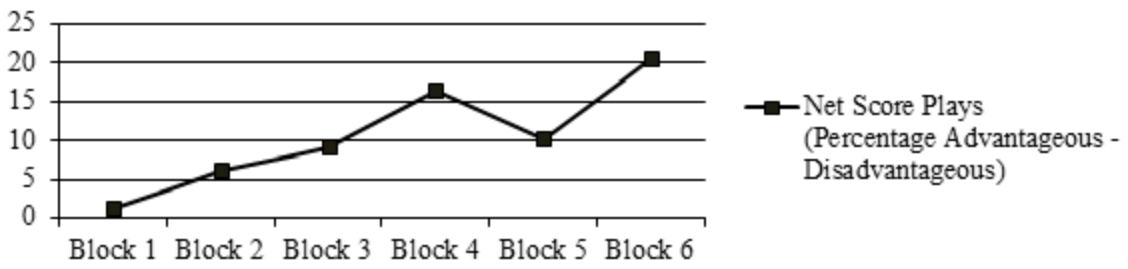


*Figure 11.* Net Score Plays by block (SGT).

Punishment Decks (see Figure 12), Percentage Plays from Frequent Punishment Decks (see Figure 12), and Net Score Punishment (see Figure 13). Similar to IGT subgroup findings, there was no linear effect of blocks on Percentage Plays from Infrequent Punishment Decks, $F(1, 38) = .02$, $p = .893$, and no linear effect of blocks on Percentage Plays from Frequent Punishment Decks, $F(1, 38) = .51$, $p = .479$. In addition, no linear effect of blocks on Net Score Punishment was found either, $F(1, 38) = .76$, $p = .390$. Participants in the SGT subgroup therefore failed to develop any preferences for different types of punishment schedules as they progressed through the task.

The totality of these analyses disconfirmed the second part of our second hypothesis, as overall, participants did not learn better with the SGT compared to the IGT. The only striking

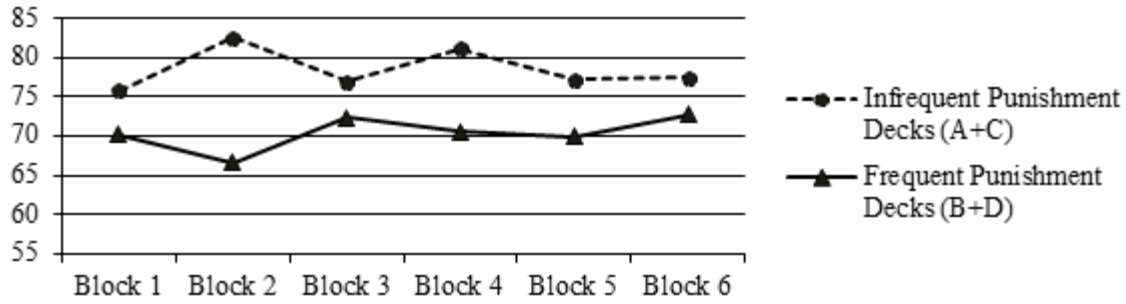


*Figure 12.* Percentage Plays from Infrequent and Frequent Punishment Decks by block (SGT).

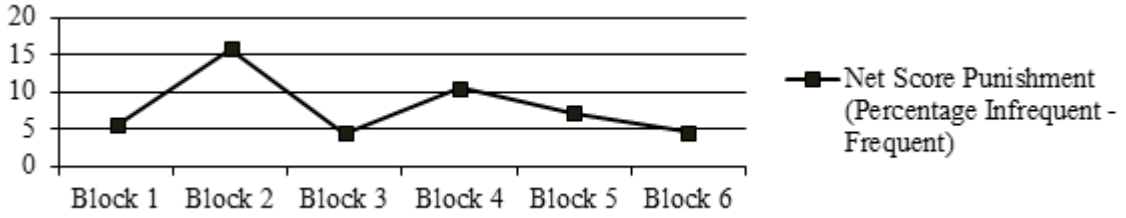


*Figure 13.* Net Score Punishment by block (SGT).

difference in findings between both groups and tasks was that participants learned to play less from disadvantageous deck C in the SGT (deck B on the IGT), which they did not on the IGT. Overall, findings pertaining to patterns of plays from individual decks were somewhat similar to IGT findings reported by Cauffman et al. (2010), except for the SGT deck D, for which the slope was close to flat. In addition, consistent with IGT results, the adolescents in the current study learned to play more from good SGT decks (approach behavior), but not less from bad SGT decks (avoidance behavior).

**Bivariate Correlations**

Bivariate correlations were examined for the IGT and the SGT groups separately. The variables entered were: age, Risk-Taking Perception, Risk-Taking Behavior, Comfort with Social Risk-Taking, Frequency of Social Risk-Taking, Percentage Advantageous Plays, Percentage

Disadvantageous Plays, Net Score Plays, Percentage Plays from Infrequent Punishment Decks, Percentage Plays from Frequent Punishment Decks, and Net Score Punishment.

**IGT subgroup.** Results for this subgroup are presented in Table 4. Among predictor variables, age was positively related to Risk-Taking Behavior, which is consistent with previous findings. Risk-Taking Behavior was also positively related to Social Risk-Taking Frequency. In addition, it is worth noting that the inverse relation between Risk-Taking Behavior and Risk-Taking Perception approached significance at the .05 level, $p = .058$. Comfort with Social Risk-taking was positively related to Social Risk-Taking Frequency.

Only one predictor variable was related to one IGT variable: Risk-Taking Perception was negatively related to Percentage Advantageous Plays. Thus, participants who perceived risk-taking behaviors to be riskier were less likely to plays instead of pass on selections from advantageous decks (C+D).

**SGT subgroup.** Results for this subgroup are in Table 5. In contrast to IGT subgroup findings, age was not related to any variables. Among predictor variables, Risk-Taking Behavior was inversely related to Risk-Taking perception. Comfort with Social Risk-taking was positively related to Social Risk-Taking Frequency, as in the IGT subgroup.

Only one predictor variable was related to one SGT variable: Risk-Taking Perception was negatively related to Percentage Plays from Frequent Punishment Decks. Therefore, participants who perceived risk-taking behaviors to be riskier were less likely to play versus pass from frequent punishment decks (B+D).

**Hierarchical Regressions**

Following Steinberg's statistical procedure (2010), the hypotheses tested with hierarchical regression were: (a) whether overall IGT or SGT performance (Net Score Plays; stacked data)

Table 4

*Results of Correlational Analyses (IGT)*

| Variable | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age | -.20 | .42** | .16 | .08 | .04 | -.08 | .10 | -.02 | -.03 | .02 |
| 2. ARQ-P | 1.00 | -.32 | .04 | .03 | -.38* | -.05 | -.24 | -.30 | -.15 | -.09 |
| 3. ARQ-B | | 1.00 | .17 | .35* | .22 | .02 | .14 | .14 | .11 | .01 |
| 4. SRTS-C | | | 1.00 | .64** | -.11 | .03 | -.10 | .12 | -.17 | .24 |
| 5. SRTS-F | | | | 1.00 | .14 | -.05 | .15 | .18 | -.08 | .20 |
| 6. Adv. | | | | | 1.00 | .17 | .59** | .69** | .51** | .07 |
| 7. Disadv. | | | | | | 1.00 | -.70** | .49** | .77** | -.32 |
| 8. NS Plays | | | | | | | 1.00 | .10 | -.26 | .31 |
| 9. IF. Punish. | | | | | | | | 1.00 | .29 | .50** |
| 10. F. Punish. | | | | | | | | | 1.00 | -.69** |
| 11. NS Punish. | | | | | | | | | | 1.00 |

Note: ARQ-P = Risk-Taking Perception; ARQ-B = Risk-Taking Behavior; SRTS-C = Comfort with Social Risk-Taking; SRTS-F = Frequency of Social Risk-Taking; Adv. = Percentage Advantageous Plays (C+D) at block 6; Disadv. = Percentage Disadvantageous Plays (A+B) at block 6; NS Plays = Net Score Plays at block 6; IF. Punish. = Percentage Plays from Infrequent Punishment Decks (B+D) at block 6; F. Punish. = Percentage Plays from Frequent Punishment Decks (A+C)at block 6; NS Punish. = Net Score Punishment at block 6
* $p < .05$ (two-tailed) ** $p < .01$ (two-tailed)

