

RUNNING HEAD: Parents' problem gambling and children's IH/I behaviors

The intergenerational association between parents' problem gambling  
and impulsivity-hyperactivity/inattention behaviors in children

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**Abstract**

Despite the well-established association between problem gambling and ADHD core categories of impulsivity-hyperactivity and inattention, the link between parents' problem gambling and impulsivity-hyperactivity/inattention (IH/I) behaviors in children has not been investigated. This study investigated the association between parents' problem gambling and children's IH/I behaviors while controlling for potential confounding variables. A population-based prospective cohort followed-up from kindergarten to age 30, the Quebec Longitudinal Study of Kindergarten Children (QLSKC), provided data over three generations. Among 1358 participants at age 30, parents with a child aged 1 year or older (N=468; Mean age=4.65 years; SD=2.70) were selected. Generalized Linear Models included measures of grandparents' and parents' problem gambling, parents' IH/I behaviors in childhood, and a host of risk factors and comorbidities to predict IH/I in children. Intergenerational bivariate associations were observed between grandparents' problem gambling, parents' IH/I in childhood and problem gambling at age 30, and between parents' IH/I, problem gambling, and children's IH/I behaviors. Parents' problem gambling predicted children's IH/I behaviors above and beyond the effects of covariates such as family and socioeconomic characteristics, alcohol and drug use, depression symptoms and parents' gambling involvement. Parents' IH/I behaviors in childhood also predicted children's IH/I and had a moderating, enhancing effect on parents' problem gambling association with their offspring's IH/I behaviors. Problem gambling is a characteristic of parents' mental health that is distinctively associated with children's IH/I behaviors, above and beyond parents' own history of IH/I and of typically related addictive, psychopathological or socioeconomic risk factors and comorbidities.

**Keywords:** Problem Gambling; Parents; Children; Impulsivity-hyperactivity; Inattention; Parental influence

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## **Introduction**

Decades of research on children of substance abusers have shown the adverse effects of growing up with an addicted parent (Johnson and Leff, 1999). Recently, following the unprecedented rise in access to gambling in western countries - partly due to the advent of Internet gaming - and the identification of problem gambling as an emergent public health issue, gambling behaviors have received increasing attention from researchers, clinicians and public health policymakers (Calado and Griffiths, 2015; Shaffer and Martin, 2011). Although still sparse, studies on the children of problem-gambler parents (CPGP) suggest that they are at risk of poor interpersonal relations, conduct problems, depression and anxiety symptoms, alcohol and drug use or abuse, early gambling involvement, and gambling problems (Jacobs et al., 1989; Lesieur and Rothschild, 1989; Vachon et al., 2004; Vitaro et al., 2008).

To our knowledge, no research has explored the prevalence of Attention-Deficit/Hyperactivity Disorder (ADHD) core categories, notably impulsivity-hyperactivity/inattention (IH/I), in CPGP. This is surprising for several reasons. First, IH/I – especially the hyperactivity-impulsivity component – is a well-established risk factor of problem gambling. For instance, impulsivity in childhood or early adolescence has been shown to triple the odds of meeting criteria for problem gambling in late adolescence or adulthood (Liu et al., 2013; Shenassa et al., 2012). Second, comorbidity between the two disorders is significant, with respective rates of ADHD and problem gambling in problem gamblers and ADHD-positive individuals 2 to 5 times higher than controls or population-based prevalence levels across studies and samples (Faregh & Derevensky, 2011; Kessler et al., 2008; Specker et al., 1995). Third, IH/I and problem gambling share several risk factors such as being male, low SES, dysfunctional or broken families, parental depression and addictive behaviors, and poor relationships (Biederman et al., 2011; Cherkasova

et al., 2013; Haroon et al., 2004; Vitaro et al., 2008). Fourth, both IH/I and problem gambling have consistently shown an important comorbidity with alcohol and drug use/abuse and depression (Blanco et al., 2012; Kessler et al., 2006, 2008). Finally, both IH/I and problem gambling are driven by substantial genetic influences (Larsson et al., 2006; Slutske et al., 2010), which are hypothesized to underlie in part the intergenerational transmission observed for each condition (Vachon et al., 2004; Wilens et al., 2005). Importantly, genetically informed studies found that problem gambling and impulsivity-hyperactivity partly share the same genes (Comings et al., 1999; Eisenegger et al., 2010). Consistent with these results, recent work focussing on a key component of impulsivity (temporal discounting: a decline in one's subjective value of reward with increasing delay), suggests that this highly heritable trait (Anokhin et al., 2015) is common to ADHD, problem gambling, and other addictive behaviors (Bickel, 2015; Bickel et al., 2012).

In light of these points, one would expect a link between parents' problem gambling and their offspring's IH/I behaviors, but whether this link remains when common risk factors and comorbidities are taken into account is unclear. From a developmental psychopathology perspective, genetic and environmental factors operate jointly to influence the development and to sustain, aggravate, or reduce individuals' adjustment problems (Rutter & Sroufe, 2000). We do not know whether parents' problem gambling represents a distinct risk factor for children to develop IH/I behaviors, or if it is the expression of the same underlying syndrome. If the intergenerational transmission of IH/I is entirely explained by common genetic and related risk factors, parent gambling should not predict children's IH/I behaviors once their own IH/I and its associated comorbidities and risk factors are controlled. If not, then parent gambling may play a unique and additive predictive role, for instance through some socialisation process. It is also possible that the contribution of parents' gambling could be conditioned by their liability for IH/I.

For instance, given that both disorders have been associated with a dysfunctional family environment and maladaptive parenting, such as coercive or inconsistent disciplinary practices and low monitoring (Chronis-Tuscano et al., 2008; Johnston et al., 2012; Vachon et al., 2004; Vitaro et al., 2008), gambling parents' inappropriate behaviors may be intensified by IH/I symptoms, resulting in a multiplicative rather than additive effect on child's behavior. Thus, the investigation of the association between parents' problem gambling and children's IH/I should be conducted within a framework that considers parents' history of IH/I and the above-mentioned risk factors and comorbidities common to both mental health conditions. Such investigation may provide important insights for etiological, clinical and public health perspectives pertaining to CPGP's health.

