Les précurseurs et les corrélats des trajectoires précoces de jeu: un modèle développemental intégré (2007-AC-118285)

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Rapport de recherche soumis au Fonds québécois de la recherche sur la société et la culture et au Ministère de la Santé et des Services sociaux (MSSS) dans le cadre de l'action concertée sur Les impacts socioéconomiques des jeux de hasard et d'argent – Phase 2

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Troisième section – Rapport de recherche intégral (20 pages + annexes)

Préambule

Cette troisième section comprend deux articles de recherche. Le premier article correspond à l'étude réalisée auprès des 1125 enfants de l'ÉLDEQ. Le second article, présenté en annexe, décrit les résultats recueillis auprès des 205 paires de jumeaux monozygotes. Dans les deux cas, les comportements de jeu des enfants se limitent à un seul point de mesure, soit à l'âge de 10 ans parce que nous voulions examiner d'abord les facteurs associés à la pratique précoce des jeux de hasard et d'argent qui semble émerger à cet âge. À noter toutefois qu'un deuxième point de mesure sera disponible ce printemps. Ce deuxième point de mesure sera combiné aux deux points de mesure subséquents que nous recueillerons dans le cadre de la nouvelle subvention que nous avons obtenue du FQRSC et de ses partenaires pour la poursuite de nos travaux. Nous pourrons alors établir les trajectoires de jeu que divers sous-groupes de jeunes suivront du milieu de l'enfance (i.e. 10 ans) au milieu de l'adolescence (i.e. 15 ans). Nous pourrons également examiner les facteurs de risque et de protection associés aux diverses trajectoires de jeu ainsi que leurs possibles conséquences, par exemple, sur le rendement scolaire ou d'autres comportements de prise de risque.

Article 1

Interplay between personal dispositions and parent gambling

in predicting early gambling in children

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Abstract

This study examined whether low inhibition (i.e., low anxiety) predicted early gambling, above and beyond disinhibition (i.e., impulsivity) and whether the two personal dispositions operated independently or interactively. It also examined whether the predictive role of these personal dispositions towards early gambling depended on parent gambling. Children's personal dispositions were assessed at ages 6, 7, and 8 years through teacher ratings. Parent gambling was assessed when the children were 8 years old. Finally, children's early gambling was measured through self-reports when the children were 10 years old. Results showed that teacher-rated impulsivity predicted early gambling for both genders. In addition, low anxiety predicted early gambling behavior, above and beyond impulsivity and control variables, albeit only in boys. However, impulsivity and anxiety did not interact with each other, nor did they interact with parent gambling in predicting early gambling. Yet, parent gambling additively predicted early gambling for boys and for girls. The theoretical and practical implications of these findings are discussed.

Interplay between personal dispositions and parent gambling in predicting early gambling in children

Gambling behavior starts early. Already by pre-adolescence, 15% of boys and 5% of girls are involved in daily or weekly gambling (Ladouceur, Dubé, & Bujold, 1994; Stinchfield, Cassuto, Winters, & Latimer, 1997). Early initiation deserves attention since adolescent and adult problem gamblers report that they started gambling at an early age (approximately 10 years of age) (Burge, Pietrzak, & Petry, 2006; Derevensky & Gupta, 2001; Wynne, Smith, & Jacobs, 1996). However, very little is known about the risk factors that are prospectively related to early gambling behaviors.

Two categories of risk factors have been reported to predict early gambling in the few prospective studies that examined this issue. The first category includes dispositional factors, such as impulsivity; the second category includes environmental factors such as parent gambling (Govoni, Rupcick, & Frisch, 1996; Langhinrichsen-Rohling, Rohde, Seeley, & Rohling, 2004; Oei & Raylu, 2004; Pagani, Derevensky, & Japel, 2009). The finding that impulsivity is prospectively linked to gambling is in line with a growing body of literature showing an association of disinhibitory traits and gambling across the lifespan (Barnes, Welte, Hoffman, & Dintcheff, 1999; Pagani et al., 2009; Slutske, Caspi, Moffitt, & Poulton, 2005; Vitaro, Arseneault, & Tremblay, 1999; Vitaro, Brendgen, Ladouceur, & Tremblay, 2001). However, disinhibition may be only one of a number of different personal precursors of early gambling. In addition, environmental risk factors such as parent gambling may represent precursors of early gambling. Moreover, personal dispositions and environmental risk factors may operate synergistically rather than independently.

Personal Dispositions: Impulsivity and Anxiety

There is accumulating evidence suggesting that diverse bio-behavioral elements are involved in gambling (Goudriaan, Oosterlaan, de Beurs, & Van den Brink, 2004). Following pioneer work by Gray (1970, 1981), two bio-behavioral systems seem involved: The behavioral inhibition system (BIS) which is sensitive to reward and the behavioral activation system (BAS)

which is sensitive to punishment. Together, the BIS and the BAS promote or interrupt motor behavior, depending on their relative strength. Hence, a low BIS, as reflected in high disinhibition and strong sensitivity to reward, and a high BAS, as reflected in low inhibition and low sensitivity to punishment, are theoretically implicated in risk-taking behaviors such as gambling. These two systems are not redundant since they seem to rest on distinct neuro-physiological structures (Gray, 1990). Disinhibition, as reflected in high trait impulsivity, is related to an under-regulation of the dopamine system in the brain. Interestingly, an under-regulation of the dopamine system has been linked to high reward sensitivity and sensation seeking, two characteristics that might explain how impulsivity is predictively related to adolescent and adult gambling (Chambers, Taylor, & Potenza, 2003; Driver-Dunckley, Samanta, & Stacy, 2003; Grant, Chambers, & Potenza, 2004; Ibanez, Blanco, & Saiz-Ruiz, 2002). In contrast, low inhibition, as reflected in low trait anxiety, derives from central serotonergic mechanisms. Importantly, a failure in these mechanisms translates into an inability to monitor punishment and inhibit ongoing behaviors, two characteristics that have also been linked to gambling (Beauchaine & Neuhaus, 2008; Gray & McNaughton, 2000). As a result, it is possible that impulsivity (i.e., high disinhibition) and anxiety (i.e., low inhibition) have independent contributions to gambling since they do not share the same neural circuits and they separately control distinct, although correlated, behavioral predictors of gambling (Ibanez et al., 2002; Lee & Coccaro, 2007; van Goozen, Fairchild, Snoek, & Harold, 2007).

As suggested by some authors (Cloninger, 1986, 1987; Tremblay, Pihl, Vitaro, & Dobkin, 1994) the contributions of the BIS and the BAS may also be synergistic or interactive. For example, low inhibition could potentiate the effect of disinhibition on gambling, whereas high inhibition may mitigate the effect of disinhibition on gambling. Indeed, it has been found that impulsive children who are also anxious become less delinquent than their impulsive counterparts who are not anxious (Kerr, Tremblay, Pagani-Kurtz, & Vitaro, 1996). Impulsive children who are also anxious may be more cautious in perpetrating illegal acts because they are afraid of their possible negative consequences. This interaction might also be observed in regard

to gambling which involves a risk of loss. Impulsive children who are low on anxiety might be particularly at risk for early gambling because they lack the inhibitory mechanisms (i.e., sensitivity to potential losses) that could help them refrain from engaging in risk-taking behaviors. However, no empirical evidence is yet available to support this view.

Environmental Factor: Parent Gambling

The predictive power of the above personal dispositions may, furthermore, be conditional on environmental factors such as parent gambling. This would imply that children's personal dispositions would predict early gambling only under the right family circumstances. For example, such a link between personal dispositions and early gambling may be found only if parents themselves model or approve of gambling. Without parent indulgence, vulnerable children may only become involved in risk-taking behavior such as gambling later in adolescence when the socializing influence of parents declines (Catalano, Kosterman, Hawkins, Newcomb, & Abbott, 1996). Indeed, parents who participate in gambling activities may be more indulgent and supportive of their children's gambling activities (Govoni et al., 1996; Jacobs, 1989).

However, parents appear to be unaware of the risks associated with gambling (Ladouceur, Vitaro, & Côté, 2001). Thus, parents may not monitor and control their offspring's gambling as they adopt other risky behaviors. This view is supported by the lack of observed links between parental supervision and gambling in adolescence (e.g., Barnes et al., 1999; Vitaro et al., 2001). In addition, children do not seem concerned about being caught gambling by their parents (Gupta & Derevensky, 1997). In sum, the extent to which links between personal dispositions and early gambling are dependent or independent of parental gambling remains unclear.

There is extensive empirical support for a direct link between parent gambling and adolescent gambling, independent of the way parent gambling is measured (i.e., through adolescents' perceptions or parent reports) (Cronce, Corbin, Steinberg, & Potenza, 2007; Hardoon, Gupta, & Derevensky, 2004; Langhinrichsen-Rohling et al., 2004; Vachon, Vitaro, Wanner, & Tremblay, 2004; Winters, Stinchfield, Botzet, & Anderson, 2002). However, only

one study, to our knowledge, examined the association between parent gambling and gambling behavior in pre-adolescents (Pagani et al., 2009). Surprisingly, this study found no link between parent gambling and gambling in 12 year-old children. Furthermore, no study to our knowledge has tested the possible interaction between personal dispositions and parent gambling.

The Present Study

The present study thus investigated whether low inhibition (as reflected in low anxiety) predicts early gambling above and beyond high disinhibition (as reflected in high impulsivity). It also explored whether the two categories of personal dispositions (i.e., low inhibition and high disinhibition) operate in an additive or interactive mode in predicting early gambling. Similarly, it investigated the possible additive or interactive interplay between either of the two personal dispositions and parent gambling in predicting early gambling. An additive combination would require that both sets of risk factors need to be addressed for prevention programs to yield optimal results. In contrast, an interactive combination would signify that offsetting one set of risk factors would be sufficient to prevent or mitigate early gambling. Clarifying these issues may also have important consequences for the elaboration of a comprehensive etiological model with respect to the emergence of early gambling during the pre-adolescent years.