Table 5

*Results of Correlational Analyses (SGT)*

| Variable | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age | .04 | .22 | -.04 | -.03 | -.09 | -.08 | .02 | -.11 | -.07 | -.02 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2. ARQ-P | 1.00 | -.47** | .00 | -.03 | -.28 | -.29 | .09 | -.28 | -.32* | .10 |
| 3. ARQ-B | | 1.00 | .22 | .24 | .06 | .10 | -.06 | .02 | .15 | -.14 |
| 4. SRTS-C | | | 1.00 | .74** | .21 | .07 | .08 | .02 | .22 | -.21 |
| 5. SRTS-F | | | | 1.00 | .12 | .22 | -.13 | .07 | .27 | -.22 |
| 6. Adv. | | | | | 1.00 | .32* | .37* | .72** | .55** | .02 |
| 7. Disadv. | | | | | | 1.00 | -.76** | .63** | .84** | -.36* |
| 8. NS Plays | | | | | | | 1.00 | -.12 | -.45** | .36* |
| 9. IF. Punish. | | | | | | | | 1.00 | .44** | .37* |
| 10. F. Punish. | | | | | | | | | 1.00 | -.67** |
| 11. NS Punish. | | | | | | | | | | 1.00 |

Note: ARQ-P = Risk-Taking Perception; ARQ-B = Risk-Taking Behavior; SRTS-C = Comfort with Social Risk-Taking; SRTS-F = Frequency of Social Risk-Taking; Adv. = Percentage Advantageous Plays (C+D) at block 6; Disadv. = Percentage Disadvantageous Plays (A+B) at block 6; NS Plays = Net Score Plays at block 6; IF. Punish. = Percentage Plays from Infrequent Punishment Decks (B+D) at block 6; F. Punish. = Percentage Plays from Frequent Punishment Decks (A+C)at block 6; NS Punish. = Net Score Punishment at block 6
* $p < .05$ (two-tailed) ** $p < .01$ (two-tailed)

could be predicted by risk-taking variables and gambling task type, above and beyond sex; (b) whether overall IGT or SGT playing strategy (Net Score Punishment; stacked data), could be predicted by risk-taking variables and gambling task type, above and beyond sex; and (c) whether lower-level IGT or SGT outcome variables (Percentage Advantageous Plays, Percentage Disadvantageous Plays, Percentage Plays from Infrequent Punishment Decks, and Percentage Plays from Frequent Punishment Decks; stacked data for each variable) could be predicted by risk-taking variables and gambling task type, above and beyond sex.

Based on results from the previously reported bivariate correlations, age was excluded from regression predictors, as it was not related to any IGT or SGT variables. Among the risk-

taking variables, only Risk-Taking Perception was found to be related to gambling task variables, so it was included as a regression predictor. However, Risk-Taking Behavior was associated with perception in one subgroup, and was of central interest to the present study, so it was included as well. Finally, Social Risk-Taking Frequency was also included due to its importance in the present study, despite not being related to any variables except Social Risk-Taking Comfort. The latter variable was excluded, as it provided redundant information with the latter.

Thus, sex was entered in the first step; Task Type, Risk-Taking Perception, Risk-Taking Behavior, and Social Risk-Taking Frequency were entered in the second step; and interaction terms (Task X risk-taking variables) were entered in the final step. From the RM ANOVAs reported above, it was concluded that the primary dependent variables to examine with regression were Net score Plays and Net Score Punishment. Follow-up analyses were then aimed at looking into other, secondary variables (Percentage Advantageous and Disadvantageous Plays, and Percentage Plays from Infrequent and Frequent Punishment Decks), since there were some inconsistencies in individual decks versus deck aggregates and net score variables versus deck aggregates (c.f., RM ANOVAs).

**Net Score Plays.** Results from the first step revealed that sex on its own did not account for a significant amount of variability in Net Score Plays (see Table 6). Moreover, adding Task Type and the three risk-taking variables did not significantly predict Net Score Plays either, or improve upon the first model. Finally, adding three interaction terms (Task Type X risk-taking variables) did not significantly predict Net Score Plays either, or improve upon the second model.

**Net Score Punishment.** Results from the first step revealed that sex on its own did not account for a significant amount of variability in Net Score Punishment (see Table 7). Adding Task Type and the three risk-taking variables did not significantly predict Net Score Punishment

Table 6

*Summary of Hierarchical Regression Analysis for Variables Predicting IGT and SGT Net Score*

| Variable | *b* | *SE b* | β | *t* | $R^2$ | *F* | $\Delta R^2$ | $\Delta F$ |
|---|---|---|---|---|---|---|---|---|
| Model 1 | | | | | .03 | 2.34 | .03 | 2.34 |
| Sex | -9.54 | 6.23 | -.18 | -1.53 | | | | |
| Model 2 | | | | | .04 | .63 | .01 | .23 |
| Sex | -9.22 | 6.58 | -.17 | -1.40 | | | | |
| Task Type | -4.68 | 6.38 | -.09 | -.73 | | | | |
| ARQ-P | -1.32 | 4.68 | -.04 | -.28 | | | | |
| ARQ-B | 3.23 | 7.24 | .06 | .45 | | | | |
| SRTS-F | -1.29 | 7.76 | -.02 | -.17 | | | | |
| Model 3 | | | | | .09 | .85 | .05 | 1.20 |
| Sex | -10.10 | 6.61 | -.19 | -1.53 | | | | |
| Task Type | 5.40 | 32.74 | .10 | .17 | | | | |
| ARQ-P | 18.83 | 16.17 | .53 | 1.17 | | | | |
| ARQ-B | -.45 | 28.33 | -.01 | -.02 | | | | |
| SRTS-F | -23.22 | 23.25 | -.37 | -1.00 | | | | |
| Task Type X ARQ-P | -12.80 | 9.46 | -.83 | -1.35 | | | | |
| Task Type X ARQ-B | 1.57 | 16.07 | .05 | .10 | | | | |
| Task Type X SRTS-F | 16.60 | 16.33 | .55 | 1.02 | | | | |

Note: Task Type = IGT versus SGT; ARQ-P = Risk-Taking Perception; ARQ-B = Risk-Taking Behavior; SRTS-F = Frequency of Social Risk-Taking.
* $p < .05$ (two-tailed)

Table 7

*Summary of Hierarchical Regression Analysis for Variables Predicting IGT and SGT Net Score Punishment*

| Variable | *b* | *SE b* | β | *t* | $R^2$ | *F* | $\Delta R^2$ | $\Delta F$ |
|---|---|---|---|---|---|---|---|---|
| Model 1 | | | | | .02 | 1.42 | .02 | 1.42 |
| Sex | -6.60 | 5.42 | -.14 | -1.19 | | | | |
| Model 2 | | | | | .03 | .48 | .01 | .26 |
| Sex | -6.51 | 5.84 | -.14 | -1.12 | | | | |
| Task Type | 5.45 | 5.67 | .11 | .96 | | | | |
| ARQ-P | .21 | 4.16 | .01 | .05 | | | | |
| ARQ-B | -1.89 | 6.43 | -.04 | -.29 | | | | |
| SRTS-F | -.87 | 6.89 | -.02 | -.13 | | | | |
| Model 3 | | | | | .09 | .84 | .06 | 1.43 |
| Sex | -6.68 | 5.85 | -.14 | -1.14 | | | | |
| Task Type | -9.41 | 28.94 | -.20 | -.33 | | | | |
| ARQ-P | 11.00 | 14.29 | .35 | .77 | | | | |
| ARQ-B | -2.95 | 25.04 | -.06 | -.12 | | | | |
| SRTS-F | -34.86 | 20.55 | -.62 | -1.70 | | | | |
| Task Type X ARQ-P | -7.14 | 8.36 | -.53 | -.85 | | | | |
| Task Type X ARQ-B | -.53 | 14.21 | -.02 | -.04 | | | | |
| Task Type X SRTS-F | 25.54 | 14.44 | .96 | 1.77 | | | | |

Note: Task Type = IGT versus SGT; ARQ-P = Risk-Taking Perception; ARQ-B = Risk-Taking Behavior; SRTS-F = Frequency of Social Risk-Taking.
* $p < .05$ (two-tailed)

either, or improve upon the first model. Finally, adding the three interaction terms did not significantly predict Net Score Punishment, or improve upon the second model.

**Percentage Advantageous Plays.** Results from the first step revealed that sex on its own did not account for a significant amount of variability in Percentage Advantageous Plays (see Table 8). However, adding Task Type and the three risk-taking variables led to significant prediction of Percentage Advantageous Plays, and a significant improvement in the model. Finally, adding the three interaction terms did not significantly predict Percentage Advantageous Plays, or improve upon the second model. Only one Beta coefficient was significant: Risk-Taking Perception, in the second model. Hence, approach behavior on the IGT and the SGT was only negatively related to perceiving risk-taking behaviors as riskier, above and beyond sex. This finding is consistent with the results of the correlational analyses.