The present study aimed to do this by capitalizing on an existent longitudinal population cohort and on data collected over 24 years and three generations. Specifically, the goal of the study was to investigate the association between problem gambling in study participants (i.e., the parents) at age 30 and their children's IH/I behaviors, while taking into account family and personal risk factors and comorbidities common to the two dimensions: Grandparents' alcohol and gambling problems; parents' IH/I behaviors in childhood; parents' alcohol/drug use and related problems, depression symptoms, and gambling involvement – strongly associated with problem gambling (Carbonneau et al., 2015) – at age 30; and family and socioeconomic characteristics. We hypothesized significant associations across generations between problem gambling and IH/I behaviors (i.e., between grandparents and parents, and between parents and children). Given its documented impact on family environment, parents' problem gambling should also have a distinct effect on children's IH/I behaviors beyond the effect of parents' childhood IH/I. However, the nature of the association between the two key predictors remains uncertain, as it is conceivable that part of the total effect of parents' IH/I on children's IH/I

(expected given prior evidence of intergenerational transmission) may be mediated by problem gambling. Alternatively, parents' IH/I may act additively on family management problems for problem-gambler parents, or increase these problems in a multiplicative manner, thus moderating the resulting effect on children's IH/I behaviors. Consequently, we tested not only the unique and additive role of parents' problem gambling and early IH/I, but also a possible mediation effect of parents' problem gambling, as well as a possible interaction between the two variables in predicting children's IH/I behaviors.

## **Methods**

### Study Population

Participants were part of the Québec Longitudinal Study of Kindergarten Children (QLSKC; Rouquette et al., 2014), a population cohort (N=3017; 52.0% males) representative of children attending kindergarten in public schools of the province of Quebec, Canada, in 1986-1987. The study design was reviewed and ethical approval of all aspects of the study was provided by the University of Montreal and the Ste-Justine Hospital's Institutional Review Board. Informed written consent of the participants was obtained separately for each assessment wave. Measures used in the present study were collected when the cohort's target participants (i.e., the parents in the present study) were 6 (T1) and 15 (T2) years old. At age 30 (T3), 1358 (45.0%) were successfully reassessed, and their children were assessed for the first time. These participants were compared to those who dropped out on demographic, socioeconomic and behavior measures at T1: grandmother's and grandfather's age at the birth of first child, education and occupational SES, family structure (intact/non-intact), parents' sex, and childhood IH/I behaviors. Significant differences between the two groups were observed for all but one variable – grandfather's age at the birth of first child. To compensate for differential attrition, propensity score weighting (Guo and Fraser, 2010), conditional on observed baseline differences

between age-30 participants and lost subjects, was applied in the analyses. Using this approach, we first determined the probability (propensity) that a subject would be reassessed at age 30 based on the above socioeconomic and demographic variables assessed at baseline (age 6; T1), then weighted the observations collected at age 30 by the inverse of estimated propensity scores. Based on a logistic regression model, the propensity scores were estimated from the predicted probabilities generated by the model. Analyses that are weighted for the inverse probability of attrition have been shown to reduce bias due to differential attrition in longitudinal studies (Weuve et al., 2012).

However, while most scholars would agree that differential attrition can lead over time to a significant underestimation of means or prevalence rates in outcomes, the consequence of selective attrition in association or predictive studies based on longitudinal data, as in the present investigation, is a different issue (Wolke et al., 2009). Indeed, a body of work based on both empirical and simulation studies have shown that the validity of regression models is only mildly or marginally affected by selective drop-out (Gustavson and Borren, 2014; Gustavson et al., 2012; Wolke et al., 2009). Moreover, these reports concluded that long-term longitudinal studies are valuable for investigating associations between risk/protective factors and behavior/mental health outcomes even in the presence of substantial attrition rates reaching up to 70% when the same variables that were related to the drop-out process were used as predictors of a behaviour disorder outcome (Gustavson et al., 2012; Wolke et al., 2009). Moreover, this effect is likely to lead to an underestimation of the predictor-outcome association (Weuve et al., 2012; Wolke et al., 2009).

As could be expected, since the less adjusted participants/families are typically more likely to drop out of longitudinal studies on mental health problems (Fischer, Dornelas and Goethe, 2001), attrition in the present study was linked with the measure of parents' IH/I at age 6.

However, the magnitude of this association was relatively modest:  $\eta^2=.175$ ,  $p<.001$  (i.e., 3.06% of variance in IH/I explained), based on a difference in means of .298 representing about a third of a SD (.35) for this standardized variable. Importantly, differential dropout was not associated with grand-parents' problem gambling ( $V = .024$ ,  $p = .271$ ). Nevertheless, we examined potential differences in baseline (T1) correlations between parents' early IH/I and the demographic and socioeconomic measures (grandparents' age at the birth of first child, education, and occupational SES, and family structure) for those who stayed and those who dropped out of the study.

Although 6 of the 7 measures at baseline differentiated the two groups, none of the association coefficients ( $r$  or  $\eta^2$ ) between parents' (participants) early IH/I behaviors and these variables were significantly different for participants who stayed and those who dropped out of the study by age 30. Thus, similar to previous research (Gustavson et al., 2012) regarding the validity of regression models despite a non-random loss of participants, these findings support the idea that the estimates of associations between these variables can be robust to selective attrition.

Finally, among age-30 participants, 575 (42.3%) were parents. To obtain valid assessments of IH/I behaviors, their children were included in the present study if they were at least one year old ( $N=468$ ; Mean age=4.65 years,  $SD=2.70$ , range: 1-14 years). This decision was based on recent reports showing that: 1) parent-rated externalizing behaviors coalesce into a psychologically meaningful construct as early as 8 months of age (Lorber et al., 2015), 2) instruments rating IH/I or ADHD problems in preschool children start under age two (e.g., CBCL 1.5-5; Achenbach & Rescorla, 2000), and 3) children who follow a stable high trajectory of hyperactivity-impulsivity across the preschool years based on parental ratings already display this level of HI behavior at age 1½ (Carbonneau et al, 2016).