Children with highly impulsive dispositions demonstrate low performance on executive functions such as decision making, feedback processing, and risk estimation (van Meel, Oosdterlaan, Heslenfeld, & Sergeant, 2005). Poor performance on these mental functions may represent lower intellectual capabilities. Hence, it is important to control for general intellectual functioning while assessing the link between impulsivity (or any other trait) and gambling, to ensure this link is not spurious. Socio-economic status also has been linked to youth and adult gambling (Welte, Barnes, Wieczorek, Tidwell, & Parker, 2004). Consequently, we controlled for children's general intellectual functioning and socio-economic status in the present study. We also controlled for children's gender since boys tend to gamble more than girls (Ladouceur, Boudreault, Jacques, & Vitaro, 1999). By adolescence, boys also tend to experience more gambling-related problems than girls (Gupta & Derevensky, 1998). In addition to main effects

and interactions of personal dispositions and parental behavior, we examined whether children's gender moderated the association between personal dispositions and early gambling or the association between parent gambling and children's early gambling. Given that boys tend to be more impulsive and less anxious than girls, we expected the links between these two behavioral dispositions and early gambling to be stronger in boys than in girls. No gender differences, however, were expected with respect to the link between parent gambling and children's early gambling. We examined "early gambling" when the children were 10 years old since adolescent and adult problem gamblers retrospectively reported that they started their gambling activities at about that age (Derevensky & Gupta, 2001; Wynne et al., 1996).

Method

Sample

Participants were part of the Québec Longitudinal Study of Child Development, a sample of children born in Montreal, Quebec in Canada, between October 1997 and July 1998 (excluding children born in Cree or Inuit territories, Native Canadian reserves, or northern Quebec). Participants were selected from the Quebec Birth Registry through a stratified sampling procedure based on living area and birth rate. Families ($N = 2675$) were contacted by mail and telephone when children were approximately 5 months of age, and 83.1% participated in the first assessment, resulting in an initial sample of 2120 children. Signed informed consent was obtained from mothers during the home visit. The ethics board of Santé Québec, the agency responsible for the data collection, approved the study. At time 1, 51.2% of the children were boys and most (81%) were living in French-speaking families. On average, mothers and fathers were aged 28.8 and 31.8 years, respectively; 16.9% of mothers and 19.9% of fathers did not hold a high school degree; 27.7% reported an income lower than CaD $30 000 (US $29 451), and 7.1% families were headed by a single parent. Before the first assessment used in this study, children were assessed at 6 additional times, at age 5 months, 17 months, 2.5 years, 3.5 years, 4 years, and 5.1 years of age.

Data from times 7 to 10 were used in this study. At time 7, i.e., by the end of kindergarten, children were on average 6.1 years old (*SD* = .30), at time 8, i.e., by the end of grade 1, they were 7.2 years old (*SD* = .31), and at time 9, i.e., by the end of grade 2, they were 8.2 years old (*SD* = .34). Finally, at time 10, by the end of grade 4, they were 10.1 years old (*SD* = .36). To maximize the use of available data, boys and girls with complete data on parent gambling and self-reported gambling, and at least 1 data point with respect to teacher ratings (see measures below) were included in the analysis (*n* = 1,125; 48% boys). Compared to these 1,125 participants, children who dropped out of the study (*n* = 995) were rated by their had a more difficult temperament according to their mothers at ages 5 and 17 months and were living in low income families.

Measures: Predictors

Teacher-Reports of Impulsive and Anxious Behaviors were assessed via the Child Social Behavior Questionnaire (Tremblay, Vitaro, Gagnon, Piché, & Royer, 1991). Impulsive behaviors were measured through the use of three items: jumps from one activity to another, difficulty waiting his-her turn, impulsive-acts without reasoning. Anxiety symptoms were measured through the use of three items also: anxious when faced with novel situation; shy with new people; easily worried. All of the items were scored on a 3-point scale (0 = never, 1 = sometimes, 2 = often). Cronbach's alphas were .77, .79, and .81 for impulsivity problems, and .76, .77, and .80 for anxiety symptoms at ages 6, 7, and 8 years, respectively. We computed for each child the average score across the three times of measurement for impulsivity and anxiety. To improve the distributional quality of both scales we performed a log transformation (Skewness = 0.71, Kurtosis = -0.44; Skewness = -0.33, Kurtosis = -0.32; for impulsivity and anxiety, respectively).

Parent Gambling was assessed when the children were 8 years old. Parents (mothers and fathers separately) were administered the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987). The SOGS assesses gambling participation and gambling problems. However, only gambling participation was considered in this study for the following reasons: First, gambling problems are highly correlated with gambling participation (Holtgraves, 2009; Welte et

al., 2004). Including both gambling participation and problems in the analyses might lead to issues with colinearity. Second, parent gambling participation is likely to be more strongly related to child gambling because young children may witness and even take part in their parents gambling activities, whereas children are less likely to be aware of their parents' gambling problems. Finally, the only other study that examined the link between parent gambling and children's early gambling used a measure of parent involvement in gambling activities, but not of parents' gambling problems (Pagani et al., 2009).

For this study, the list of possible gambling activities included 11 items. For each activity, parents indicated whether they never (scored 0), less than monthly (scored 1), monthly (scored 2), weekly (scored 3), or daily (scored 4) participated in it over the past 12 months. A participation score was computed for each parent by averaging the frequency scores for all the different gambling activities for the past 12 months. However, given that mother and father gambling were moderately correlated ($r = .38$, $p < .05$), a mean score across the two parents was considered in the analyses after adjusting for differences in the range across fathers and mothers. The mean and standard deviation for parent gambling participation is presented in Table 1. Internal consistency for the mean parent gambling participation scale was satisfactory (alpha = .67; Skewness = 1.01, Kurtosis = 1.39).

Measures: Outcomes

We used a self-reported four-item questionnaire to assess involvement in gambling when the children were aged 10 years. With the exception of a Bingo item (which was not used), the four items were similar to the ones used by Pagani et al. (2009) (e.g., how many times during the past 12 months did you play cards for money with non family members?). The response scale contained four possible responses: Never (0), once or twice (1), more than two times but less than 10 times (2), and more than 10 times (3). Distributions were extremely skewed, with the vast majority of the children reporting that they never participated in any of the gambling activities. We therefore created a total gambling participation variable, scored 0 = *never* (82.6%) and 1 = *at least once* (17.4%).

Measures: Controls

IQ was assessed when children were 6 years old. Each child was individually administered the Kaufman Assessment Battery for Children (K-ABC). The K-ABC is intelligence and achievement test for children aged 2-1/2 to 12-1/2 years (Cahan & Noyman, 2001). Internal consistency was high (alpha = .85) in this study.

Family socioeconomic status was assessed by asking parents to indicate their total household income (split into nine categories). We took the mean of time 1 through time 8.

Analytical Strategy

We handled missing data, assuming that the data was missing at random (Little & Rubin, 1989), with multiple imputations available in SAS 9.1.3. More specifically, we employed Markov Chain Monte Carlo estimation and 10 random draws. Given that our outcome variable (i.e., child gambling) was dichotomous, we conducted hierarchical logistic regression analysis to address our objectives. We used the Nagelkerke R2 to estimate the proportion of the total variance explained in our dependent variable (child gambling at age 10). We also used the Hosmer–Lemeshow test, a χ^2-based goodness-of-fit test, to investigate the null hypothesis predicting that the identified model fits the data well. A *p*-value greater than 0.05 indicates that model predictions are not significantly different from the observed values, thus failing to reject the null hypothesis.

Results

We examined to what extent (a) teacher ratings of children's personal dispositions at ages 6 to 8 years would predict subsequent self-reported gambling at age 10 years, and (b) what role parent gambling plays in this context. Specifically, we examined (1) an additive model, where all predictors would have independent direct effects on children's gambling, (2) an interaction model, where children's disinhibitory (i.e., impulsivity) and inhibitory (i.e., anxiety) characteristics would interact to predict children's gambling, and (3) an interaction model, where parent gambling would moderate the links between personal dispositions and gambling. We also tested whether boys and girls would differ in this regard. Prior to these tests, we examined the

bivariate links between the predictor variables and the outcome. Table 1 shows the means and standard deviations as well as the zero-order correlations among all predictor variables and the outcome variable. As seen in this table, with the exception of anxiety, each of the predictors was significantly linked to child gambling in these univariate analyses.