**Percentage Disadvantageous Plays.** Sex on its own did not account for a significant amount of variability in Percentage Disadvantageous Plays (see Table 9). Adding Task Type and the three risk-taking variables did not significantly predict Percentage Disadvantageous Plays either, or improve upon the model. Finally, adding the three interaction terms did not lead to significant prediction of Disadvantageous Plays, or improve upon the second model. Only two Beta coefficients approached significance at the .05 level: sex, $p = .058$, and Risk-Taking Perception, $p = .051$, in the third model.

**Percentage Plays from Infrequent Punishment Decks.** Sex on its own did not account for a significant amount of variability in Percentage Plays from Infrequent Punishment Decks (see Table 10). Adding Task Type and the three risk-taking variables did not significantly predict Plays from Infrequent Punishment Decks either, or improve upon the model. Finally, adding the three interaction terms did not lead to significant prediction of Infrequent Punishment Deck

Table 8

*Summary of Hierarchical Regression Analysis for Variables Predicting IGT and SGT Percentage Advantageous Plays*

| Variable | *b* | *SE b* | β | *t* | $R^2$ | *F* | $\Delta R^2$ | $\Delta F$ |
|---|---|---|---|---|---|---|---|---|
| Model 1 | | | | | .00 | .09 | .00 | .09 |
| Sex | -1.39 | 4.53 | -.04 | -.31 | | | | |
| Model 2 | | | | | .15 | 2.49* | .15 | 3.09* |
| Sex | 1.50 | 4.43 | .04 | .34 | | | | |
| Task Type | -5.78 | 4.30 | -.15 | -1.35 | | | | |
| ARQ-P | -8.94** | 3.15 | -.35 | -2.84** | | | | |
| ARQ-B | -.20 | 4.88 | -.01 | -.04 | | | | |
| SRTS-F | 5.76 | 5.23 | .13 | 1.10 | | | | |
| Model 3 | | | | | .16 | 1.61 | .01 | .27 |
| Sex | 1.14 | 4.55 | .03 | .25 | | | | |
| Task Type | -12.59 | 22.51 | -.33 | -.56 | | | | |
| ARQ-P | -9.40 | 11.11 | -.37 | -.85 | | | | |
| ARQ-B | -14.34 | 19.47 | -.37 | -.74 | | | | |
| SRTS-F | 3.44 | 15.98 | .08 | .22 | | | | |
| Task Type X ARQ-P | .08 | 6.50 | .01 | .01 | | | | |
| Task Type X ARQ-B | 8.12 | 11.05 | .39 | .74 | | | | |
| Task Type X SRTS-F | 1.95 | 11.23 | .09 | .17 | | | | |

Note: Task Type = IGT versus SGT; ARQ-P = Risk-Taking Perception; ARQ-B = Risk-Taking Behavior; SRTS-F = Frequency of Social Risk-Taking.
* $p < .05$ (two-tailed) ** $p < .01$ (two-tailed)

Table 9

*Summary of Hierarchical Regression Analysis for Variables Predicting IGT and SGT Percentage Disadvantageous Plays*

| Variable | *b* | *SE b* | β | *t* | $R^2$ | *F* | $\Delta R^2$ | $\Delta F$ |
|---|---|---|---|---|---|---|---|---|
| Model 1 | | | | | .03 | 2.12 | .03 | 2.12 |
| Sex | 8.15 | 5.60 | .17 | 1.46 | | | | |
| Model 2 | | | | | .09 | 1.30 | .06 | 1.09 |
| Sex | 10.72 | 5.77 | .22 | 1.86 | | | | |
| Task Type | -1.10 | 5.60 | -.02 | -.20 | | | | |
| ARQ-P | -7.62 | 4.10 | -.24 | -1.86 | | | | |
| ARQ-B | -3.43 | 6.35 | -.07 | -.54 | | | | |
| SRTS-F | 7.05 | 6.81 | .12 | 1.04 | | | | |
| Model 3 | | | | | .13 | 1.23 | .04 | 1.11 |
| Sex | 11.23 | 5.81 | .23 | 1.93 | | | | |
| Task Type | -18.00 | 28.78 | -.37 | -.63 | | | | |
| ARQ-P | -28.23 | 14.21 | -.88 | -1.99 | | | | |
| ARQ-B | -13.89 | 24.89 | -.29 | -.56 | | | | |
| SRTS-F | 26.65 | 20.43 | .47 | 1.30 | | | | |
| Task Type X ARQ-P | 12.88 | 8.31 | .94 | 1.55 | | | | |
| Task Type X ARQ-B | 6.55 | 14.13 | .25 | .46 | | | | |
| Task Type X SRTS-F | -14.66 | 14.35 | -.54 | -1.02 | | | | |

Note: Task Type = IGT versus SGT; ARQ-P = Risk-Taking Perception; ARQ-B = Risk-Taking Behavior; SRTS-F = Frequency of Social Risk-Taking.
* $p < .05$ (two-tailed)

Table 10

*Summary of Hierarchical Regression Analysis for Variables Predicting IGT and SGT Percentage Plays from Infrequent Punishment Decks*

| Variable | *b* | *SE b* | β | *t* | $R^2$ | *F* | $\Delta R^2$ | $\Delta F$ |
|---|---|---|---|---|---|---|---|---|
| Model 1 | | | | | .00 | .00 | .00 | .00 |
| Sex | .08 | 4.39 | .00 | .02 | | | | |
| Model 2 | | | | | .10 | 1.63 | .10 | 2.03 |
| Sex | 2.86 | 4.41 | .08 | .65 | | | | |
| Task Type | -.72 | 4.28 | -.02 | -.17 | | | | |
| ARQ-P | -8.17* | 3.14 | -.33 | -2.61* | | | | |
| ARQ-B | -2.76 | 4.86 | -.07 | -.57 | | | | |
| SRTS-F | 5.97 | 5.20 | .14 | 1.15 | | | | |
| Model 3 | | | | | .12 | 1.13 | .01 | .37 |
| Sex | 2.84 | 4.52 | .08 | .63 | | | | |
| Task Type | -19.99 | 22.35 | -.53 | -.89 | | | | |
| ARQ-P | -13.32 | 11.04 | -.54 | -1.21 | | | | |
| ARQ-B | -15.59 | 19.34 | -.42 | -.81 | | | | |
| SRTS-F | -2.38 | 15.87 | -.05 | -.15 | | | | |
| Task Type X ARQ-P | 2.91 | 6.46 | .27 | .45 | | | | |
| Task Type X ARQ-B | 7.07 | 10.97 | .35 | .65 | | | | |
| Task Type X SRTS-F | 6.41 | 11.15 | .31 | .58 | | | | |

Note: Task Type = IGT versus SGT; ARQ-P = Risk-Taking Perception; ARQ-B = Risk-Taking Behavior; SRTS-F = Frequency of Social Risk-Taking.
* $p < .05$ (two-tailed)

Plays, or improve upon the second model. Only one Beta coefficient was significant: Risk-Taking Perception, in the second model. Hence, after sex has been accounted for, individuals who perceived risk-taking behaviors to be riskier tended to play less and pass more from infrequent, but high magnitude, punishment decks on the IGT and the SGT. This result is inconsistent with the results of the correlational analyses.

**Percentage Plays from Frequent Punishment Decks.** This variable exhibited the same pattern as Percentage Plays from Infrequent Punishment Decks did (see Table 11). The first, second and third models did not significantly predict Percentage Plays from Frequent Punishment Decks. The second failed to improve upon the first model, just as the third model failed to improve upon the second model. Only one Beta coefficient was significant: Risk-Taking Perception, in the second model. Hence, after sex has been accounted for, individuals who perceive risk-taking behaviors to be riskier tend to play less and pass more from frequent, but low magnitude, punishment decks on the IGT and the SGT. This result is consistent with the results of the correlational analyses.