## Measures

*Children's IH/I Behaviors* were assessed based on parent-ratings of five hyperactivity-impulsivity items (can't stand still, is agitated; fidgety; difficulty remaining quiet; impulsivity: impulsive, acts without thinking; difficulty waiting for his/her turn) and two inattention items (is easily distracted, has trouble sticking to any activity; cannot concentrate, cannot pay attention for long). These items relied on the early childhood behavior scale from the Canadian National Longitudinal Study of Children and Youth (Statistics Canada, 1995). The items used were similar to those used in previous investigations from preschool to adolescence (Galéra et al., 2011; Nagin & Tremblay, 1999), which showed good internal consistency ( $\alpha = .85-.89$  from age 6 to 15) and predictive validity for parent-rated preschool hyperactivity-impulsivity in regards to teacher's assessment of IH/I behaviors in first grade (Cohen's  $d = .83$  and  $.59$ , respectively, for teacher-rated hyperactivity and inattention; Carbonneau et al., 2016). Notably, only 2.4% of the children in our study were above 10 years old. All items referred to the past year (although, typically, respondents for younger children were advised to rely particularly on the last few months) and were coded on a Likert-type scale (never=0, sometimes=1, often=2). Items were summed to a 14-point indicator of IH/I. Children's scores were first computed within each age group (i.e., ages 1-2, 2-5, 5-7, 7-10, and over 10 years), then standardized and aggregated into a global scale. The internal consistency across age groups was respectively 0.56, 0.73, 0.82, 0.84, and 0.84 ( $\alpha$ ; average 0.76). As it is often the case with disruptive behavior scales during the preschool years, coefficients were lower at younger ages (e.g., Basten et al., 2016; Carbonneau et al., 2016; Shaw et al. 2005).

*Target Participants' (i.e., Parents') Gambling Participation and Gambling Problems* were assessed at age 30 with the South Oaks Gambling Screen (SOGS; Lesieur and Blume, 1987). The most cited screening instrument for pathological and problem gambling (National

Center for Responsible Gaming, 2010; Petry, 2005), the SOGS is based on DSM-III and validated against DSM-III-R criteria for pathological gambling, with good reliability and internal consistency (Lesieur and Blume, 1987; Stinchfield, 2002). All gambling items referred to the last year prior to assessment. Gambling participation referred to participants' gambling variety and gambling frequency (Carbonneau et al., 2015). *Gambling Variety* was based on 12 gambling-for-money activities (cards; skill games; betting on sports; betting on races; bingo; dice games; gambling machines; lottery tickets; other games; going to casinos; playing the stock or commodities market; and games on the internet). Items were coded as 1/0 to indicate whether the participant had engaged in the activity or not, and summed into a 12-point indicator of gambling variety. *Gambling Frequency* refers to the overall frequency across gambling activities.

*Gambling Problems* were based on 20 items from the SOGS (try to win back money lost; falsely claiming to win money gambling; feel you have a problem with gambling; gamble more than intended to; criticized for your betting or told you had a problem; feel guilty about gambling; wanting to stop gambling but didn't think you could; hide signs of betting/gambling from people; money arguments about your gambling; borrowed money and didn't pay back because of your gambling; lost time from work or school due to gambling; borrowed money – from nine possible sources - to gamble or to pay gambling debts), coded yes/no (1,0), and summed into a 20-point scale. The internal consistency reliability (alpha) of this scale was .80. Because of the restricted distribution of the data in our population-based cohort, scores were recoded into a 3-level scale indicating whether an individual had experienced no problem (0; 91.2% of sample), or experienced one (1; 5.5%), or two or more problems (2; 3.3%). These thresholds included both gambling problem categories as defined on the SOGS-score sheet (i.e., score 1-4: Some problems with gambling, 8.0%; score 5 or more: Probable pathological gambler, 0.8%), while allowing some distinction among participants reporting gambling problems.

*Grandparents' SES, Alcoholism and Gambling Problems.* Grandparents' (parents' parents) SES was based on their occupational prestige (Blisshen et al., 1987) when the parent was age 6. Grandparents' alcoholism and gambling problems were assessed through structured interviews with grandparents when parents were age 15. Alcoholism was assessed with the Diagnostic Interview Schedule (DIS; Robins et al., 1981) while the SOGS was used to assess gambling problems.

*Parents' IH/I Behaviors at Age 6.* Teacher-rated and parent-rated versions of the Social Behavior Questionnaire (SBQ; Tremblay et al., 1991) were used to assess parents' IH/I behaviors at age 6. The SBQ was used in several large cohort studies that documented its predictive validity, particularly for IH/I (Fontaine et al., 2008; Pingault et al., 2011), on a range of adolescent and adult outcomes (O.R ranging between 2.14 – 7.66 across outcomes for IH/I subjects vs controls). Rated on a 2-point scale ranging from “never applies” to “frequently applies”, the following items were used for Impulsivity-Hyperactivity (restless, runs about or jumps up and down, does not keep still; squirmy, fidgety child; alpha: 0.84), and for Inattention (weak capacity for concentration, cannot maintain his/her attention for a long time on a task; easily distracted; absent-mindedness; and gives up easily; alpha: 0.85). The two scales were aggregated into a 12-point indicator of parents' childhood IH/I behaviors.

*Parents' SES, Education, Family Structure, Social Network, Substance Use/Problems, and Depressive Symptoms at Age 30.* Participants' household income was used as SES indicator at age 30. Education was coded as holding a high-school diploma or not. Family structure was coded as intact (when both parents were living together: 85.4% of sample) or non-intact. Social network, used as an indicator of relationships, was based on the number of friends reported. Substance use measures were based on separate indicators for alcohol and any type of illicit drug use, including the frequency of use over the last year. Problems related to either alcohol or drug

use were based on five situations (e.g., fighting, police intervention/arrest), coded as yes/no (1,0), and summed-up. The indicator of risky behaviors under the influence was based on reporting at least one (1) vs. none (0) of three situations (going to school/work; driving a motor vehicle; practicing sports). Depression over the last year was assessed with nine DSM (American Psychiatric Association, 2013) symptoms (depressed mood for a 2-week period; significant weight loss or gain; sleep problems; fatigue or loss of energy; feelings of worthlessness or guilt; markedly diminished interest or pleasure in almost all activities; difficulty to concentrate; recurring thoughts of death or suicide; symptoms causing impairment in occupational functioning), coded as yes (1) or no (0), and summed into a 9-point scale.