A hierarchical logistic regression analysis was performed to predict child gambling at age 10 years, using non gamblers as the reference category. On the first step of the logistic regression, we included child's gender, family income, intelligence, personal dispositions (i.e., impulsivity and anxiety) as predictors in the model. On the second step, we tested whether impulsivity and anxiety would interact to predict gambling and whether these links would differ between boys and girls. We thus entered on step 2a the interaction between impulsivity and anxiety (i.e., impulsivity * anxiety). On step 2b, we entered the two-way interaction of impulsivity and gender (i.e., impulsivity * gender). Similarly, on step 2c, we entered the interaction of anxiety and gender (i.e., anxiety * gender). Then, on step 2d, we tested the three-way interaction of both personal dispositions and gender. On this last step, we thus included each of the previous two-way interactions of step 2a to 2c and, in addition, the three-way interaction term (i.e., impulsivity * anxiety * gender). Notably, following the recommendations of McClelland & Judd (1993), steps 2a through 2d were tested in a mutually exclusive sequence without protection against an inflated family-wise error rate. On the third step, we added parent gambling frequency. On the fourth step, we tested whether the predictive effects of parent gambling were moderated by child personal dispositions and whether the moderated links would differ between boys and girls. For example, in order to test an interactive effect between parent gambling and impulsivity, we added this two-way interaction term (i.e., parent gambling * impulsivity) on step 4a. Next, we tested whether parent gambling would be linked differently to child gambling for boys and girls and thus included the two-way interaction of parent gambling * gender on step 4b. On step 4c, we tested the interactive effect of parent gambling and impulsivity and potential gender differences in this respect. We thus added the following two-way and three-way interaction terms on step 4c: parent gambling * impulsivity, parent gambling * gender,

impulsivity * gender, and parent gambling * impulsivity * gender. The same rationale was employed to test interactive effects between parent gambling and anxiety on steps 5a to 5c. In Table 2 we present the overall model fit and χ^2-change associated with each step, the *t*-test associated with each predictor, as well as the specific odds ratio (and its 95% confidence interval) associated with each predictor of child gambling at age 10 years.

The results of the first step of the logistic regression showed that gender was the only control variable to contribute significantly to children's gambling. In contrast, family income and intelligence were unrelated to child gambling. Compared to girls, boys were 60% (reciprocal *OR* = 1.60, $p < .01$) more likely to gamble. With respect to child characteristics, impulsivity increased the odds of gambling by 21% (*OR* = 1.21, $p < .05$), whereas anxiety failed to yield a significant link to child gambling.

Of the interactions entered on the second step, only the interaction between anxiety and gender was significant (*OR* = 1.60, $p < .01$). As seen in Table 2, for boys, each unit increase in anxiety was associated with a decrease in the likelihood of gambling (*OR* = 0.79, $p < .05$). To probe the interaction, we recoded gender and the interaction term such that girls were the reference category. The results of this regression model showed that, for girls, anxiety was not significantly linked to gambling (*OR* = 1.26, 95% CI: 0.97, 1.64).

On the third step, we entered parent gambling. Each unit increase in parent gambling frequency increased the likelihood of child gambling by 36% (*OR* = 1.36, $p < .001$). On this step of the logistic regression, the unique contribution of impulsivity to child gambling dropped to a non significant level ($p = .07$) due to shared variance among impulsivity and parent gambling. A Sobel test, adjusted for the dichotomous outcome, confirmed that the reduction in the effect size of the prospective association between impulsivity and early gambling was significant ($z = 2.56$, $p = .01$). Finally, on the fourth step, we tested interactions regarding child personal dispositions, parent gambling, and gender. However, none of those interactions was significant.

Discussion

The results indicate that impulsivity averaged across ages 6, 7, and 8 predicted early gambling by age 10 years for both genders. In addition, low anxiety predicted early gambling behavior, above and beyond impulsivity and control variables, but only in boys. Moreover, parent gambling frequency additively predicted early gambling for boys and for girls. However, impulsivity and anxiety did not interact with each other, nor did they interact with parent gambling to predict early gambling. These results and their implications are discussed.

Impulsivity and Anxiety

Consistent with past studies, teacher-rated impulsivity was found to predict self-reported early gambling, even after controlling for possible confounders such as family income, gender, and children's intellectual functioning. This is the first study, however, to examine this link in 10-year old children for whom gambling behavior is relatively recent. It is also the first study to examine low anxiety as an additional precursor of early gambling. In line with our expectations, low anxiety made a unique contribution to the prediction of early gambling, but only for boys. As suggested by personality theorists and neuro-developmentalists alike, both the disinhibition (BIS) and the inhibition (BAS) systems and, by extension, their respective neuro-physiological bases are likely involved in predicting early gambling (and possibly other risk-taking behaviors) (Beauchaine, Klein, Crowell, Derbidge, & Gatzke-Kopp, 2009; Chambers et al., 2003). Heightened dopaminergic activity in the brain (i.e., reflecting high disinhibition) is linked with sensation seeking and reward sensitivity whereas neural serotonergic disregulation (i.e., low inhibition) is related to insensitivity to punishment and inability to regulate ongoing behavior when reinforcement contingencies have changed (Beauchaine & Neuhaus, 2008; Chambers & Potenza, 2003).

Our theoretical modeling and empirical results are in line with findings showing that impulsivity is related to behavioral decision-making deficits in gambling-like tasks (Crone, Vendel, & van der Molen, 2003; Franken, van Strien, Nijs, & Muris, 2008; Vitaro et al., 2001). More specifically, impulsive individuals display a decreased performance in learning of reward

and punishment associations in order to make appropriate decisions when faced with uncertain choices, and impaired adaptation of choice-behavior according to changes in stimulus-reward contingencies. They also display a high sensitivity to immediate reward (Sonuga-Barke, Taylor, Sembi, & Smith, 1992). If the same individuals are also non anxious, then they may also be less sensitive to possible future punishment and unfavorable fluctuations in reward contingencies, at least, for males. Together, these psychological processes and their neurophysiological substrates, may explain how impulsive and, for boys, non anxious individuals are more inclined to participate in risk taking behaviors such as gambling which offers intermittent reinforcement in the short term but (almost) certain punishment in the long term.

The present results regarding the additive role of anxiety in the prediction of early gambling in boys are in line with some but not all past studies that examined the link between anxiety and gambling. For example, consistent with the present findings, Vitaro, Wanner, Ladouceur, Brendgen, and Tremblay (2004) reported that low anxiety assessed during pre-adolescence was related to chronic gambling in adolescent males. However, Hardoon and Derevensky (2002) found that adolescent problem gamblers were concurrently more, not less, anxious than non-gamblers. Yet, they were more excitable, extroverted, and under-controlled than non-gamblers. Other researchers also found that adolescent gamblers report higher rates of anxiety and depressive symptoms than non gamblers (Gupta & Derevensky, 1998; Stinchfield & Winters, 1998). These apparently contradictory results suggest the possibility for a transactional interplay between anxiety and gambling across different developmental periods: low, not high, anxiety may set the stage for early involvement in gambling. However, as gambling problems develop during the adolescent years, emotional problems may also develop. This might represent an illustration of the ‘’turnabouts’’ model proposed by Rutter (1996) to explain the reversals of causal priority or direction between risk factors and adjustment problems over the course of development.

Contrary to our expectations, we found no interaction between anxiety and impulsivity. Hence, low anxiety did not exacerbate the link between impulsivity and later gambling.

Conversely, high anxiety did not mitigate the above link. It thus appears that the BIS and BAS systems operate independently to predict early gambling. Provided these results are confirmed in future studies, it would mean that both systems need to be represented in etiological models of early gambling, at least for male gambling. Moreover, prevention studies might need to address directly and separately the cognitive and emotional aspects linked to hyper-sensitivity to rewards and hypo-sensitivity to punishment.

Parent Gambling

Parent involvement in gambling activities predicted children's gambling above and beyond children's personal dispositions. Different processes could account for this result, although none could be formally tested in the present study. First, the link between parent gambling and offspring's early gambling could indicate that parents serve as models or as trainers of their offspring's emergent gambling behavior, possibly during family activities involving gambling. After all, the majority of adolescent who gamble have been introduced to gambling by their parents (Ladouceur & Mireault, 1988). It may also indicate that parents who are involved in gambling activities are more tolerant of their children's gambling behaviors or are less effective in monitoring their children's behaviors (Gupta & Derevensky, 1998; Vachon et al., 2004). The possibility for a genetic transmission of parent vulnerability to gambling, however, should not be overlooked. This possibility is more than likely in light of the present finding that children's impulsivity lost its predictive power when parent gambling was entered in the final regression model. Such a finding suggest that a common third variable such as genes might be involved. Hence, the contribution of parent gambling to children's gambling can be accounted for by either genetic or cultural processes. More research is needed on the intergenerational transmission of gambling.

The fact that our findings do not concur with the only other study that examined the predictive link between parent gambling and childhood gambling deserves some comments (Pagani et al., 2009). First, Pagani et al. used four items to assess a "general construct of (parent) gambling involvement". This measure might have generated less variance than our more

sensitive 11-item measure. Second, selection effects also may have reduced variance in the previous study. Specifically, participants in the Pagani et al. study were less socio-economically and ethnically diverse than the representative sample in the current study. Finally, the rather small sample size might have created a power issue in the Pagani et al. study.

Interplay between Personal Dispositions and Parent Gambling

Surprisingly, no interaction between parent gambling and either category of personal dispositions was found. This result has both theoretical and practical implications. At the theoretical level, it will be important in the future to acknowledge both sets of predictors as independent and additive. Personal dispositions may represent the genetic contribution of parents' gambling to their offspring's early gambling, whereas their gambling behavior may reflect a cultural contribution. In any case, both elements need to be targeted in prevention programs to obtain optimal results. Eliminating one set of risk factors or replacing it by its positive counterpart will not be sufficient to mitigate or buffer the contribution of the other set of risk factors in regard to early gambling. Finally, the popular but speculative view of an interactive interplay between personal dispositions and environmental risk factors held by many theorists needs to be revisited in favor of an additive perspective in the case of early gambling.