Table 11

*Summary of Hierarchical Regression Analysis for Variables Predicting IGT and SGT Percentage Plays from Frequent Punishment Decks*

| Variable | *b* | *SE b* | β | *t* | $R^2$ | *F* | $\Delta R^2$ | $\Delta F$ |
|---|---|---|---|---|---|---|---|---|
| Model 1 | | | | | .02 | 1.57 | .02 | 1.57 |
| Sex | 6.68 | 5.34 | .14 | 1.25 | | | | |
| Model 2 | | | | | .12 | 1.91 | .10 | 2.00 |
| Sex | 9.37 | 5.38 | .20 | 1.74 | | | | |
| Task Type | -6.17 | 5.22 | -.13 | -1.18 | | | | |
| ARQ-P | -8.38* | 3.82 | -.28 | -2.19* | | | | |
| ARQ-B | -.88 | 5.92 | -.02 | -.15 | | | | |
| SRTS-F | 6.84 | 6.34 | .13 | 1.08 | | | | |
| Model 3 | | | | | .16 | 1.63 | .04 | 1.15 |
| Sex | 9.52 | 5.41 | .21 | 1.76 | | | | |
| Task Type | -10.58 | 26.79 | -.23 | -.40 | | | | |
| ARQ-P | -24.32 | 13.23 | -.80 | -1.84 | | | | |
| ARQ-B | -12.64 | 23.18 | -.27 | -.55 | | | | |
| SRTS-F | 32.48 | 19.03 | .60 | 1.71 | | | | |
| Task Type X ARQ-P | 10.05 | 7.74 | .77 | 1.30 | | | | |
| Task Type X ARQ-B | 7.60 | 13.15 | .31 | .58 | | | | |
| Task Type X SRTS-F | -19.13 | 13.36 | -.75 | -1.43 | | | | |

Note: Task Type = IGT versus SGT; ARQ-P = Risk-Taking Perception; ARQ-B = Risk-Taking Behavior; SRTS-F = Frequency of Social Risk-Taking.
* $p < .05$ (two-tailed)

# CHAPTER 4

## Discussion

The aim of the current study was to validate the Social Gambling Task (SGT) as a measure of adolescent risk-taking by investigating its relationship to risk-taking variables (Risk-Taking Behavior, Risk-Taking Perception, Social Risk-Taking Frequency and Comfort) and sex, as well as comparing its structure to that of the Iowa Gambling Task (IGT), among mid- to late-adolescents. The first hypothesis, that adolescents would exhibit good overall performance on the IGT, was partially supported. Participants obtained positive mean Net Score Play Scores over the second half of trials and learned to play more from advantageous decks as trials progressed, but not less from bad decks (consistent with Cauffman et al., 2010). However, the second hypothesis, that adolescents would perform less well on the SGT compared to the IGT, was not supported. Participants learned to play more from good decks, and also obtained positive mean Net Score Play Scores over the second half of trials on the SGT, similar to the IGT. In addition, no support was found for the third hypothesis, that females would show a preference for infrequent punishment decks on both tasks, since there were no sex effects on any of the punishment variables. As well, no support was found for our fourth hypothesis, that females would outperform males on the SGT, since there were no overall sex effects on any of the play variables. Finally, no support was found for the central hypotheses of the study, as the SGT did not predict self-reported Risk-Taking Perception and Behavior to a greater degree than the IGT, after accounting for sex.

### IGT and SGT Comparisons

On both gambling tasks, greater infrequent punishment decks plays were more strongly associated with greater advantageous deck plays compared to disadvantageous deck plays, and

conversely, greater frequent punishment deck plays were more strongly associated with greater disadvantageous deck plays compared to advantageous decks plays. Hence, punishment sensitivity or playing strategy partially accounted for approach behavior of good and bad decks. This effect was more pronounced in the SGT than in the IGT, as only in the SGT was overall performance (Net Score Plays) negatively related to greater frequent punishment deck plays, and positively related to a preference for low punishment decks (Net Score Punishment). It can therefore be concluded that punishment sensitivity or playing strategy has a greater impact on overall SGT performance than overall IGT performance.

The SGT presented a few structural differences with the IGT. In the SGT, increased plays from advantageous decks and disadvantageous decks were negatively related and increased plays from low punishment frequency and high punishment frequency decks were positively related. However, these two pairs of variables have been found to be independent in the IGT in the current study, consistent with theoretical underpinnings (e.g., Cauffman et al., 2010). A plausible reason for SGT punishment variables not being independent may be that participants failed to learn to discriminate between infrequent compared to frequent punishment decks in the SGT, and thus played similarly from both types of decks. This hypothesis is supported by the finding that participants showed no learning effects on either type of deck in the SGT. The advantageous and disadvantageous play variables not being independent may be accounted for by the following hypothesis: the problematic “preference for deck B” effect (e.g., Chiu et al., 2008; also found but not discussed in Cauffman et al., 2010; Johnson et al., 2008; Sevy et al., 2007) appeared less marked in the SGT than in the IGT, especially at block 6 (see Figures 4 and 9). As a result, SGT participants who played more from good decks also played less from both bad decks simultaneously, by block 6. By comparison, the SGT appears more consistent with the expected

value account of gambling task performance proposed by Bechara et al. (1994) than the IGT, since SGT participants were better able to identify expected value as the SGT progressed. However, the fact that this trend was exhibited simultaneously with punishment variables accounting for part of overall SGT performance sheds doubt on the conclusion by Chiu et al. (2008) that expected value and punishment frequency are mutually exclusive explanations for gambling task performance.

**Age, Sex, and Gambling Task Performance**

The current study revealed no age or sex effects on IGT or SGT performance. Indeed, consistent with Overman et al. (2004), but not with Cauffman et al. (2010), our participants (ages 14-18) did not exhibit different performance on IGT performance according to age. One hypothesis may, at least in part, account for this discrepancy with Cauffman et al. (2010), as in our study, the curvilinear effect of age was not hypothesized or tested. No hypotheses had been formulated about the relation between SGT performance and age, given that it was not central to the current study. Hence, all that can be concluded from this finding is that the SGT behaves similarly to the IGT with regard to age. Regarding sex, finding no effect on overall IGT performance was consistent with past results with adolescent populations (Cauffman et al., 2010; Crone et al., 2005; Hooper et al., 2004; Hooper et al., 2008; Overman et al., 2004). The current study also found no effect of sex on other IGT and SGT outcome variables (Percentage Advantageous or Disadvantageous Plays, and Percentage Plays from Infrequent or Frequent Punishment Decks), which is discrepant with past IGT findings (Cauffman et al., 2010; Crone et al., 2005; Hooper et al., 2004; Overman et al., 2004). It therefore seems that both the IGT and the SGT, as indexed by all outcome variables, are relatively insensitive to sex-specific processes which underlie sex differences in real-life risk-taking. However, past findings pertaining to sex

had shown inconsistent effects of sex, so the current results may simply have been due to the simultaneous presence of opposing sex effects (e.g., some males select more from advantageous decks, but some females did as well), which cancelled each other out.

**Association with Risk-Taking Perception**

When both gambling tasks were analyzed together, only Risk-Taking Perception was found to be related to some of the outcome variables above and beyond sex (Percentage Advantageous Plays, Percentage Plays from Infrequent Punishment Decks, and Percentage Plays from Frequent Punishment Decks). When the IGT and the SGT were analyzed separately, Risk-Taking Perception was negatively associated with Percentage Advantageous Plays in the IGT, and with Percentage Plays from Frequent Punishment Decks in the SGT. These findings suggest that adolescents who perceived risk-taking behaviors to be riskier were less likely to play from good decks on the IGT, whereas they were less likely to play from frequent (but low) punishment decks on the SGT. In addition, when both tasks were considered together, adolescents who perceived risk-taking behaviors as riskier were less likely to play from good, low frequency punishment, and high frequency punishment decks, with no significant differences between tasks. Higher risk-perception thus appears to be negatively related to approach behavior in situations of risk, as assessed by both the IGT and the SGT, but without any relation to real-life risk-taking behavior.

Importantly, the lack of associations with risk-taking behaviour indicated a lack of convergent validity of both the IGT and the SGT as assessment tools for adolescent risk-taking behavior in normative adolescent populations. This conclusion has important implications for the assessment of adolescent risk-taking, since a fundamental premise for using a behavioral measure of risk-taking is that adolescents take more risks in situations of high emotional salience, such as

group settings, and behavioral measures such as the IGT or the SGT are hypothesized to increase emotional salience (Cauffman & Steinberg, 2000; Chein et al., 2011; Gardner & Steinberg, 2005; Steinberg, 2004; Steinberg, 2005; Steinberg, 2008; Steinberg & Scott, 2003). It is therefore possible that the IGT–and even the SGT, with its social reward and punishments–do not sufficiently increase emotional salience to adequately capture the processes involved in real-life adolescent risk-taking. Part of the issue here may be that these behavioral measures are still used in an individual setting. Additionally, in the context of the SGT specifically, the rewards and punishments in the task may also not be perceived as realistic enough (e.g., multiple "likes" from one person, which does not happen in social media) to sufficiently increase emotional salience, activate social-affective networks, or be perceived as different from monetary incentives. Furthermore, it is also possible that the processes involved in adolescent risk-taking are not differentially impacted by the use of social incentives compared to monetary incentives in laboratory-based measures such as the IGT and the SGT. If this is the case, the issue with assessing real-life adolescent risk-taking propensities with the IGT or the SGT lies not in the type of incentives used, but in the nature of the tasks themselves. Future research will be needed to test this hypothesis, by investigating the relation between SGT, IGT, adult versus adolescent gambling task performance, as well as other risk-taking measures, with a larger sample.