#### Comparison of Parents and Non-parents

Participants who were parents at age 30 were compared to non-parents on the concurrent socioeconomic, personal and social adjustment indicators used subsequently as covariates in the prediction of children's IH/I behaviors (Table 1). Females were more likely to be parents than non-parents (78.5% vs 49.8%, respectively;  $X^2(1df) = 97.71, p < .001$ ). In consequence, sex was controlled in the subsequent comparisons. Although non-parents were slightly more likely to hold a high school diploma and to have more friends, they presented overall a less adjusted profile than parents: the former had a lower income, higher frequency of alcohol and drug use, higher likelihood of reporting problems related to drug use, more depressive symptoms, and a higher variety of gambling behaviors than the latter.

#### Data Analysis

Generalized Linear Modeling (hereafter: GLM) in SPSS v24 (Armonk, NY: IBM) was conducted to test the association between parents' problem gambling and children's IH/I behaviors. GLM is a flexible generalization of linear regression that can accommodate many types of response variables that have error distribution models other than a normal distribution,

including count, binary, proportions, and positive valued continuous distributions (Hardin and Hilbe, 2007). Because IH/I symptoms are usually highly skewed in population samples (i.e., many subjects have few or no symptoms), GLM was preferred in our analyses including children's IH/I behaviors as outcome (see below). However, it should be noted that the Skewness 95% CI (Skewness  $\pm$  2SES) for children's IH/I measure (.470 - .698) overlapped with the critical value of  $\pm$ .500 under which the distribution is considered approximately symmetric and with the  $\pm$  (.5 to 1) range of moderate asymmetry, thus remaining well below the threshold of  $\pm$  1, which would be indicative of problematic asymmetry (Bulmer, 1979; Joanes and Gill, 1998).

As a preliminary step, bivariate associations between grand-parents' problem gambling, parents' age-6 IH/I, parents' age-30 problem gambling, and children's IH/I behaviors were first examined. Then, GLM analyses were performed, including independent and control variables, risk factors and comorbidities of parents' problem gambling and early IH/I to predict children's IH/I behaviors. Although covariates were specifically selected for their association with problem gambling and IH/I, only one pairwise correlation ( $r=.63$  between gambling frequency and diversity at age 30) was above  $r=.5$ , and colinearity remained below the threshold of  $r=.70$  (Dormann et al., 2013). Variables included in the full model were: child sex and age group as control variables, and parent sex, grandparents' SES, alcoholism and problem gambling; parents' IH/I behaviors at age 6; parents' adjustment at age 30 (i.e., education, household income, family structure, social network, frequency of alcohol and drug use and related problems or risky behaviors, depressive symptoms, frequency and variety of gambling activities, problem gambling), and the interaction between parents' problem gambling and their early IH/I behaviors. The association between the above potential confounders ( $n=17$ ) and parents' problem gambling and IH/I are presented in Table 2. All selected covariates were significantly associated with either

IH/I (13/17; range: .042 - .225,  $p < .05$ ; average coefficient: .118) or problem gambling (14/17; range: .051 - .300,  $p < .05$ ; average coefficient: .132).

Based on the significance level of the parameters in the full model, a backward selection approach was conducted (i.e., the least significant parameter was removed from the model and GLM analysis was re-run with the remaining variables). This procedure was repeated until model-fitting statistics indicated that model fit could not be further improved. The Akaike information criterion (AIC) and the Bayesian information criterion (BIC) were used to evaluate model fit. The AIC is designed to favor the predictive accuracy of a model, whereas the BIC is designed to find the most parsimonious model fitting the data (Aho et al., 2014). Finally, mediation and moderation effects were tested by regression-based methods using PROCESS v2.15 (Hayes, 2013) for SPSS. Specifically, bootstrapped (10,000 resamples) bias-corrected confidence intervals (e.g., significant when not overlapping zero) were used in testing both the estimated indirect effect (via mediator) in mediation analysis, and the simple-slopes at  $\text{mean} \pm 1\text{SD}$  of the continuous mean-centered moderator in moderation analysis (Aiken and West, 1991; Hayes, 2013). Covariates were included in both analyses. Figure 1 shows the general model of intergenerational associations, as well as the specific relationships tested in considering direct effects (c,d), mediation (a\*d), and moderation (b), to determine the nature of the links between parent's early IH/I and problem gambling, and child's IH/I behaviors.

## Results

The first step of analysis examined bivariate associations between problem gambling and IH/I behaviors across generations (Table 3). Grandparents' problem gambling was associated with both parents' IH/I behaviors at age 6 and problem gambling at age 30. Parents' IH/I behaviors at age 6 and problem gambling at age 30 were also associated, and were both linked to children's IH/I behaviors. Among all association coefficients between IH/I and problem

gambling across generations, only grand-parents' problem gambling and (their grand-) children's IH/I were not related.

The second step of analysis included all independent variables and covariates as well as the interaction between parents' problem gambling and early IH/I behaviors (Table 4). Model fitting procedure resulted in a thirteen-parameter model (according to both AIC and BIC) – twelve predictors, and the interaction – representing a substantial increase in prediction accuracy ( $\Delta AIC=10.24$ ) and a very strong improvement in fit ( $\Delta BIC=53.59$ ) compared to the initial, full model. Parents' IH/I behaviors at age 6, problem gambling at age 30, and their interaction, were part of the final model, above and beyond the significant effects of covariates. Of note, analysing unweighted data resulted in a very similar model of nine predictors (family structure, alcohol problems and drug use were slightly above significance level) with the interaction. Additional analyses also showed a similar pattern of association between parent's problem gambling and children IH/I behaviors across age groups.

No evidence of problem gambling as mediator of the relationship between parents' and children's IH/I behaviors (Figure 1, path a\*d) was found: Indirect-effect=-.004, 95%CI<sub>bootstrap</sub>: -.031, .024. Mediation analysis without covariates provided very similar, non-significant results (Indirect-effect=-.007, 95%CI<sub>bootstrap</sub>: -.040, .054). Probing of the interaction between parents' problem gambling and early IH/I (Figure 1, path b) revealed that moderate (conditional-effect=1.06, 95%CI<sub>bootstrap</sub>: 0.30-1.82, at Mean value) to high (conditional-effect=1.99, 95%CI<sub>bootstrap</sub>: 0.84-3.13, at Mean+1SD value) levels of parents' IH/I behaviors in childhood increased the risk of IH/I behaviors in children of problem gamblers (Figure 2).