Limitations and Concluding Remarks

This study has many assets: it used a moderately large community sample and a longitudinal perspective. The latter is important in helping to disentangle the directionality of the links between personal dispositions or parent gambling and children's gambling. The use of different informants for the predictor and the outcome variables also ensured that the predictive links were not artificially inflated through shared method variance. Finally, the inclusion of children's intellectual abilities and socio-economic status in the analyses reduced the possibility for spurious links. As usual, the study also has some limitations which need to be kept in mind when interpreting the findings. First, other possible relevant personal dimensions besides impulsivity and anxiety (such as sensation seeking) were not included. Second, no mediating mechanisms were investigated. Third, the possibility of a developmental shift regarding the directionality of

the link between anxiety and gambling could not be examined. To address this question, the links between anxiety and gambling needed to be tested in a transactional manner over time. Moreover, this shift may only occur later in adolescence than in the time window examined in the present study. Finally, the specific ethnic composition of the sample may limit the generalizability of the findings. Despite these limitations, it appears that high impulsivity and, for boys, low anxiety both independently predict early gambling and that parent gambling operates additively rather than interactively in this context. Prevention programs targeting children's personal dispositions or parent gambling could help uncover the possible causal role played by these early risk factors.

Author note

Both authors are also affiliated with the Research Unit on Children's Psycho-Social Maladjustment, University of Montreal, and with the Ste-Justine Hospital Research Centre.

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Annexe 1

Références, tableaux et figures
se rapportant à l'article 1

References

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Table 1

Means, Standard Deviations, and Zero-Order Correlations of Predictor Variables

	1	2	3	5	6	7	8	*Mean (SD)*
1. Gender	---							
2. Socioeconomic Status	.010	---						6.885 (1.822)
3. ABC Intelligence	.004	.177***	---					23.620 (9.999)
5. Teacher: Impulsivity	-.303***	-.095**	-.158***	---				0.129 (0.123)
6. Teacher: Anxiety	.053	-.112***	-.174***	-.190***	---			0.483 (0.247)
7. Parent Gambling	-.023	-.062	-.039	.110**	.002	---		0.092 (0.061)
8. Child Gambling	-.111***	-.031	-.029	.111***	-.026	.139***	---	

Note. Gender is coded such that 1 indicates girls and 0 indicates boys.

* = $p < .05$, ** = $p < .01$, *** = $p < .001$, two-tailed tests

Table 2

Hierarchical Logistic Regression Analysis Predicting Gambling Behavior at Age 10

	Overall Model Statistics					Odds Ratio Estimates		
	χ^2-Change (df)	*p*	Nagelkerke R^2-change	Predictor *t*(1 df)	*p*	*OR*s	Lower CI	Upper CI
Step 1	21.77 (5)	.001	.032					
Gender				-2.68	.01	0.62**	0.44	0.88
Socioeconomic Status				-0.70	.48	0.94	0.80	1.11
Intelligence				-0.45	.65	0.96	0.81	1.14
Teacher: Impulsivity				2.19	.03	1.21*	1.02	1.44
Teacher: Anxiety				-0.35	.73	0.97	0.81	1.15
Step 2c	8.29 (1)	.004	.012					
Gender				-2.67	.01	0.62**	0.44	0.88
Socioeconomic Status				-0.67	.51	0.95	0.81	1.11
Intelligence				-0.37	.71	0.97	0.82	1.15
Teacher: Impulsivity				2.12	.03	1.21*	1.01	1.43
Teacher: Anxiety				-1.96	.05	0.79*	0.63	1.00
Anxiety*Gender				2.68	.01	1.60**	1.13	2.25

Table 2 (continued)

Hierarchical Logistic Regression Analysis Predicting Gambling Behavior at Age 10

	Overall Model Statistics					Odds Ratio Estimates		
	χ^2-Change (df)	*p*	Nagelkerke R^2-change	Predictor *t*(1 df)	*p*	*OR*s	Lower CI	Upper CI
Step 3	17.04 (1)	.0001	.025					
Gender				-2.74	.01	0.61**	0.43	0.87
Socioeconomic Status				-0.47	.61	0.96	0.82	1.13
Intelligence				-0.32	.74	0.97	0.82	1.16
Teacher: Impulsivity				1.77	.07	1.17	0.98	1.39
Teacher: Anxiety				-1.96	.05	0.79*	0.62	1.00
Anxiety*Gender				2.63	.01	1.59**	1.13	2.25
Parent gambling				3.86	.001	1.36***	1.16	1.59

Note. Gender is coded 0 = boys and 1 = girls; CI = 95% confidence interval of odds ratio; the change in χ^2 and R^2 reported in the second and in the fourth column is a change compared to the χ^2 and R^2 in the previous step; The Hosmer-Lemeshow tests were nonsignificant for modeling step 1 to 3; $\chi^2(8) = 9.26$, $p = .32$; $\chi^2(8) = 2.65$, $p = .95$; $\chi^2(8) = 10.33$, $p = .24$; respectively. Only the step were a significant interaction was found is reported (i.e., step 2c with interaction of Anxiety and Gender)

* = $p < .05$, ** = $p < .01$, *** = $p < .001$, two-tailed tests.

Annexe 2

Contexte théorique, Méthodologie, Résultats, Discussion, Références, Tableaux et Figures se rapportant à l'Article 2

Running head: A TWIN DIFFERENCE STUDY OF EARLY GAMBLING

Article 2

The Role of Parenting in the Interplay of Reward Sensitivity, Academic Achievement, and Gambling in Middle Childhood: A Monozygotic Twin Difference Study

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Abstract

Background: The identification of specific nonshared environments and mediating processes accounting for early gambling is a key challenge. **Methods:** A monozygotic (MZ) twin difference method was used to examine, first, whether within-pair differences in early childhood coercive and over-controlling parenting (ages 5 and 18 months) were prospectively associated with differences in twins' academic achievement (AA) and reward sensitivity (RS) in grade 1 (age 7 years). Second, we examined whether within-pair differences in AA and RS mediated the hypothesized links between parenting and early gambling in grade 4 (age 10 years). We controlled for initial differences in birth weight obtained from hospital registries, gender, and socio-economic status (SES). Participants were 205 MZ twin pairs who were part of an ongoing longitudinal study in Quebec, Canada. **Results:** RP and AA mediated the link between coercive parenting and early gambling, although mediation was only significant for AA. The hypotheses regarding over-controlling parenting were not supported. No evidence with respect to SES- and gender-related mean-level differences or moderating effects was found. Conclusions: Coercive parenting is related to early risky behavior such as gambling and this relationship is mediated by psychopathological tendencies and academic adjustment. **Keywords**: Nonshared environment, monozygotic twins, gambling, reward sensitivity , academic achievement, environmental influences, school twins.

The Role of Parenting in the Interplay of Reward Sensitivity, Academic Achievement, and Gambling in Middle Childhood: A Monozygotic Twin Difference Study

A minority of children have been found to gamble for money already at the end of middle childhood and continuing this risky behavior throughout adolescence (Vitaro, Wanner, Ladouceur, Brendgen, & Tremblay, 2004). Early initiation deserves attention since adolescent and adult problem gamblers report that they started gambling at an early age (approximately 10 years of age) (Burge, Pietrzak, & Petry, 2006; Derevensky & Gupta, 2001; Shaffer, Hall, & Vander Bilt, 1999; Wynne, Smith, & Jacobs, 1996). Although quantitative genetic studies show that gambling is partly under genetic influences, genetic factors usually do not account for more than about 60% of the variance (Eisen et al., 1998; Winters & Rich, 1998). The remaining unexplained variance in gambling seems mostly attributable to environmental factors that are nonshared, rather than shared between children growing up in the same family (Eisen et al., 1998).

Parenting has been found to be a salient nonshared environmental influence on children's development (Asbury, Dunn, Pike, & Plomin, 2003; Burt, McGue, Iacono, & Krueger, 2006). Ineffective parenting such as hostile-coercive parenting style has been shown to be linked to youth gambling either directly or indirectly (e.g., Vitaro, Wanner, Brendgen, & Tremblay, 2008). Over-controlling parenting may have similar effects on youth gambling. Two different theoretical viewpoints suggest different pathways that link ineffective parenting with early gambling: Havighurst's (1972) developmental task model and social learning models on the development of antisocial behavior (e.g., Dishion, French & Patterson, 1995; Dishion, Patterson, Stoolmiller, & Skinner, 1991).

School adjustment as a developmental task

Being successfull in school represents a task that normatively has to be solved when entering school. According to Havighurst (1972) failure to successfully solve age-graded developmental tasks negatively affects individuals' developmental prospects in an accumulative manner. From this theoretical perspective, children's involvement in gambling would represent a coping response to negative consequences and stress experienced due to failure in the academic life domain. One pathway linking ineffective parenting styles to early gambling, hence, may be through their detrimental effects on academic achievement. Evidence for these assumptions is provided by findings showing that hostile-coercive and over-controlling (or laissez-faire as the opposite) parenting styles are linked to low academic achievement (Forgatch & DeGarmo, 1999; Steinberg, Lamborn, Dornbusch, & Darling, 1992) which, in turn, has been found to be linked to gambling (Ladouceur, Boudreault, Jacques, & Vitaro, 1999). Studies examining older samples provided further evidence for the assumption that gambling is related to maladaptive and avoidant coping with life stressors (e.g., Bergevin, Gupta, Derevensky, & Kaufman, 2006).

Development of early antisocial behavior and impulsivity

Social learning models on the development of antisocial behavior (e.g., Dishion, French & Patterson, 1995; Dishion, Patterson, Stoolmiller, & Skinner, 1991) posit that early initiation of antisocial behaviors including gambling are predicted by personality traits such as impulsivity. In turn, personality traits are influenced by ineffective parenting, especially erratic coercive-hostile parenting. Hence, a second pathway linking ineffective parenting to early gambling may be through impulsivity. Children of inconsistent and coercive parents are often impulsive and aggressive (Buschgens, van Aken, Swinkels, Ormel, Verhulst & Buitelaar, 2009; Shaffer, 2000). Either the parents inadvertently and occasionally reinforce their children's impulsive behaviors, thus, making the behavior more frequent and more persistent, or they genetically transmit a

proneness to impulsivity to their children, as discussed later. A study (Asbury et al., 2003) using the MZ-difference method (see below), showed that differences in coercive parenting experienced by 4-year old MZ twins were related to the twins' differences in hyperactivity, a trait that is closely related to impulsivity according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., *DSM–IV;* American Psychiatric Association, 1994).