**Limitations and Future Directions**

There were several limitations to the current study. First, the sample size was only moderate due to time and financial constraints. As such, hierarchical regression analyses may have been underpowered, particularly in the second and third steps of the regression analyses (Tabachnik & Fidell, 2007), especially given the between-subjects design. Since these two steps were crucial to testing several of the study's hypotheses, the current results will need to be

verified with a larger sample. Second, due to carryover effects, it was not possible to use the within-subjects design which had been originally planned. Hence, the lack of effects of gambling Task Type effects, differentiating the impact of using the IGT versus the SGT, on gambling task outcome variables may have been partially due to between-subjects variability, especially in the context of a moderate sample size. In the future, attempting to factor out within-subjects variability, perhaps by administering both tasks several weeks apart or attempting to "average out" between-subjects variability by greatly increasing the sample size, would greatly inform IGT versus SGT comparisons.

Third, the current study did not include adults in the sample, due to time and financial constraints. It was therefore impossible to conclude whether the SGT might account for differences in socioemotional variables which pertain specifically to adolescent risky decision-making versus adult risky decision-making and which can account for the difference between adolescent and adult levels of risk-taking behavior. Future research should therefore be aimed at comparing adolescents and adults on SGT performance and risk-taking behavior.

Fourth, there were limitations pertaining to the population sampled. Indeed, adolescents in our sample exhibited a very restricted range of Risk-Taking Behavior, which may have attenuated associations with this variable. Most adolescents also did well on the IGT and the SGT, which is especially relevant when one considers that the IGT has been reported to be sensitive to differences between high and low adolescent risk-takers (e.g., Ernst et al., 2003; Johnson et al., 2008; Stanovich et al., 2003), but not between healthy adolescents and adults (Ernst et al., 2003). Thus, the sample of youth from the database, who participated in research studies, may not have been representative of the adolescent population as a whole and failed to provide the variability in risk-taking (as assessed by gambling tasks or self-report measures)

necessary to obtain significant effects between the IGT or SGT and risk-taking variables. It is worth noting, though, that some authors have suggested that adolescent risk-taking has been vastly overestimated (e.g., Males, 2009), which could mean our sample is representative of adolescents in general, without considering the high-risk strata which exist in all age groups. Regardless of whether this is, in fact, true, future research should make use of a more diverse sample, in terms of behavioral tendencies, location, and ethnic or racial background, to ensure internal as well as external validity of findings. Moreover, socioeconomic status (SES) was not assessed, and may be a central variable to predicting risk-taking (Males, 2009), so not only should future research assess SES and its effects, but also make use of a diverse sample in terms of SES.

Fifth, there were limitations to how real-life risk-taking was assessed, so strong conclusions about the SGT's validity as a measure of this behavior could not be made. Self-reported risk-taking measures may be answered honestly (e.g., Abbott- Chapman et al., 2008), but we nonetheless could not rule out the effect of dishonesty on levels of self-reported Risk-Taking Behavior. Future research may address this issue by using triangulation of SGT and self-report measures with other behavioral measures which have been used to study adolescent risk-taking, such as the Balloon Analogue Risk Task and its variants (e.g., Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Lejuez, Aklin, Zvolensky, & Pedulla, 2003; Lejuez et al., 2002; MacPherson, Magidson, Reynolds, Kahler, & Lejuez, 2010), the Columbia Card Task (e.g., Figner et al., 2009), the Stoplight Task (Chein et al., 2011), or "Chicken" (e.g., Gardner & Steinberg, 2005). In addition, future research could benefit from including other self-report measures of risk-taking behaviors, especially since the ARQ might exclude important risk-taking behaviors that many youth currently engage in today, such as hitchhiking, sunbathing without a sunscreen, using

tanning beds, getting a body piercing, or texting or speaking on a cell phone while driving (Abbott-Chapman et al., 2008; Eaton et al., 2008; Kann et al., 2014; National Research Council, 2007).

Additional future directions might involve adding other psychological, personality, or affective variables, which have been found to be associated with adolescent risk-taking behavior and IGT performance, to models predicting SGT scores from risk-taking variables or vice-versa. These variables fall under categories such as: maturity of judgment (more predictive of decision-making than age, e.g., Cauffman & Steinberg, 2010), impulsivity and behavioral activation or inhibition (Crone et al., 2003; Gullo & Dawe, 2008; Gupta, Derevensky, & Ellenbogen, 2006; Steinberg, 2010), state and trait negative affect, emotionality, and stress (Abbott-Chapman et al., 2008; Casey et al., 2010; Gullo & Dawe, 2008; Hallfors et al., 2004; Hooper et al., 2008; Michael & Ben-Zur, 2007; Myers, Aarons, Tomlinson, & Stein, 2003), and five-factors of personality (Essau, 2004). Affective variables may be especially important given that adolescence is also a period of heightened emotionality for many (e.g., Casey et al., 2010; Somerville et al., 2010; Yurgelun-Todd, 2007). Some social variables may also need to be tested for their potential role in models predicting SGT scores from risk-taking variables or vice-versa: the nature and influence of teen social norms which may impact risk-taking and risky decision-making (Fischhoff, 2008), orientation towards peer group and quality of relationship with parents (Abbott-Chapman et al., 2008; Michael & Ben-Zur, 2007), and adolescent bonding as well as impact of school environment (McBride et al., 1995).

Finally, since this was a pilot study testing a new measure, future research avenues entail improving upon the SGT itself. First, an incentive to perform could be given, as has been done with the IGT, in which participants were told their compensation depended on task performance

(e.g., Cauffman et al., 2010), or in which their compensation depended on task performance (e.g., Hooper et al., 2004; Hooper et al., 2008). An SGT adaptation of this type of incentive would be to tell participants they will complete a group task with the pre-established group of peers that they made the most plays from (with one group per deck). This would likely increase the emotional salience of card selections. Another way to increase emotional salience would be to ask participants to send a picture of their face a few days or weeks before they come into the laboratory; tell them the adolescents whose pictures and ratings ("likes" and "dislikes") they see rated their picture; and those real ratings were then put into the game to see if they would be able to discover which group likes them most through playing. In addition, emotional salience might be increased by getting participants to come in with a friend who can help them make their play or pass decisions, to create a group decision-making situation. A final way to improve the SGT would be to put pictures of multiple adolescents on cards which yield multiple "likes" and "dislikes", to increase credibility, since one person can only like a picture once in real social media sites.

**Conclusion**

Given the study's limitations and its pilot nature, it is not possible to conclude with certainty whether adolescents are similarly sensitive to social and monetary rewards and punishments, or whether further research is simply needed to perfect the SGT and associated prediction models. Current findings seem to indicate that adolescents were equally sensitive to a social reinforcement schedule as to a monetary one, though. If this is the case, both the IGT and the SGT may capture similar risk processing, yet are inappropriate measures of adolescent risk-taking propensity.

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Appendix A

Letters of Information

## Parent Letter of Information

**Background Information:**

Your adolescent has chosen to participate in a research project aimed at validating a new measure of decision-making, specifically designed for adolescents. While this is a novel instrument, it is a modification of a well-established measure of adult decision-making. This study has been granted clearance according to the recommended principles of Canadian ethics guidelines, and Queen's policies.

**Details of the Study:**

We invited your adolescent for a visit to Queen's University that will last approximately 1 hour. During the study, and after instructions are clear, your adolescent will complete a series of computerized tasks, followed by computerized questionnaires, and a pen-and-paper questionnaire. Later, we will analyze the responses obtained and look for patterns that are general to all participants. Individual data, specific to your adolescent, will not be attached to their name and will not be analyzed on its own.

The two computerized tasks consist of the Iowa Gambling Task (Cauffman, Shulman, Steinberg, Claus, Banich, Graham, & Woolard, 2010) and a modified gambling task developed for the current study. Both assess decision-making. This procedure and our debriefing have already received approval from ethics.