## Discussion

The present study aimed to investigate the association between parents' problem gambling and children's IH/I behaviors, while taking into account family background of problem gambling and IH/I, and a host of other risk factors and comorbidities associated with both dimensions across three generations. First, our preliminary analyses showed a series of significant bivariate associations among problem gambling and IH/I behaviors across generations. Second, our main hypothesis was supported: Parents' problem gambling was a significant risk factor for children's IH/I behaviors, above and beyond the effects of socioeconomic and family characteristics, parents' alcohol or drug use/problems, depressive symptoms, gambling involvement, and parents' childhood IH/I behaviors. Indeed, our findings suggest that the risk inherent to parents' problem gambling is not due to a mediation of the effect of parents' early IH/I behaviors or to risk factors and comorbidities frequently associated with both conditions (Cherkasova et al., 2013; Kessler et al., 2008), including the transmission of a common genetic liability. Importantly, the presence in the final model of other dimensions associated with problem gambling (education, income, problems and risky behaviors related to alcohol use), which could also represent proxies of the effect of parents' early IH/I on child outcomes, did not account for the lack of mediation by parents' problem gambling. Indeed, mediation analysis without these covariates provided very similar, non-significant, results for the test of mediation. Instead, the significant effects of parents' early IH/I and current gambling problems and their interaction suggest that other aspects of the two dimensions contribute to children's risk of developing IH/I behaviors.

The substantial genetic basis of IH/I (Larsson, Lichtenstein and Larsson, 2006) likely explains its homotypic continuity across generations. Furthermore, the enhancing, moderating effect of parents' early childhood IH/I in the present study, is consistent with previous reports

indicating more severe problem gambling and associated problems (e.g., substance use/abuse or other psychiatric comorbidities) in problem gamblers with a comorbid ADHD disorder (Breyer et al, 2009; Grall-Bronnec et al, 2011). A similar interactive effect may increase adverse family conditions associated with parental problem gambling (e.g., negative or inconsistent parenting, family tensions and violence, psychological distress, lack of parental interest, involvement and emotional availability) (Abbott, Kramer and Sherrets, 1995; Darbyshire, Otter and Carrig, 2001; Dowling, 2014). This would also be consistent with reports of maladaptive parenting in parents with ADHD and its impact on family environment (Chronis-Tuscano et al., 2008; Johnston et al., 2012). In that respect, the potential effect of early IH/I on dimensions of parent gamblers' family environment and subsequent influence on their children's IH/I behaviors may represent a type of heterotypic continuity across generations. It is important to note that a number of these dimensions, i.e., covariates relative to family conditions, comorbidities, and other aspects of gambling behaviors, were co-investigated in the present study. Thus, understanding the basis of this moderating effect would require further investigations examining other aspect of the family environment.

Interestingly, previous reports indicate that high coercive disciplinary practices and low monitoring in problem gambler parents were associated with their children's depressive symptoms, conduct problems, gambling involvement and problems in adolescence, even when controlling for SES, parental mental health, and family configuration (Vachon et al., 2004; Vitaro et al., 2008). Such inadequate parenting has been shown to impede children's learning of self-control (Ehrenreich et al, 2014; Piotrowski et al, 2013), and is linked with children's IH/I behaviors (Chronis-Tuscano et al, 2008). Consistent with the potential influence of these parenting behaviors on CPGP's IH/I, some reports suggest that negative environmental factors can alter the developing brain regions related to impulsivity (temporal discounting) in ways that

promote problem behaviors (Mackey et al., 2016). Thus, the potential pathways accounting for the intergenerational association of parents' early IH/I and problem gambling with their children's IH/I, may be based on a combination of genetic, homotypic and heterotypic continuity, and environmental influences, which could affect child's behavior through social interactions, as well as through their impact on developing neurobiological processes. Future research focussing on parenting and parent-child relationship in families of CPGP, in association with children's IH/I, might be helpful to uncover the mechanisms underlying the associations observed between parental problem gambling and IH/I behaviors across generations.

Nevertheless, present findings support the idea that reducing parents' gambling problems should result in fewer IH/I behaviors in the offspring. The present findings also suggest that parenting and family management should be key targets for early preventive intervention with problem-gambler parents and their children. Moreover, given that an imbalance between the competing executive and impulsive systems of the brain is hypothesized to underlie temporal discounting (Bechara, 2005; Bickel et al., 2012), which is common to ADHD, problem gambling, and a number of other problem outcomes, parents training might improve their educational practices in order to help reduce the impulsivity of their offspring. Additionally, social skills training for children might help reinforce the skills that could act as protective factors to prevent chronicity of childhood IH/I and its consequences (Tremblay et al., 1995; Vitaro, Brendgen and Tremblay, 1999).

### **Strengths, Limitations and Conclusion**

The present study innovates in three ways. First, IH/I behaviors have not been investigated in CPGP. Second, most studies on CPGP did not investigate problem gambling comorbidities and correlates in parents, that could either account for its possible impact on children, or help understand which factors may moderate this impact. Third, the study of parents'

problem gambling and children's IH/I behaviors across three generations is unprecedented. This strategy helped to understand the interplay between the two dimensions and strengthened our conclusions.

Despite these assets, our study is not without limitations. First, a 24-year longitudinal study inevitably involves some attrition. While we applied a widely used procedure to compensate for differential attrition, this strategy relied on baseline characteristics of participants and thus could not take into account how the lost cases might have evolved over time. However, as discussed earlier, it is important to underline that the present study was not focussed on prevalence rates or differences in means measured in a longitudinal follow-up, which are notably affected by selective attrition over time. Instead, our study examined the associations between parents' early IH/I and problem gambling, and children's IH/I behaviors and estimated associations between predictors and outcomes in regression models based on longitudinal data have been shown to be robust even in the context of substantial selective attrition (Gustavson et al., 2012). Moreover, the effect of attrition on the estimated associations between predictors and outcomes is more likely to lead to an underestimation of the predictor-outcome association (Weuve et al., 2012; Wolke et al., 2009). The use of propensity scores weighting represented an additional tool to reduce the possible impact of differential attrition. Thus, the results of the present study should not be significantly biased despite the substantial attrition in the sample. The similarity between results based on weighted and unweighted data, especially in regards to IH/I and problem gambling measures, further supports this assumption.