Tasks involving gambling such as, for example, the Iowa Gambling Task (Bechara, Damasio, Damasio, & Anderson, 1994) and the Card-Playing Task (Newman, Patterson, & Kosson, 1987) have been used as measures of impulsivity in adult and adolescent samples, respectively (e.g., Petry, 2001; Vitaro, Arseneault, & Tremblay, 1999). It has been suggested that those tasks mainly measure reward sensitivity and that they provide insight in reward and punishment processing when gambling cues are present (Goudrian, Oosterlaan, de Beurs, & Van den Brink, 2004). Reward sensitivity reflects whether children learn from punishment and negative experiences and, therefore, inhibit previously reinforced behavior after an inversion in reinforcement contingencies or whether their striving and behavior remain dominated by the drive to obtain reward. Already by age 4 years, most children become proficient in learning the gain/loss schedule involved in such tasks (Gao, Youggang, Bai, Lin, & Li, 2009).

The Card-Playing Task has been found to be linked to pathological gambling in adolescents (Vitaro et al., 1999) and the Iowa Gambling Task has been found to be linked to pathological gambling in adults (Cavedini, Riboldi, Keller, D'Annucci, & Bellodi, 2002). These findings are in line with findings of studies using self-reports of impulsivity that also provided evidence for links to gambling in early and mid-adolescence (Barnes, Welte, Hoffman, & Dintcheff, 1999; Pagani, Derevensky, & Chapel, 2009; Slutske, Caspi, Moffitt, & Poulton, 2005; Vitaro, et al., 1999; Vitaro, Brendgen, Ladouceur, & Tremblay, 2001). In the present study, we used a child

version of the Card-Playing Task as an index of reward sensitivity to predict children's early gambling at age 10 years and as a mediator of the link between early ineffective parenting and children's early gambling. Due to its resemblance to a gambling game it likely elicits the excitement of gambling and some of the clinical symptoms of pathological gambling (i.e., chasing).

Two opposing views on the link between academic performance and gambling

From the perspective of social learning models on the development of antisocial behavior (e.g., Dishion, French & Patterson, 1995), failure in the academic domain is part of the syndrome of initiating not only one but many antisocial behaviors. Accordingly, the link between gambling and academic achievement can be assumed to be explained, at least in part, by the causing personality trait (e.g., impulsive behaviors such as reward sensitivity). Hence, parenting would predict increases in reward sensitivity which, in turn, predicts both gambling and low academic achievement. Findings showing that impulsivity is also linked to academic achievement during primary school years (Merrell & Tymms, 2001; Spira & Fischel, 2005), point to the possibility that our measure of reward sensitivity (gambling task) is also linked to academic achievement. As a consequence, the assumed mediating effect of academic achievement on the link between ineffective parenting and early gambling may, at least in part, disappear when controlling for reward sensitivity. It should be noted that from a developmental task and coping perspective (e.g., Havighurst, 1972), academic failure would have predictive power on gambling as a coping response on its own. Hence, from this perspective low academic achievement would be linked to gambling, even after controlling for personality and parenting. However, thus far it is neither known (a) whether academic achievement and gambling are linked nor it is known (b) whether reward sensitivity and gambling are linked before early adolescence, or (c) whether reward

sensitivity and academic achievement are linked in childhood. Furthermore, it is not known whether reward sensitivity and/or low academic performance mediate the link between ineffective parenting and early gambling in youths.

In addition, past evidence is based on correlational studies that do not take into account confounding gene-environment processes such as gene-environment correlations (Rutter, Pickles, Murray, & Eaves, 2001; Scarr & McCartney, 1983). Three types of gene-environment correlations (rGE) have been described (Plomin, DeFries, & Loehlin, 1977): *Passive* rGE (individuals receive both genetic and environmental risk factors from their parents), *active* rGE (individuals seek out environments consistent with their genetic predispositions), and *evocative* rGE (individuals' genetically influenced behavior elicits reactions from their environment). Passive and evocative rGE may be particularly relevant with respect to the association between ineffective parenting and children's early gambling, via reward sensitivity and/or low academic performance. The associations among ineffective parenting, reward sensitivity, low academic performance, and gambling thus could be explained by a heritable third variable that accounts for those correlations.

The monozygotic (MZ) twin difference method offers a powerful tool to study nonshared environmental factors such as exposure to ineffective parenting independently of genetic and gene-environment effects, as well as independently of shared environmental factors (Moffitt & Caspi, 2007; Pike, Reiss, Hetherington, & Plomin, 1996; Rutter et al., 2001). With this method, MZ twin differences in experiences of ineffective parenting can be related to MZ twin differences in behavior (i.e., reward sensitivity, academic achievement, gambling behavior). Because MZ twins do not differ genetically and share the same family environment, associations between differences in parenting and differences in their behavior necessarily reflect the net

contribution of parenting as a unique, nonshared environmental influence on behavior, provided other pertinent nonshared experiences are accounted for. Such conclusions would be even more impressive if these associations were demonstrated longitudinally instead of cross-sectionally.

Therefore, in the present study, we employed the MZ twin difference method to examine whether differential ineffective parenting during the first 18 months predicted an increase in MZ twins' discordance regarding gambling at age 10 years and whether this link was mediated by within-pair differences in academic achievement and reward sensitivity at age 7 years. In early childhood, even if they attend day care, most children are likely to spend more time with parents than with peers or other socialization agents. Hence, ineffective parenting may have its strongest effects during this age period. In addition, it is remarkably stable throughout childhood (Dallaire & Weinraub, 2005). As a first objective, we examined whether differences in parenting during early childhood (i.e., ages 5 and 18 months) would be prospectively linked to differences in early gambling by middle childhood (i.e., age 10 years). Notably, the younger the children the more their activities are under parental control. This may explain why gambling behaviors appear only to be initiated at about age 10 years. The finding that such early initiation is associated with problem gambling at older ages emphasizes the importance of examining associated risk factors. Our second objective was to examine whether reward sensitivity and academic achievement in grade 1 (i.e., age 7 years) would mediate the link between discordant parenting in early childhood and twins' differences in early gambling. Academic achievement is the first time available when children were in grade 1. Moreover, at this age children may sufficiently understand instructions that enable participation in the gambling task that taps into reward sensitivity (Gao et al., 2009). Given that the putative mediators (i.e., academic performance and reward sensitivity) were likely correlated, as predicted by the social learning model, it was thus

important to establish the unique mediating effects by means of controlling for their shared effects. We thus tested the mediating effect of academic achievement, while controlling for the effects of reward sensitivity and vice versa. We hence tested whether academic achievement was a mediator independent from reward sensitivity, as predicted by the developmental task and coping model (Havighurst, 1972).

To avoid spurious effects, we controlled for birth weight as a correlated non shared factor that might have produced differences in any of the target variables. Differences in birth weight for MZ twins are due to gestational factors. Generally, low birth weight is associated with a multitude of developmental problems. More specifically, low birth weight has been found to be linked to academic underachievement and externalizing problems, including impulsive behaviors (Aarnoudse-Moens, Weisglas-Kuperus, Goudoever, & Oosterlaan, 2009; Asbury, Dunn, & Plomin, 2006). Large differences in birth weight between twins may also indicate that parents are challenged by the smaller twin's problem behaviors and therefore parents may turn either to ineffective hostile or over-controlling parenting behaviors. Parents sometimes appear to exaggerate the twins' existing physical and behavioral differences evident at birth (Allen, Greenspan, & Pollin, 1976). An increasing body of research indicates that parents indeed respond differently to MZ twins which, in turn, has been found to yield differences in twin's developmental outcomes (e.g., Asbury et al., 2006; Asbury, et al., 2003; Oliver, Pike, & Plomin, 2008).

We collected data from different sources for each of the variables, therefore avoiding inflated links due to shared method variance. Most study variables (i.e., gambling, low academic achievement, and impulsive behavior as indexed by reward sensitivity) have been found to be more prevalent in boys than in girls (e.g., Ladouceur et al., 1999). Previous research also

indicates links between socioeconomic status (SES) and those problem behaviors (e.g., Huston, McLoyd, & Coll, 1994). We thus examined potential moderating effects of gender and socioeconomic status.

Method

Participants

The 205 MZ twin pairs (109 female pairs) who participated in the present study were part of an ongoing longitudinal study (The Quebec Newborn Twin Study, QNTS) of a population-based sample of twins from the greater Montreal area in the Province of Quebec, Canada, who were recruited at birth between November 1995 and July 1998 (N = 648 twin pairs; 254 MZ twin pairs). For same-sex twin pairs, zygosity was assessed at 18 months based on physical resemblance via the Zygosity Questionnaire for Young Twins (Goldsmith, 1991). For a subsample of these same-sex twin pairs (N = 123), DNA was collected to test for 10 highly polymorphous genetic markers. The comparison of zygosity based on the similarity of these genetic markers with zygosity based on physical resemblance revealed a 94% correspondence rate, which is similar to rates obtained in older twin samples (Forget-Dubois et al., 2003). Eighty-four percent of the families were of European descent, 3% were of African descent, 2% were of Asian descent, and 2% were Native North Americans. The remaining families (9%) did not provide ethnicity information.