No harm can result from participation in this study. However, some participants may feel stressed or anxious as a result of the two computerized games, or of having to answer questions about risk-taking and the size of their friendship networks. If feelings of discomfort do occur, participants are welcome to stop participation at any time. If emotional issues arise that you would like to follow up on, please feel free to ask for a list of professionals who may be of service. A list will be given to your adolescent on the debriefing sheet. This study has been granted clearance according to the recommended principles of Canadian ethics guidelines, and Queen's policies.

**Benefits:**

We expect everyone in this study to have a positive experience. It can be interesting and informative to both you and your adolescent to learn about–and if you wish to do so, discuss–individual risk-taking behaviors, as well as their potential consequences.

**Freedom to withdraw or participate:**

Your adolescent's participation in this research is completely voluntary. He or she can decide not to participate and you can choose to stop him or her from participating at any point. The decision not to participate, or to stop participating, will be respected. No negative evaluation, pressure, or any other unpleasant outcome will result from withdrawing from the study.

**Compensation:**

Your adolescent will receive $10. This is intended to thank you and your child for your participation in this study.

**Confidentiality:**

Any information gathered from this study will remain confidential, and published reports will not mention individuals. All files, including data from the computerized games, will be given a code number rather than a name to identify it. Only staff members of the project (including research assistants and graduate students working with Dr. Hollenstein) will have access to the files, and all research assistants will have signed a confidentiality agreement. Data from the computerized games will be stored in a password protected file on a lab computer in a locked room. Questionnaires and consent as well as assent forms will be stored in two separate, locked, secure, cabinets in a locked room. Your data will be destroyed after 10 years. When the study is complete, we will be glad to share the results with you, and you are free to contact us at any time to learn more about the procedures or the results.

## Adolescent Letter of Information (14-15 Year-olds)

We are requesting your involvement in a research project aimed at examining a new measure of decision-making, specifically designed for adolescents. While this is a novel instrument, it is a modification of a well-established measure of adult decision-making. This study has been granted clearance according to the recommended principles of Canadian ethics guidelines, and Queen's policies.

**Details of the Study:**

Participating in this study will require you to come to Queen's University and fill out questionnaires as well as play two computer games. The whole procedure last about an hour. Your parents will accompany you to Queen's University, so they can also give their consent for you to participate. They will then have the choice of waiting in another room in the building, coming back when you are done, or leaving and having you come back by public transit. During the study, you will play two computer games and fill out a few questionnaires. Later, we will combine the results from all participants and look for patterns general to all participants. After we give you the assent letter, we will give you an identification code (e.g. #102), and your name will no longer be associated with any of your results. None of your individual results or answers will be shared with your parents.

When you arrive, your parents will fill out consent forms first. Next, you will first be read your own letter of assent, at which time you may ask any questions you wish and choose to participate or not. Your parents have already consented to your participation, and you have already indicated that you are interested in participating, but you are still completely free to refuse to participate, with no negative consequences of any kind to you or your parents.

If you choose to participate, you will then go to a room containing computer stations, in which you will be asked to play two computer games. These games have been designed to examine decision-making patterns (e.g. Cauffman et al., 2010). All you will need to do is follow the instructions offered on the computer screen: in both games you will have to decide whether to turn over cards from four different piles. In one game, the goal is to maximize how much pretend

money you have. In the other game, the goal is to maximize how many "likes" you get from other, pretend, adolescents.

Once the games are finished, you will complete a few questionnaires on the computer, followed by one questionnaire on paper. You will then receive a debriefing letter, which includes information such as details about the purpose of this study and the measures you completed.

No harm can result from participation in this study. However, some participants may feel stress as a result of the computer games, or of responding to questionnaires. If feelings of discomfort do occur, you are welcome to stop participation at any time. If you would like to follow up on any negative feelings you may have after participating in the study, please contact Michelle Cru at 1-514-473-8867, or by email (michelle.cru@mail.mcgill.ca). You can also contact Dr. Thomas Hollenstein at 613-533-3288, or by email (tom.hollenstein@queensu.ca). However, we expect everyone in this study to have a positive experience. It can be interesting to learn about individual patterns of decision-making and how they change during these two computer games.

**Freedom to withdraw or participate:**

Your participation in this research is completely voluntary and you can decide to stop participating at any point. As mentioned before, your parents' consent should have no impact on your decision. This is your choice and yours alone. Refusing to participate or stopping you participation during the study will not result in any negative consequences to you or your parents: no negative evaluations, pressure, or any other unpleasant outcome.

**Compensation:**

You will receive $10 as a thank you for your participation in this study.

**Confidentiality:**

Any information gathered from this study will remain confidential and private, and published reports will not mention individuals. All files and questionnaires, including computer game data, will be given a code number rather than a name to identify it. Only staff members of the project (including Michelle Cru and other students working with Dr. Hollenstein) will have access to the files and questionnaires. Computer game data will be stored in a password protected file on a lab computer in a locked room. Questionnaires will be kept separately from your assent forms, and both will be in locked cabinets, in a locked lab room. Your data will be destroyed after 10 years. When the study is complete, we will be glad to share the results with you, and you are free to contact us at any time to learn more about the procedures or the results.

## Adolescent Letter of Information (16-18 Year-olds)

We are requesting your involvement in a research project aimed at examining a new measure of decision-making, specifically designed for adolescents. While this is a novel instrument, it is a modification of a well-established measure of adult decision-making. This study has been granted clearance according to the recommended principles of Canadian ethics guidelines, and Queen's policies.

**Details of the Study:**

Participating in this study will require you to come to Queen's University and fill out questionnaires as well as play two computer games. The whole procedure last about an hour. Your parents may have accompanied you or not. If they did, they will then have the choice of waiting in another room in the building, coming back when you are done, or leaving and having you come back by public transit. During the study, you will play two computer games and fill out a few questionnaires. Later, we will combine the results from all participants and look for patterns general to all participants. After we give you the assent letter, we will give you an identification code (e.g. #102), and your name will no longer be associated with any of your results. None of your individual results or answers will be shared with your parents.

When you arrive, your parents will fill out consent forms first. Next, you will first be read your own letter of assent, at which time you may ask any questions you wish and choose to participate or not. Your parents have already consented to your participation, and you have already indicated that you are interested in participating, but you are still completely free to refuse to participate, with no negative consequences of any kind to you or your parents.

If you choose to participate, you will then go to a room containing computer stations, in which you will be asked to play two computer games. These games have been designed to examine decision-making patterns (e.g. Cauffman et al., 2010). All you will need to do is follow the instructions offered on the computer screen: in both games you will have to decide whether to turn over cards from four different piles. In one game, the goal is to maximize how much pretend money you have. In the other game, the goal is to maximize how many "likes" you get from other, pretend, adolescents.

Once the games are finished, you will complete a few questionnaires on the computer, followed by one questionnaire on paper. You will then receive a debriefing letter, which includes information such as details about the purpose of this study and the measures you completed.

No harm can result from participation in this study. However, some participants may feel stress as a result of the computer games, or of responding to questionnaires. If feelings of discomfort do occur, you are welcome to stop participation at any time. If you would like to follow up on any negative feelings you may have after participating in the study, please contact Michelle Cru at 1-514-473-8867, or by email (michelle.cru@mail.mcgill.ca). You can also contact Dr. Thomas Hollenstein at 613-533-3288, or by email (tom.hollenstein@queensu.ca). However, we expect everyone in this study to have a positive experience. It can be interesting to learn about individual patterns of decision-making and how they change during these two computer games.

**Freedom to withdraw or participate:**

Your participation in this research is completely voluntary and you can decide to stop participating at any point. As mentioned before, your parents' consent should have no impact on your decision. This is your choice and yours alone. Refusing to participate or stopping you participation during the study will not result in any negative consequences to you or your parents: no negative evaluations, pressure, or any other unpleasant outcome.

**Compensation:**

You will receive $10 as a thank you for your participation in this study.

**Confidentiality:**

Any information gathered from this study will remain confidential and private, and published reports will not mention individuals. All files and questionnaires, including computer game data, will be given a code number rather than a name to identify it. Only staff members of the project (including Michelle Cru and other students working with Dr. Hollenstein) will have access to the files and questionnaires. Computer game data will be stored in a password protected file on a lab computer in a locked room. Questionnaires will be kept separately from your assent forms, and both will be in locked cabinets, in a locked lab room. Your data will be destroyed after 10 years. When the study is complete, we will be glad to share the results with you, and you are free to contact us at any time to learn more about the procedures or the results.