Second, participants in our population-based study manifested on average fewer gambling problems than in other studies, and most likely remained at a subclinical level. However, this suggests that a low, subclinical level of gambling problems in parents may be sufficient to result in a significant association with their children's IH/I behaviors. In that respect, parents with

«only» some gambling-related problems warrant consideration for eventual assistance or prevention initiatives concerned with the well-being of their children.

Third, the available measures of hyperactivity-impulsivity and inattention provided indicators of children's and parents' early IH/I behaviors. Despite the face validity of their constituent items and their predictive validity reported in previous studies (Carbonneau et al., 2016; Fontaine et al., 2008; Pingault et al., 2011), these indicators did not constitute diagnoses, nor did they fully cover the range of DSM ADHD criteria. Additionally, although impulsivity symptoms are highly correlated with the other symptoms of the hyperactivity-impulsivity subcategory (Wolraich et al., 2003), the available measures for parents at age 6 lacked items specific to impulsivity. Given the primary interest of the IH/I variables in the present study, this led us to use a joint measure of the three core symptoms for both the parents' and the children's IH/I indicators. Consequently, we did not examine the differential effects of inattention, hyperactivity and impulsivity, and further studies would be needed to determine whether the findings reported here vary across the sub-categories of ADHD for both parents and children. Although the use of consistent assessments across age groups is warranted in the present study, using the same set of IH/I items also comes with its pitfall. The lower reliability of the scale for younger children, although consistent with prior reports (e.g., Basten et al., 2016; Carbonneau et al., 2016; Shaw et al. 2005), is likely due to the fact that some of the items are less appropriate at that early age and were probably less often endorsed. Children's scores were standardized within each age group to limit this potential influence. Moreover, additional analyses showed a similar pattern of association between parent's problem gambling and children IH/I behaviors across age groups. Finally, the IH/I measure for parents at age 6 was based on their own parents' and their teachers' ratings, which is coherent with the requirement of a cross-situational assessment for the diagnosis of ADHD, whereas the measure for children was based solely on parents' ratings.

However, as in other similar large scale studies, an affordable alternative reporting source for young, mostly preschool children, in such a large sample size was not available due to budgetary limitations (Egger & Angold, 2006; Keenan & Wakschlag, 2004; Shaw et al., 2005; Tremblay et al., 2004). Thus, results should be considered in the perspective of the above limitations regarding the IH/I measures used for parents and their children.

A fourth limitation concerns the use of childhood IH/I behaviors for parents as potential confounder for the effect of current gambling problems. Studies have shown that IH/I (or ADHD) symptoms can also emerge later in development (Agnew-Blais et al., 2016). The choice of our earliest (age 6) measure of IH/I for parents was made on the basis that this age-period was the closest to children's average age (4.65 years,  $SD=2.70$ ) at the time of the study. Because the link between parents' and children's IH/I behaviors was part of the study's focus, using measures at similar age-periods seemed more appropriate. Previous reports have indicated that different genetic factors may be involved in the emergence of these symptoms at different ages (Pingault et al., 2015). Thus, aggregating parents who displayed IH/I behaviors at any point in their past might have resulted in the introduction of another form of bias, if early and later onset IH/I in parents have a different impact on children's early IH/I behaviors. However, if IH/I emerging later in parents' childhood, adolescence or adulthood showed a similar association with their gambling problems as adults, and eventually with their children's IH/I behaviors, this would make our results conservative. In any case, the observed multiple links between IH/I and gambling problems in the present study should be considered on the basis of early childhood IH/I behaviors for both parents and children.

Fifth, while using a measure of parental gambling as close as possible to children's IH/I assessment made sense to study the association between both dimensions, using the last year as reference period for problem gambling probably left out some parents who may have reported

such problem on a lifetime basis. However, aggregating all parents reporting any problem gambling in their past would have introduced the issue of distant vs proximal association with children's IH/I, along with the corresponding methodological issues related to the inclusion of confounders measured at different time points. Nevertheless, if the same association with children's behaviors is observed for parents who report lifetime but not last-year problem gambling, then aggregating parents who had experienced problem gambling in a more distant past with parents who did not in the previous year may have resulted in conservative associations. Sixth, although grandparents' problem gambling and alcoholism were considered in our study design as potential risk factors for parents' IH/I behaviors at age 6 and their problem gambling at age 30, these grandparent variables were assessed when parents were age 15. However, given that a) the age of onset of alcohol use disorders peaks in the late teens or early to mid-20s according to DSM-V (APA, 2013), and b) the mean age of grandparents at the birth of the parent was 27.5 years in our sample, it seems reasonable to assume that a majority of grandparents in our study had some problems with alcohol before the birth of their offspring (the parent) and the assessment of the parent's IH/I behaviors at age 6. A similar rationale applies to grandparents' problem gambling, which is alleged to begin in adolescence or early adulthood and to follow a similar trajectory as substance dependence (Ibanez, Blanco, Moreryra, & Saiz-Ruiz, 2003; Leeman & Potenza, 2012). Finally, the spouse of the parent-participant was not included, while a majority of these spouses are males. Considering that males are more prone to gambling problems, there might be a number of problem-gambler parent-partners confounded in the parents without gambling problems who reported IH/I behaviors for their children, which is likely to lead to conservative results.

In spite of these limitations, the present study provides important insights regarding the association between parents' problem gambling and children's IH/I behaviors. First, the multiple

links observed across three generations underline the importance of this association in the developmental processes associated with both conditions. Second, parents' problem gambling represents a specific risk for their offspring to develop IH/I behaviors, above and beyond parents' history of IH/I, and common addictive, psychopathological or socioeconomic correlates. Thus, this characteristic of parents' mental health needs serious attention in order to prevent an intergenerational cycle of maladjustment, including IH/I behaviors early in their children's development.