The demographic characteristics of the twin families were compared to those of a sample of single births that is representative of the large urban centers in the province of Quebec (Santé Québec, Jetté, Desrosiers, & Tremblay, 1998) when the children were 5 months of age. The results showed that the same percentage (95%) of parents in both samples lived together at the time of birth of their child(ren); 44% of the twins compared to 45% of the singletons were the

first born children in the family; 66% of the mothers and 60% of the twins' fathers were between 25 and 34 years old compared to 66% of mothers and 63% of fathers for the singletons; 17% of the mothers and 14% of the twins' fathers had not finished high school compared to 12% and 14% of mothers and fathers respectively for the singletons; the same proportion of mothers (28%) and fathers (27%) in both samples held a university degree; 83% of the twin parents and 79% of singleton parents were employed; 10% of the twin families and 9% of the singleton families received social welfare or unemployment insurance; finally 30% of the twin families and 29% of the singleton families had an annual total income of less than CAN$30,000, 44% (42%) had an annual total income between CAN$30,000 and CAN$59,999; and 27% (29%) had an annual total income of more than CAN$60,000. These results indicate extremely similar socio-demographic profiles in the twin sample and the representative sample of single births.

The sample was followed longitudinally at 5, 18, 30, 48 and 60 months focusing on a variety of child-related and family-related characteristics. Two additional waves of data collection were completed at 84, and 120 months of age to assess children's social adaptation in grades 1 and 4. The present paper describes findings from these first two and last two data collections. The average age at assessment was 5.7 months (SD = 3.2) (T1), 18.6 months (SD = 3.3) (T2), 7.4 years (SD = 0.4) in grade 1 (T3), and 10.5 years (SD = 0.4) in grade 4 (T4). 205 twin pairs had valid data on at least three measures across the four assessment waves and thus were included in the study. In consequence, attrition in this study was 19.3% (254 MZ pairs in the original sample – 205 participating MZ pairs in the present study = 49 MZ pairs lost from the study). MZ twins remaining in the study did not differ from those lost in regard to parent-rated temperament at 5 months of age. The lost twin families also did not differ from the remaining twin families in regard to any of the socio-demographic measures mentioned previously except

that fathers in the remaining study sample had a slightly higher level of education than fathers of the twins who were lost from the study.

Measures and Procedure

All instruments were administered either in English (21%) or in French (79%), depending on the language spoken by the children and the teachers. Instruments that were administered in French but were originally written in English were first translated into French and then translated back into English. Bilingual judges verified the semantic similarity between the back-translated items and the original items in the questionnaire. Prior to data collection, active written consent from the parents of all the children in the classroom was obtained. Data collection took place in the spring of the school year, to ensure that the teachers had become familiar with the children and that the children had become familiar with each other. The instruments were approved by the University of Montreal's Institutional Review Board and the school board administrators. Different informants were involved in the data collection: parents provided information about SES and parenting at the first two time points, teacher reported on academic performance (i.e., reading, writing, and mathematics) in grade 1, children provided information regarding their gambling in grade 4. In grade 1, children also participated in the Reward Dominance task that assesses reward sensitivity (see below, measures).

In 73% of the cases, the two members of a twin pair were in different classrooms in grade 1 and 4. A series of t tests revealed no differences between twins in the same classroom and twins in different classrooms with respect to difference scores on any of the variables used in this study.

Twins' gambling. We used a self-reported four-item questionnaire to assess involvement in gambling when the twins were aged 10 years. With the exception of a Bingo item (which was not

used), the four items were similar to the ones used by Pagani et al. (2009) (e.g., how many times during the past 12 months did you play cards for money with non family members?). The response scale contained four possible responses: Never (= 0), once or twice (= 1), more than two times but less than 10 times (= 2), and more than 10 times (= 3). Distributions were extremely skewed, with the vast majority of the children reporting that they never participated in any of the gambling activities. We therefore created a total gambling participation variable, scored 0 = *never* (*N* = 353, 86.1%) and 1 = *at least once* (*N* = 57, 13.9%).

Parenting. Mothers and fathers provided information on family income and their parenting styles with respect to each twin when the children were 5 and 18 months old. Parents rated their parenting behaviors using the Parental Cognitions and Conduct toward the Infant Scale (PACOTIS; Boivin, Pérusse et al., 2005). The PACOTIS is a 23-item scale assessing parents' perceptions about their self-efficacy and their parental impact with regard to their child's behavior as well as their tendency to act in a hostile-coercive or over-controlling manner towards their child. Only the scales measuring parents' behavior (i.e., hostile-coercive parenting and over-controlling scale) were used in this study. Parental hostile-coercive behaviors include hostile and restrictive responses to difficult behaviors in the child. Examples of the six items of the hostile-coercive scale are: 'How often do you yell at the child' and 'Inflict physical punishment'. Parental over-control refers to behaviors reflecting excessive concern for the safety and protection of the child. Examples of the five items of the latter scale are: 'Keeping child close to me at all times' and 'prefer that child sleeps in reach at night'. Each item could be scored on a six point scale, with higher scores indicating more hostile-coercive or more over-controlling parenting. Cronbach's alphas ranged between .76 -.81 at 5 and 18 months. Given the relatively high correlations among the 5- and the 18-month ratings of mothers and fathers with correlations

ranging from $r = .31$ to $r = .67$ and $r = .29$ to $r = .51$; for over-controlling and coercive parenting, respectively), a total score was calculated across the two data points as well as the two respondents for both parenting dimensions.

Putative mediators: Reward sensitivity. In grade 1, we tested the twins using an adaptation of the Reward Dominance Task (O'Brien & Frick, 1996) that in turn is based on the card-playing task for adults (Newman, et al, 1987). This computer-controlled task was administered at the university laboratory when the twins were 7 years old. The task assesses reward sensitivity and response modulation as a function of changes in reinforcement contingencies (i.e., behavior adaptation or flexibility). The task assesses whether a child can inhibit his habitual response (i.e., can stop playing) after being used to winning a lot of points, when the game contingencies change so that he loses increasingly more points. Each twin was instructed that he-she could win the best prize of three prizes if he-she obtains the largest amounts of points. Two computerized games were used during the task: a fishing game and a candy box game. Both games were structured the same way and the order of presentation was randomized. The first game was used for practice; thus only the number of trials of the second game was used for the analyses. On the computer screen for the fishing game, a fisherman is displayed that pulls the rod out of the water and either takes out a fish (+1 point) or no fish (-1 point), each time the child presses a button until either (a) the child presses a second button to quit the game or (b) 100 trials have been played. In the second game, a candy box opens and either has a candy inside (+1 point) or not (-1 point). What the child doesn't know is that, at the beginning of the game, probabilities of winning (i.e., catching a fish or finding a candy) are high (9 out of 10 trials), but after each 10-trial block, the probabilities of winning decrease by 10%. Points are shown on the screen, with individual fish or candies, placed in rows, and are added or

removed as a function of the child's gains or losses. The optimal moment to stop playing is between 40 and 60 trials, after which the child starts to lose more than he-she wins. The maximum number of points is 74. If the child continues up until the very end (100 trials), he-she will only have 40 points remaining.

Teacher reported on academic performance (i.e., reading, writing, and mathematics) in grade 1. Grades ranged from 1 to 5 and were scored such that a higher grade indicates better academic achievement. The three assessments were highly correlated (with rs ranging between .74 and .90; Cronbach's alpha = .91). A total school achievement score was calculated (mean of the three ratings) and used in the analyses.

Control variables: Together with some other medical information, twins' weight at birth was obtained from records provided by the hospital where the twins were born.

Family-wide control variable: Family income. Mothers provided information on family income when the children were 48 and 60 months old. An average score over the two data points was used for family income.

Results

Preliminary Analyses: Individual Scores and Difference Scores

Following the strategy most commonly used in MZ-Differences studies (Moffitt & Caspi, 2007; Pike et al., 1996), within-pair difference scores were calculated for each of the variables by randomly assigning one of the twins of in each pair as Twin#1 and the other as Twin#2 and subtracting the Twin#2 score from the Twin#1 score. However, to ensure that the dichotomous gambling variable has only scores of 0 and 1, for the 37 (18.5%) of twin pairs that were discordant regarding gambling, we assigned the twin that scored=1 as Twin#1 and the twin that scored=0 as Twin#2. Hence, gambling is coded such that a score = 1 indicates that only one of

the twins is involved in gambling, whereas a score = 0 indicates that the twins do not differ in this respect. However, only in N=11 (5.4 %) of the cases both twins were gambling. 22 out of 96 male twin pairs and 15 out of 109 female twin pairs had a score = 1 on this variable.

Table 2 (below the diagonal) presents the bivariate correlations among study variables based on individual scores. Since the individual child served as the unit of analysis for these correlations, nonindependence of the data for each pair of twins was accounted for through the use of intra-class correlations. The inter-correlation table partly supports the validity of the pattern of results. First, twins' academic achievement was negatively related to gambling. Second, reward sensitivity (RS) was positively linked to one of the ineffective parenting behaviors (i.e., over-controlling parenting). However, none of the parenting variables was linked to academic achievement. Coercive parenting was linked to gambling, although this link was only significant on a tend level (p = .06). Gambling was negatively related to academic achievement and positively related to RS. Above the diagonal, the table depicts the correlations of the MZ difference scores. Contrary to the previous correlational patterns, coercive parenting was linked to each of the putative mediators (i.e., RS and academic achievement) in expected directions. Coercive parenting was also significantly linked to the outcome (i.e., gambling).The correlations of over-controlling parenting, however, failed to reach significant levels. Birth weight showed across both sets of correlations a positive link to academic achievement. Contrary to our expectations, this control variable was also positively related to gambling in terms of MZ difference scores, whereas it was unrelated to gambling in terms of intra-class correlations. Across both sets of correlations, RS was unrelated to achievement. Both sets of correlation patterns revealed no co-linearity problem.