Appendix B

Consent and Assent Forms

**Parent Consent Form (14-15 Year-olds)**

**Background Information:**

We are requesting your adolescent's involvement in a research project aimed at validating a new measure of decision-making, specifically designed for adolescents. While this is a novel instrument, it is a modification of a well-established measure of adult decision-making. This study has been granted clearance according to the recommended principles of Canadian ethics guidelines, and Queen's policies.

**Details of the Study:**

We have invited your adolescent for a visit to Queen's University that will last approximately 1 hour. You must accompany your adolescent, to provide parental consent, but can then choose to leave and come back at a set time, wait in the Psychology Department building, or go home (your adolescent would take public transit to go home). You will, however, not be able to wait in the same room, as this could affect your adolescent's performance. During the study, and after instructions are clear, your adolescent will complete a series of computerized tasks, followed by computerized questionnaires, and a pen-and-paper questionnaire. Later, we will analyze the responses obtained and look for patterns that are general to all participants. Individual data, specific to your adolescent, will not be attached to their name and will not be analyzed on its own.

The two computerized tasks consist of the Iowa Gambling Task (Cauffman, Shulman, Steinberg, Claus, Banich, Graham, & Woolard, 2010) and a modified gambling task developed for the current study. Both assess decision-making. This procedure and our debriefing have already received approval from ethics.

No harm can result from participation in this study. However, some participants may feel stressed or anxious as a result of the two computerized games, or of having to answer questions about risk-taking and the size of their friendship networks. If feelings of discomfort do occur, participants are welcome to stop participation at any time. If emotional issues arise that you would like to follow up on, please feel free to ask for a list of professionals who may be of service. A list will be given to your adolescent on the debriefing sheet. This study has been granted clearance according to the recommended principles of Canadian ethics guidelines, and Queen's policies.

**Benefits:**

We expect everyone in this study to have a positive experience. It can be interesting and informative to both you and your adolescent to learn about–and if you wish to do so, discuss–individual risk-taking behaviors, as well as their potential consequences.

**Freedom to withdraw or participate:**

Your adolescent's participation in this research is completely voluntary. He or she can decide not to participate and you can choose to stop him or her from participating at any point.

The decision not to participate, or to stop participating, will be respected. No negative evaluation, pressure, or any other unpleasant outcome will result from withdrawing from the study.

**Compensation:**

Your adolescent will receive $10. This is intended to thank you and your child for your participation in this study.

**Confidentiality:**

Any information gathered from this study will remain confidential, and published reports will not mention individuals. All files, including data from the computerized games, will be given a code number rather than a name to identify it. Only staff members of the project (including research assistants and graduate students working with Dr. Hollenstein) will have access to the files, and all research assistants will have signed a confidentiality agreement. Data from the computerized games will be stored in a password protected file on a lab computer in a locked room. Questionnaires and consent as well as assent forms will be stored in two separate, locked, secure, cabinets in a locked room. Your data will be destroyed after 10 years. When the study is complete, we will be glad to share the results with you, and you are free to contact us at any time to learn more about the procedures or the results.

**PARTICIPANT STATEMENT AND SIGNATURE SECTION:**

I have read and understand the consent form for this study. I have had the purposes, procedures and technical language of this study explained to me. I have been given sufficient time to consider the above information and to seek advice if I chose to do so. I have had the opportunity to ask questions which have been answered to my satisfaction. I am voluntarily signing this form. If I wish, I will receive a copy of this consent form for my information.

I understand that I may contact Ms. Michelle Cru (the graduate student carrying out the research) or Dr. Hollenstein (Ms. Cru's supervisor) at any time during or after the study. Ms. Cru may be reached by email at: michelle.cru@mail.mcgill.ca or by telephone at: 1-514-473-8867. Dr. Hollenstein may be reached by email at: tom.hollenstein@queensu.ca or by telephone at: 613-533-3288.

I may also contact the Chair of the General Research Ethics Board by email at: chair.GREB@queensu.ca or by telephone at: (613) 533-6081 if any ethical concerns about the study arise.

Circling "I agree" below indicates that I have read and understand the information provided above, that I willingly agree to let my adolescent participate, and that I may withdraw this consent and discontinue participation at any time.

I agree I do not agree

Signature: _____ Date: _____

**Adolescent Assent Form**

I understand that the aim of this study is to learn more about decision-making patterns specific to adolescents.

I understand that I will participate in two computer games that assess decision-making, and complete a series of questionnaires on paper.

I understand that computer game data will be stored as a password protected file on a computer in a locked room.

I understand that my filled-out assent form and questionnaires will be kept separately, in locked cabinets, in a locked lab room.

I understand that all files and paper-based materials will be private, and seen only by Michelle Cru, Dr. Hollenstein and the research assistants working for him. I know that I will be assigned a number, and that my name will not be connected to my results.

I understand that I may skip any question that I do not want to answer. I understand that I may get out of the study at any time without giving a reason and I will still get my 10$. My parent can also decide, at any time, that we don't want to be in this study any longer.

I understand that I may contact Michelle Cru at any time during the study if I have questions. Michelle Cru may be reached by email at: michelle.cru@mail.mcgill.ca or by telephone at: 1-514-473-8867. I can also contact Dr. Thomas Hollenstein by email at: tom.hollenstein@queensu.ca, or by telephone at: 613-533-3288. Finally, I may also contact the Chair of the General Research Ethics Board by email at: chair.GREB@queensu.ca or by telephone at: 613-533-6081 if I have any ethical concerns about the study.

Circling "I agree" below means that I would like to participate in the study.

I agree I do not agree

Signature: _____ Date: _____

Appendix C

Debriefing Forms

**Parent Debriefing Form (14-15 Year-olds)**

**Thank you for allowing your adolescent to participate in our study today!**

Now that your adolescent has finished the study we would like to take this opportunity to tell you a little bit about what we hope to learn from it. Here is a summary of the study design along with some of our expectations about what we will find.

Your adolescent participated in two computerized tasks: the Iowa Gambling Task (IGT; Cauffman et al., 2010) and the revised, Social Iowa Gambling Task (SGT, designed for this study). Both tasks were introduced to participants as computer games, which have been designed to examine decision-making, and in which the goal is to maximize their money (IGT) or "likes" received from fictional adolescents, represented by pictures of adolescents' faces (SGT). Participants will not be told beforehand that these tasks specifically assess *risky* decision-making, as this could influence their behavior, and thus the validation of the SGT. This is the type of decision-making which is involved in situations with uncertain positive and negative consequences, such as when an adolescent decides to drive fast or engage with a social group.

We want to see whether performance on the IGT and the SGT differs across adolescents, whether the SGT captures risky decision-making to a greater degree than the IGT, and whether the SGT is more highly related to other measures of risk-taking and perceptions of risk compared to the IGT. In addition, we examined potential predictors of performance on the IGT and SGT with questionnaires your adolescent filled out: age, gender, social anxiety, social risk-taking, and friendship network size as well as characteristics (number of closest friends, good friends, and other friends). The fact that the IGT AND SGT measure risky decision-making has been shared with you in this letter, and has been similarly shared with your adolescent in the debriefing letter given to her or him.

The SGT differs from the IGT in that it uses social rewards and punishments instead of monetary ones. Adolescents take many more, and more serious risks, compared to adults, yet their performance on the IGT differs little or not at all from adult performance. Since adolescents are uniquely sensitive to social rewards and punishments, the SIGT was designed to capture the mechanisms underlying risky decision-making that are specific to adolescents. Being able to capture these mechanisms will help us understand why risk-taking peaks in adolescence, with often disastrous consequences, despite adolescent reasoning and intellectual being very similar to that of adults. In addition, we hope to be able to use this increased understanding to inform programs aimed at preventatively reducing–and therapeutically addressing–adolescent risk-taking.

The questions your adolescent answered, and the games he or she participated in, may have triggered some negative feelings about receiving negative social feedback, or about his or her friendship network size, social anxiety, and risk-taking behaviors. This is a perfectly natural

reaction to thinking about these issues. If your adolescent would like to talk to someone about his or her feelings or problems you may be having, please consult your family doctor and he or she can refer your child for treatment. If your child feels like she or he needs to talk to someone right away, please have them call the Kids Help Phone crisis line:

Kids Help Phone 1-800-668-6868

Once again, thank you for participating in this study. Please contact Michelle Cru (michelle.cru@mail.mcgill.ca) or Dr. Hollenstein (tom.hollenstein@queensu.ca ) if you or your adolescent have any questions or concerns about this study. If for any reason your participation has made you or your child feel upset in any way, you may also contact Michelle Cru (the graduate student carrying out the research) or Dr. Hollenstein (Ms. Cru's supervisor).