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Table 1 Comparison of parent and non-parent participants at age 30 (N=1358)

Characteristics of participants at age 30	Participant status		Sig.	
	Non-parent	Parent		
	Mean (SD) or %	Mean (SD) or %		
Gender (Male/Female) <sup>1</sup>	50.2 / 49.8	21.5 / 78.5	< <b>.001</b>	
Education/High school degree	91.4	87.9	<b>.002</b>	
Income	6.24 (2.95)	6.75 (2.77)	<b>.002</b>	
Social network: Number of friends	6.04 (4.10)	5.12 (3.19)	< <b>.001</b>	
Frequency of Alcohol use	3.64 (1.78)	2.94 (1.73)	< <b>.001</b>	
Problems related to alcohol use	0.58	0.34	.295	
Risky behaviors while using alcohol	27.7	17.5	.226	
Frequency of Drug use	0.55 (1.02)	0.34 (0.77)	< <b>.001</b>	
Problems related to Drug use	0.68	0.40	<b>.048</b>	
Risky behavior while using drug	23.3	15.6	.359	
Number of Depression symptoms	2.49 (3.29)	2.14 (3.12)	< <b>.001</b>	
Gambling Frequency	1.29 (0.97)	1.21 (0.87)	.828	
Gambling Diversity	1.90 (1.62)	1.52 (1.34)	<b>.023</b>	
Number of Gambling Problems	0	90.1	92.7	.207
	1	5.4	5.7	
	2+	4.4	1.6	

<sup>1</sup>: Comparisons on other characteristics are controlled for gender differences between parents and non-parent participants.

Table 2 Bivariate associations<sup>1</sup> between potential confounders and parents' early IH/I behaviors and problem gambling (N=468)

	Parent - IH/I behaviors age-6	Parent - problem gambling
Grandparents - Family SES / parent age-6	<b>-.149**</b>	-.019
Grandparents - alcoholism	-.002	<b>.059**</b>
Grandparents - problem gambling	<b>.130**</b>	<b>.191**</b>
Parent - gender	<b>.225**</b>	<b>.135**</b>
Education	<b>-.191**</b>	-.029
Household income	<b>-.127**</b>	<b>-.054**</b>
Family structure	-.028	<b>.056*</b>
Social network	<b>.052*</b>	-.012
Frequency of alcohol use	-.014	<b>.051**</b>
Problems related to alcohol use	<b>.117**</b>	<b>.177**</b>
Risky behaviors under alcohol influence	.026	<b>.138**</b>
Frequency of drug use	<b>.106**</b>	<b>.094**</b>
Problems related to drug use	<b>.103**</b>	<b>.125**</b>
Risky behaviors under drug influence	<b>.123**</b>	<b>.123**</b>
Number of Depression symptoms	<b>-.053**</b>	<b>.060**</b>
Frequency of gambling	<b>.094**</b>	<b>.280**</b>
Variety of gambling	<b>.070**</b>	<b>.300**</b>
Average correlation	<b>.118</b>	<b>.132</b>

<sup>1</sup>: Spearman rho between continuous variables; Eta between categorical and continuous variables. Significant coefficients are indicated in Bold. Unless otherwise specified, variables refer to parents' assessments. \*:  $p < .05$  \*\*:  $p < .01$

Parents' problem gambling and children's IH/I behaviors

Table 3 Bivariate associations between problem gambling and IH/I behaviors across generations<sup>1</sup> (N=468)

	Grandparents-GP	Parent- IH/I-6	Parent-GP-30	Child-IH/I
Grandparents-GP	-	.171**	.221**	.015
Parent- IH/I-6		-	.073*	.141**
Parent-GP-30			-	.120**
Child-IH/I				-

GP: Gambling problems. IH/I: Impulsivity-Hyperactivity/Inattention behaviors. 6: age 6; 30: age 30.

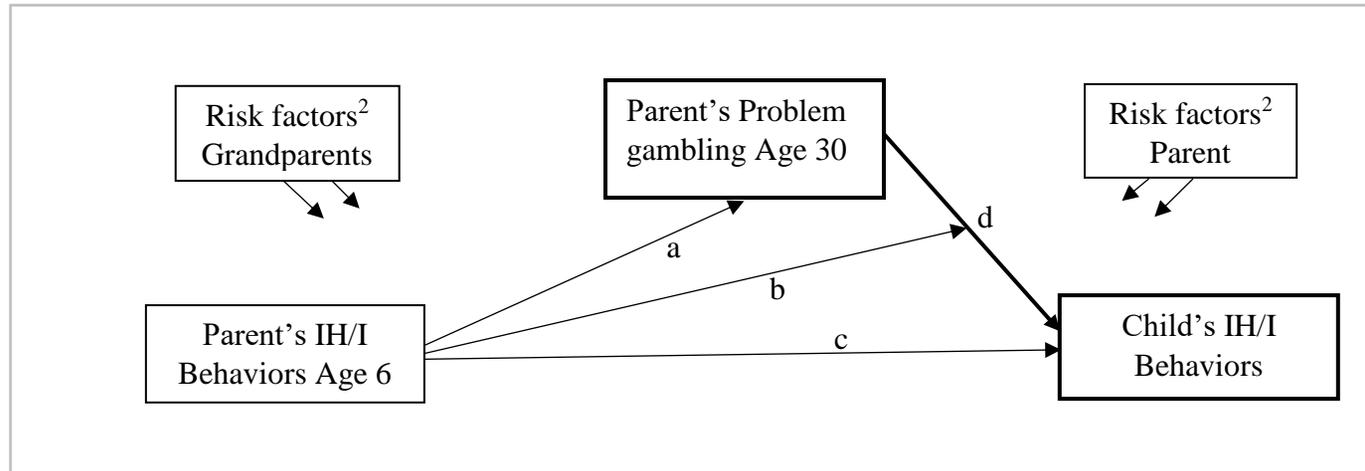
<sup>1</sup>: Spearman *rho* between continuous variables; *Eta* between categorical and continuous variables; *Phi / V* between categorical variables. \*\*: p<.01 \* : p<.05

Table 4 Results of full model and best-fitting model of children IH/I behaviors (N=468)