The distributional characteristics of the MZ difference scores were acceptable with skewness ranging between -0.05 and -0.89 and kurtosis ranging between 0.17 and 1.29. Regarding kurtosis, the exceptions were over-controlling parenting (kurtosis = 4.9) and birth weight (kurtosis = 2.8). We therefore used robust estimators for path modeling instead of estimators that require normally distributed data.

Table 2 also shows the intra-twin pair correlations with respect to the study variables. As can be seen, MZ twins were similar but not identical with respect to each of the study variables with RS and gambling being the least correlated.

Main Analyses

According to Baron and Kenny (1986), the following criteria need to be met to support a mediation hypothesis. First, the predictor must predict the outcome when the mediator is not included in the model; second, the predictor must predict the putative mediator; third, the putative mediator must predict the criterion; fourth, the strength of association between the predictor variable and the criterion must be reduced once the putative mediator is included in the model equation. A formal test of this reduction requires a significant indirect effect from the main predictor via the mediator to the outcome (Holmbeck, 2002). For dichotomous outcomes, this indirect effect is usually tested via an adjusted Sobel test (Sobel, 1982). In order to test these assumptions, we conducted path analyses with the Mplus version 5.1 software package (Muthén & Muthén, 2004). We first tested a *direct effects* model that included the control variable (i.e., differences in birth weight), the main predictors of interest (i.e., differences in T1 coercive and over-controlling parenting), and outcome (i.e., differences in gambling) but not the putative mediators (i.e., differences in RS and achievement). All direct effects from the control variable and from the main predictors on gambling were estimated in this saturated model. Moreover,

parenting behaviors were allowed to co-vary. Next, a *mediational model* was tested that in addition to the previous model also included the putative mediators. In this saturated model, – in addition to all parameters from the previous model – we also included (a) paths from the control variable and from the predictor of interest (parenting) to the putative mediators (RS and achievement), and (b) paths from the putative mediators to the gambling. Moreover, we estimated within-time co-variations between the two parenting scales as well as co-variations between the two putative mediators.

In a first step, we tested potential moderating effects of gender and SES with respect to each of the parameters estimated in both the *direct effects* and the *mediational* model. To test for gender differences (i.e., moderating effects of gender), we specified a multiple-group model that freely estimated each of the parameters across gender groups. To test moderating effects of SES, we also specified a two-group model. The first group (N = 102) had SES scores above the median (Md = 0.20) and the second group (N = 103) scored lower than the median. Using the WLSMV estimator of Mplus, a robust weighted least squares estimator, we conduct nested model comparisons. For gender and SES, we thus next specified a more restrictive model in which each of the model parameters was constrained to be equal across groups. The results showed that neither gender ($\chi^2(6) = 8.72$, $p = .19$ and $\chi^2(13) = 11.17$, $p = .60$; for the *direct effects* and the *mediational* model; respectively) nor SES ($\chi^2(6) = 5.70$, $p = .46$ and $\chi^2(13) = 13.14$, $p = .44$; for the *direct effects* and the *mediational* model; respectively) moderated the links specified in the *direct effects* and the *mediational* model. For gender, a model that included in addition to the previous constraints equality constraints regarding the mean values of all predictive variables and the variances of each variables to be equal across groups also did not yield a significant difference when compared to the freely estimated *direct effects* model ($\chi^2(18)$

= 22.42, p = .21). For SES the equivalent nested model comparison resulted in a significant difference test ($\chi^2(18) = 52.41$, $p < .0001$). Freeing the variances of achievement and over-controlling parenting resulted in a nonsignificant model comparison ($\chi^2(17) = 19.62$, $p = .29$). Compared to the group with lower SES, the group with higher SES was more variable regarding achievement (*STD* = .84 vs. *STD* = 1.13) and less variable regarding over-controlling parenting (*STD* = 1.17 vs. *STD* = .81). On the basis of these results, we collapsed across gender and SES and thus used the overall sample for subsequent testing of mediating effects. We controlled for the linear effects of gender and SES and therefore used residual scores in subsequent analyses, although the previous results indicated that those effects were nonsignificant. Moreover, we used the maximum likelihood estimator with robust standard errors, instead of the WLSMV estimator to obtain odds ratios (OR) associated with logistic regressions (instead of probit regressions with WLSMV) of gambling on the remaining variables. Both estimators yielded identical results in terms of patterns of significant and nonsignificant estimates with respect to the subsequent analyses.

Inspection of the parameter estimates from the *direct effects* model showed that within-twin pair differences in T1/T2 coercive parenting significantly predicted differences in T4 twins' gambling (*OR* = 1.68, $z = 2.88$, *SE* = .08, $p < .01$), above and beyond the significant differences in the control variable (*OR* = 5.80, $z = 3.08$, *SE* = .28, $p < .01$), and the nonsignificant differences in T1/T2 over-controlling parenting (*OR* = 1.46, $z = 1.64$, *SE* = .11, *n.s.*).

In contrast to the direct effects model, the results from the *mediational model* showed that T1/T2 coercive parenting did not yield a significant link to T4 gambling after controlling for the effects of the putative mediators (see Figure 1). However, coercive parenting significantly predicted both T3 mediators in expected directions. Coercive parenting was negatively linked (*z*

= -3.62) to twins' differences in academic achievement and positively linked (z = 2.62) to twins' differences in RS, after accounting for the significant effects of the control variable on academic achievement (z = 4.44) and gambling (z = 3.60). In turn, one unit increase (i.e., 10 points) in within-twin differences in T3 RS increased the odds (z = 2.05) of one twin gambling whereas the other twin does not or, less likely, both twins gamble at T4 by 12%, controlling for the other variables in the model. Moreover, a positive difference score of T3 academic performance significantly reduced the odds (z = -3.13) of one twin gambling whereas the other twin does not or, less likely, both twins gamble at T4. A conducted Sobel test adjusted for dichotomous outcomes showed, after controlling for the (significant and nonsignificant) effects of each of the remaining variables (including RS) that twin differences in T3 academic performance indeed significantly mediated the direct link of T1/T2 coercive parenting to differences in T4 twins gambling (z = 2.12, p < .05). In contrast, with respect to RS the mediating effect was nonsignificant according to the Sobel test (z = 1.49, *n.s.*).

Discussion

We used the MZ differences method (e.g., Pike et al., 1996; Rutter et al., 2001) to investigate differential parenting as a source of non-shared environmental effect independent of genetic influence and shared environment. The goals of the study were fourfold: (1) see whether within-pair differences in ineffective parenting at ages 5 and 18 months predicted differences in early gambling at age 10 years as well as differences in academic achievement and reward sensitivity at age 7 years; (2) see whether differences in academic achievement and reward sensitivity predicted differences in early gambling, (3) test whether differences in academic achievement and reward sensitivity mediated the link between ineffective parenting and early

gambling, above and beyond differences in birth weight, and (4) test for possible moderating effects of gender and SES.

Ineffective Parenting , Reward Sensitivity, and Academic Achievement

Results showed that differences in coercive parenting, but not differences in over-controlling parenting, predicted differences in early gambling. More specifically, the twin who was treated more harshly by his or her parents during infancy was more prone to be involved in gambling activities by age 10 years. Similarly, differences in academic achievement and reward sensitivity also were predicted by differences in coercive parenting. In line with both the developmental task-coping model and the social learning-coercion model, the twin that was treated more harshly was less good in school and more sensitive to reward (i.e., more impulsive). In turn, differences in academic achievement and reward sensitivity predicted differences in gambling. More specifically, the twin who was less successful in school and who was more sensitive to rewards was more prone to gamble. Finally, in line with the developmental task-coping model, differences in academic achievement mediated the link between differences in coercive parenting and differences in early gambling. The theoretical and practical implications are discussed in the following.

The findings support the notion of the salience and predictive power of the parent-child relationship during childhood, thereby suggesting that previous interpretations of nonshared environmental influences as (at least partly) parent-driven may be indeed accurate (Asbury et al., 2003; Burt et al., 2006). However, as found in the previous studies, the associations among parenting and the child outcomes were low. Small to moderate effect sizes ought to be expected in MZ difference studies, however, given that the resulting parameters are purged of any

inflating family-wide effects, including possible gene-environment correlations (Moffitt & Caspi, 2007).

The finding that academic achievement and gambling were positively associated is in line with previous findings at older ages (Ladouceur et al., 1999). Similarly, the finding that ineffective parenting was associated with lowered academic performance replicates previous findings (Forgatch & DeGarmo, 1999; Steinberg et al., 1992). The finding that reward sensitivity was linked to gambling replicates a finding in an adolescent sample (Vitaro et al., 1999). The finding that only academic achievement but not reward sensitivity mediated the link between coercive parenting and gambling deserves a tentative explanation. One line of explanation refers to differences in the reliabilities of the measures. Reward sensitivity was assessed with a single score counting the number of trials in the second game of the lab task. In contrast, academic achievement was comprised of three teacher-rated grades (i.e., reading, writing, and mathematics) and therefore likely more reliable than the single indicator measure of reward sensitivity. However, the finding that reward sensitivity yielded significant associations with coercive parenting as well as gambling provides evidence against the assumption that reward sensitivity was unreliably measured. Another explanation for this finding would be that the experience of failure in the academic domain has more predictive power than reward sensitivity as a personality trait. Thus, this finding may provide support for the developmental task and coping perspective (e.g., Havighurst, 1972).