**Parent Debriefing Form (16-18 Year-olds)**

Now that your adolescent has finished the study we would like to take this opportunity to tell you a little bit about what we hope to learn from it. Here is a summary of the study design along with some of our expectations about what we will find.

Your adolescent participated in two computerized tasks: the Iowa Gambling Task (IGT; Cauffman et al., 2010) and the revised, Social Iowa Gambling Task (SGT, designed for this study). Both tasks were introduced to participants as computer games, which have been designed to examine decision-making, and in which the goal is to maximize their money (IGT) or "likes" received from fictional adolescents, represented by pictures of adolescents' faces (SGT). Participants were not told beforehand that these tasks specifically assess *risky* decision-making, as this could influence their behavior, and thus the validation of the SGT. This is the type of decision-making which is involved in situations with uncertain positive and negative consequences, such as when an adolescent decides to drive fast or engage with a social group.

We want to see whether performance on the IGT and the SGT differs across adolescents, whether the SGT captures risky decision-making to a greater degree than the IGT, and whether the SGT is more highly related to other measures of risk-taking and perceptions of risk compared to the IGT. In addition, we examined potential predictors of performance on the IGT and SGT with questionnaires your adolescent filled out: age, gender, social anxiety, social risk-taking, and friendship network size as well as characteristics (number of closest friends, good friends, and other friends). The fact that the IGT AND SGT measure risky decision-making has been shared with you in this letter, and has been similarly shared with your adolescent in the debriefing letter given to her or him.

The SGT differs from the IGT in that it uses social rewards and punishments instead of monetary ones. Adolescents take many more, and more serious risks, compared to adults, yet their performance on the IGT differs little or not at all from adult performance. Since adolescents are uniquely sensitive to social rewards and punishments, the SIGT was designed to capture the mechanisms underlying risky decision-making that are specific to adolescents. Being able to capture these mechanisms will help us understand why risk-taking peaks in adolescence, with often disastrous consequences, despite adolescent reasoning and intellectual being very similar to

that of adults. In addition, we hope to be able to use this increased understanding to inform programs aimed at preventatively reducing–and therapeutically addressing–adolescent risk-taking.

The questions your adolescent answered, and the tasks he or she participated in, may have triggered some negative feelings about receiving negative social feedback, or about his or her friendship network size, social anxiety, and risk-taking behaviors. This is a perfectly natural reaction to thinking about these issues. If your adolescent would like to talk to someone about his or her feelings or problems you may be having, please consult your family doctor and he or she can refer your child for treatment. If your child feels like she or he needs to talk to someone right away, please have them call the Kids Help Phone crisis line:

Kids Help Phone 1-800-668-6868

Once again, thank you for participating in this study. Please contact Michelle Cru (michelle.cru@mail.mcgill.ca) or Dr. Hollenstein (tom.hollenstein@queensu.ca ) if you or your adolescent have any questions or concerns about this study. If for any reason your participation has made you or your child feel upset in any way, you may also contact Michelle Cru (the graduate student carrying out the research) or Dr. Hollenstein (Ms. Cru's supervisor).

## Adolescent Debriefing Form

**Thank you for participating in our study today!**

Now that you have finished the study we would like to take this opportunity to tell you a little bit about what we hope to learn from it. But first, we would like to ask you not to discuss the study with friends or other kids at school because they might also be participating in the study and that might affect the results. You can talk about the study to an adult you trust, such as your parents, a counselor, a teacher, or your school principal. Here is a summary of the study design along with some of our expectations about what we will find.

First, you completed two computer games or tasks: the Iowa Gambling Task (IGT; Cauffman et al., 2010) and the Social Iowa Gambling Task (SGT; designed for this study). We told you they were designed to assess decision-making, but they were, in fact, designed to assess *risky* decision-making. This is the type of decision-making which is involved in situations with uncertain positive and negative consequences, such as when you decide to drive fast or engage with a social group. We did not share the exact details of what these tasks measure, because we did not want to influence your behavior or choices. If we had influenced you, it is possible that the tasks would not measure what they were supposed to.

Second, the computer game which involved maximizing "likes" (SGT) was only pretend or fictional. What this means: (1) the adolescents whose pictures you saw on cards were simply pictures taken from databases and not real people, (2) all participants saw the same 100 pictures in the same order, no matter what cards they selected, and (3) the "likes" and "dislikes" were fictional as well, with pre-set numbers of each being tied to specific cards in specific decks, no matter what cards you selected. There were thus no real people liking or disliking you. We

wanted to see whether adolescents respond differently to a game involving social risks (SGT), compared to one which involves money-related risks (IGT).

Third, you completed a series of questionnaires. These helped us to see two things: (1) what might explain your performance on one or both of the computer games: for example, age, gender, social anxiety, social risk-taking, and friendship network size as well as characteristics (number of closest friends, good friends, and other friends); and (2) whether performance on the SGT was more related to measures of risk-taking and perceptions of risk compared to performance on the IGT.

Finally, people of different ages make different patterns of decisions in situations of risk (described above). Adolescents take more, and more serious, risks compared to adults, which often leads to negative consequences. These consequences may include traffic accidents, unintended pregnancy, drug use problems, and health issues. However, adolescents show similar reasoning to adults, and similar or only slightly worse performance on the IGT. This is why we created the SGT, to see if we can use social risks and rewards to understand better why adolescents take these risks.

Adolescents may feel upset about the experiences they thought about when completing the SGT or when filling out the questionnaires. This is a perfectly natural and normal reaction to thinking about negative experiences such as being disliked by others, feeling shy in social situations, or taking risks that may hurt people (e.g. driving fast). How did you feel after playing the SGT game and filling out the questionnaires? Is there someone you feel comfortable talking to if you feel worried or upset? If you are not sure who you can talk to about your feelings or problems you may be having, here are some people that could help: you can talk an adult you trust like your parents, a school counselor, a teacher, or the principal at your school. If you would like to talk to someone outside of the school, you can call the Kids Help Phone.

Kids Help Phone: 1-800-668-6868

At this time, do you have concerns about the study or your feelings? Yes □ No □

Once again, thank you for participating in this study. Please contact Michelle Cru (michelle.cru@mail.mcgill.ca or 1-514-473-8867) or Dr. Thomas Hollenstein (tom.hollenstein@queensu.ca or 613-533-3288) if you have any questions or concerns about this study. If for any reason your participation has made you feel upset in any way, you may also contact Michelle Cru or Dr. Thomas Hollenstein.

# Appendix D

## Iowa Gambling Task Instructions

Instructions: "Play or Pass"
In this game, you will see a series of cards. You must decide whether you want to PLAY or PASS on each card.

If you PLAY, sometimes you will win pretend money, sometimes you will lose money, and sometimes you will neither win nor lose.

If you PASS, the amount of pretend money you have won't change.

You will need to make your decision pretty quickly, because if you don't play within 4 seconds, the computer will just automatically pass on that card.

Your job is to try to win as much pretend money as possible.

We will keep track of how much money you win. The money you win on this task will count towards your bonus.

You will start with a $2000 pretend loan.

There are good decks and bad decks in this game. You can win the most money by learning to avoid the bad decks and play more cards from the good decks.

We cannot tell you which decks are good and bad. Figuring out the good and bad decks is hard, but you should try your best to figure it out. It is OK if you do not figure it out.

Do you have any questions?

When you are ready, press Enter to begin.

Your Current Total: $2000

Appendix E

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Appendix F

Social Gambling Task Instructions

Instructions: “Play or Pass”
In this game, you will see a series of cards. You must decide whether you want to PLAY or PASS on each card.

If you PLAY, sometimes you will win pretend "likes," sometimes you will lose "likes" (given to you as "dislikes"–so each "dislike" subtracts one "like" from those you have), and sometimes you will neither win nor lose.

If you PASS, the amount of pretend "likes" you have won't change.

You will need to make your decision pretty quickly, because if you don't play within 4 seconds, the computer will just automatically pass on that card.

Your job is to try to win as many "likes" as possible.

We will keep track of how many "likes" you win. The "likes" you win on this task will count towards your bonus.

You will start with 0 "likes".

There are good decks and bad decks in this game, and each deck represents a group of friends you could join.

You can win the most "likes" by learning to avoid the bad decks/groups and play more cards from the good decks/groups.

We cannot tell you which decks/groups are good and bad. Figuring out the good and bad decks/groups is hard, but you should try your best to figure it out. It is OK if you do not figure it out.

When you are ready, press Enter to begin.

Your Current Total: 0 "likes"