Parameters <sup>1</sup>	Full Model				Best-Fitting Model			
	B	Std B	Wald X <sup>2</sup>	Sig.	B	Std B	Wald X <sup>2</sup>	Sig.
Child - gender	.570	.1527	13.961	<.001	.580	.1518	14.574	<.001
Child - age	.044	.0771	.330	.566				
Grandparents - Family SES / parent age-6	2.200	.4259	26.678	<.001	2.168	.4192	26.739	<.001
Grandparents - problem gambling	-.482	.2801	2.962	.085				
Grandparents - alcoholism	.814	.1963	17.207	<.001	.808	.1955	17.096	<.001
Parent - gender	-.219	.2075	1.115	.291				
Parent - IH/I behaviors age-6	.549	.1029	28.408	<.001	.514	.1012	25.823	<.001
Education	.810	.2550	10.098	<.001	.905	.2452	13.606	<.001
Household income	-.119	.0428	7.766	.005	-.126	.0378	11.084	.001
Family structure	-.461	.2319	3.950	.047	-.442	.2163	4.183	.041
Social network	-.091	.0236	14.843	<.001	-.087	.0230	14.156	<.001
Frequency of alcohol use	-.023	.0489	.229	.632				
Problems related to alcohol use	.239	.0738	10.434	.001	.197	.0646	9.296	.002
Risky behaviors under alcohol influence	.768	.2175	12.469	<.001	.677	.2032	11.115	.001
Frequency of drug use	-.313	.1269	6.099	.014	-.307	.1140	7.244	.007
Problems related to drug use	-.092	.0841	1.183	.277				
Risky behaviors under drug influence	.191	.2583	.545	.460				
Number of Depression symptoms	-.016	.0263	.360	.548				
Frequency of gambling	-.128	.1146	1.238	.266				
Variety of gambling	.088	.0985	.804	.370				
Problem gambling	1.001	.2518	15.789	<.001	.945	.2418	15.271	<.001
<u>Interaction</u> : Parent IH/I behaviors at age-6*Problem gambling	1.080	.3668	8.663	.003	1.131	.3642	9.641	.002

<sup>1</sup>: Except where specified, parameters refer to parent at age 30.

Figure 1 Association of parent's early IH/I and age 30 problem gambling with child's IH/I behaviors<sup>1</sup>



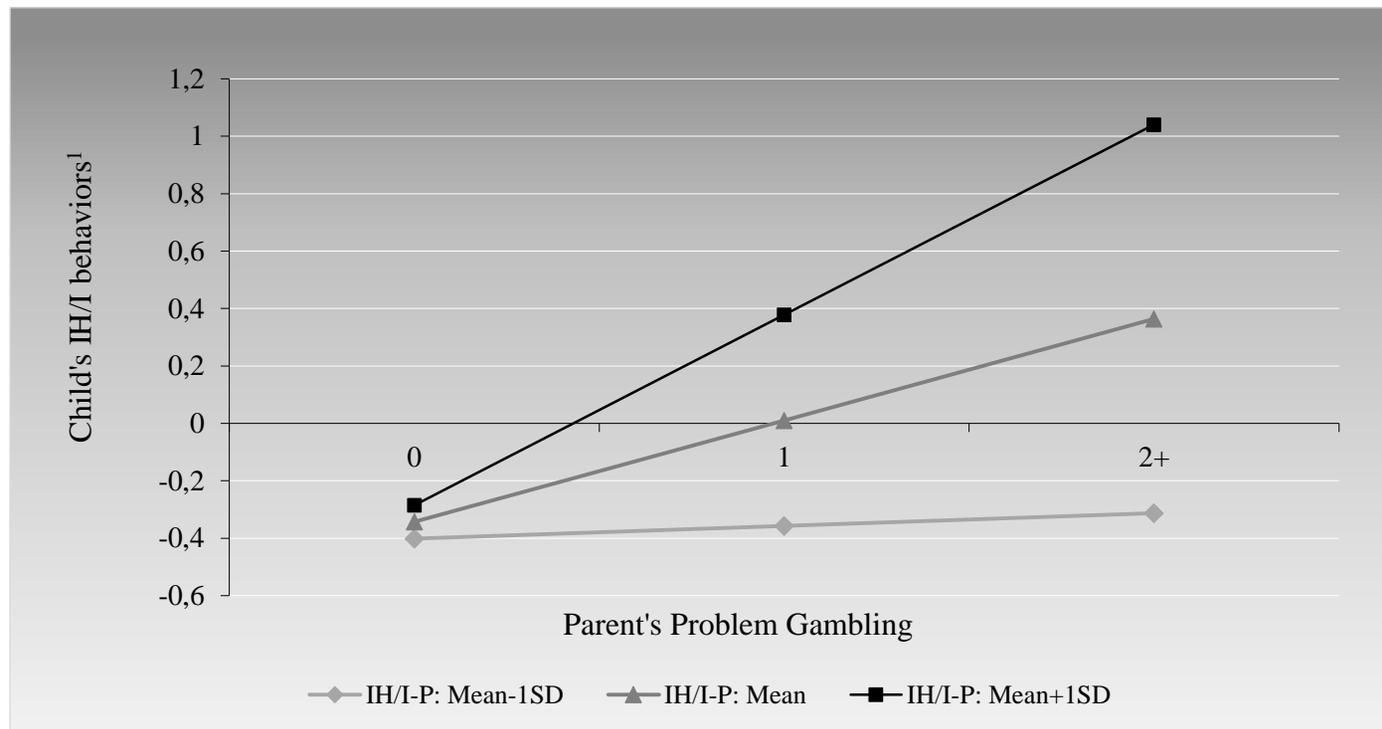
<sup>1</sup>: c, d: Direct effects; a\*d: Mediation (indirect) effect (parent's IH/I through parent's problem gambling);

b: Moderation effect (parent's IH/I on parent's problem gambling association with child's IH/I).

<sup>2</sup>: Used as control variables in the analysis.

Figure 2

Moderation of parent's problem gambling effect on child's IH/I behaviors by parent's early IH/I behaviors (IH/I-P)



<sup>1</sup>: Standardized scores, adjusted for covariates in moderation regression model.