Another unexpected finding in need of a tentative explanation is that academic performance and reward sensitivity were not concurrently correlated. Despite this overall negative finding, it is possible that that sensitivity to rewards may be in part positively related to academic tasks if positive reinforcement is at stake (e.g., monetary rewards for good grades or

praise from parents or teacher). In contrast, reward sensitivity may be negatively related to academic achievement if it causes engagement in activities that distract from academic tasks, such as gambling activities. Positive and negative associations of reward sensitivity and academic achievement thus may cancel each other. Hence, reward sensitivity can be a good and a bad thing depending on the type of reinforcing activity the child is exposed to. Parents can play a key role in this context by influencing the type of activity their child will engage in, thus channelling their child's "vulnerability" or "asset" towards reward sensitivity. This, of course, includes gambling related activities parents wrongly tend to consider innocuous for their child (Ladouceur, Vitaro, & Coté, 2001).

Gender, SES, and Birth weight

The finding that neither gender nor SES moderated the described links has to be interpreted with caution. Given the rather small overall sample, these tests were plagued with limited statistical power. Moreover, only few children had already initiated gambling at age 10 years. Hence, any group comparisons involving the latter variable were prone to yield nonsignificant results. However, previous studies using the MZ difference method to examine links of differential parenting to externalizing behaviors in much larger samples also did not find any evidence for moderating effects of gender (Asbury et al., 2003, Burt et al., 2006). The nonsignificant mean-level comparisons across gender and SES groups may also be accounted by lacking power. It was thus important to control for the linear effects of both variables after collapsing across groups, although lacking mean-level differences appeared to indicate that neither gender nor SES had any linear links to the study variables.

In line with the findings of a meta-analysis (Aarnoudse-Moens et al., 2009) and a MZ difference study (Asbury et al., 2006), birth weight was positively related to academic

achievement on the level of within-pair differences as well as on the level of a phenotypic correlation. Contrary to our expectations, however, birth weight was unrelated to both ineffective parenting dimensions. This finding suggests that the links of initial differences in birth weight between twins and parental reaction are more complex than expected. This is further supported by the finding that over-controlling and harsh parenting styles were positively correlated on a twin difference level. The twin who experienced more over-controlling parenting also tended to be treated more harshly by the parents. However, this could equally likely apply for the initially smaller or heavier twin as indicated by the zero correlations of birth weight with parenting. Future research may address whether there are moderating variables such as parental personality characteristics that may explain the opposing trends across families regarding which of the twins ended up to be the target of ineffective parenting. Somewhat puzzling is the finding that the heavier twin tended to gamble more than the smaller twin. One possible, although only speculative, explanation for this finding could be that the heavier twin's behaviors were more aggressive than the smaller twin. Early onset of risky behaviors including gambling is often associated with heightened levels of aggression throughout childhood (e.g., Vitaro, Ladouceur, & Bujold, 1996). Future research therefore should address the role of aggressive behavior in this context.

Limitations and Conclusions

The present study has a number of positive features: a) the use of two informants for the predictor and the outcome variables, thus reducing measurement error, b) the use of different informants for the putative mediator, the predictor variables, and the outcome variables, thus reducing the risk for inflated links attributable to shared method variance, c) strong internal validity through the control of a number of important possible confounders, thus reducing the

risk of spurious links, d) the use of a longitudinal perspective, thus clarifying the directionality of the links, and, finally, e) the use of the discordant twin method, thus eliminating the risk of inflated linkages between environmental factors and children's outcomes as a result of gene-environment correlations. An additional asset of this study was to examine the links between two environmental factors (i.e., differences in ineffective parenting) and a behavioral outcome (i.e., differences in twins' gambling) as potentially mediated by outcomes driven by motivational and cognitive factors (i.e., reward sensitivity and academic achievement).

In addition to these assets, the present study also has limitations, however, that need to be considered when interpreting the results: a) a small sample size, b) stabilities of the predictor and mediating variables were not controlled, and c) limited external validity given the ethnic and age composition of the sample. Despite these limitations, the present results highlight the role of parenting as a true environmental factor that can influence early onset gambling, as well other risk taking behaviors. They also highlight the predictive role of reward dependency and of low academic performance, and the mediating role of low academic performance, in regard to early onset gambling. These elements can be targeted as modifiable risk factors in programs aiming to prevent early gambling and other related risk taking behaviors. Finally, these elements can serve to build an integrated developmental model of early gambling behavior in children.

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Table 1

Phenotypic intraclass correlations and MZ difference score correlations among study variables

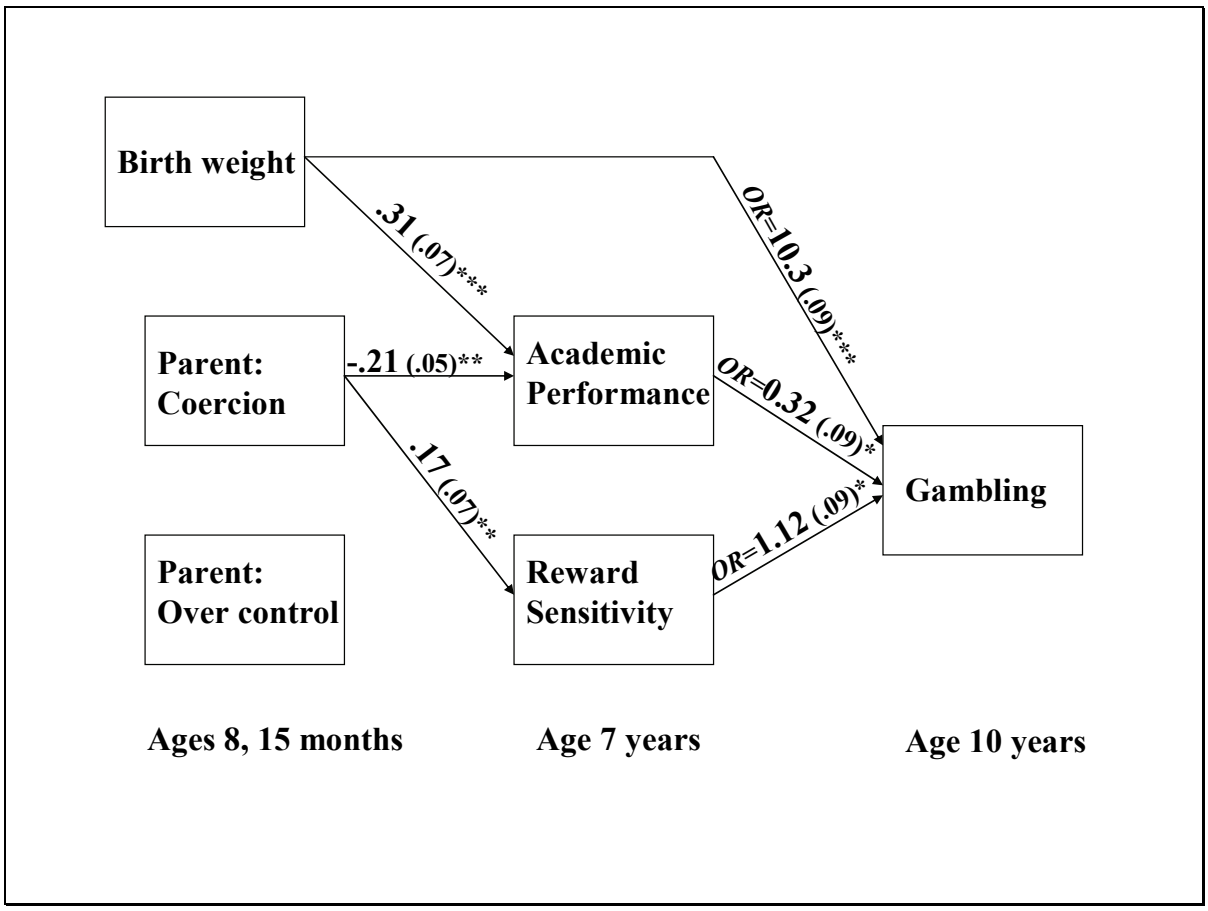
Variable	1	2	3	4	5	6
1. Birth Weight	-	-.01	.08	.29***	.07	.16*
2. Parent: Over control	-.01	-	.15*	.04	.11	.13†
3. Parent: Coercion	.00	-.01	-	-.18**	.18**	.21**
4. Academic Performance	.09**	.00	-.06	-	.03	-.18**
5. Reward Sensitivity	-.02	.11***	.04	-.02	-	.18**
6. Gambling	.04	.03	.07†	-.10***	.10*	-
Twin1 with Twin2[a]	.81	.80	.75	.78	.24	.43

Note. Phenotypic intraclass correlations are below diagonal; MZ difference score correlations above diagonal; [a] all correlations within twin pairs significant ($p < .001$).

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$.

Figure

Figure 1. Results from path analysis linking twin difference scores: T1 parenting variables to T3 gambling via T2 mediators controlling for T0 birth weight. Each link was invariant across gender. Linear effects of gender and SES (i.e., shared environment) were partialed outside the path analysis. Although in the saturated model all possible within-time correlations and across-time regression paths were estimated, only paths and correlations with coefficients that were significant at $p < .05$ are reported for parsimony of presentation. Within-time residual correlations were nonsignificant; standardized OLS coefficients or odds ratios (OR) for logistic regressions are provided; standard errors are reported in brackets. Coercive parenting was significantly linked to T3 gambling (OR = 1.68, se = .19, $p < .01$) in the path model that did not include the T2 mediators. Only the mediating effect of academic performance was significant ($z = 2.12$, $p < .05$; Sobel test adjusted for logistic regression) $N = 205$; * $p < .05$; ** $p < .01$; *** $p < .001$.


Birth weight
.31 (.07)***
OR=10.3 (.09)***
Parent: Coercion
-.21 (.05)**
Academic Performance
OR=0.32 (.09)*
Gambling
.17 (.07)**
Parent: Over control
Reward Sensitivity
OR=1.12 (.09)*
Ages 8, 15 months
Age 7 years
Age 10 years