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Impulsivity Trajectories and Gambling in Adolescence among Urban Male Youth

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Abstract

Aim—Building on the recent emerging literature on the impulsivity trajectory-gambling association, this study investigated the association between developmental trajectories of teacher-rated impulsivity in early adolescence (ages 11–15) and subsequent gambling and gambling problems (i.e. at-risk and problem gambling) by age 19.

Design—Prospective cohort design.

Setting—Urban communities in Baltimore, Maryland.

Participants—The sample consists of 310 predominately minority (87%) and low SES (70%) males followed from first grade to late adolescence.

Measurements—Impulsivity was measured using teacher ratings of classroom behavior. Self-reported gambling behavior was assessed using the South Oaks Gambling Screen-Revised for Adolescents (SOGS-RA).

Findings—Results from a conventional growth model suggest the intercept of the impulsivity development (as measured by the repeated assessments of impulsivity across the entire developmental period) was significantly associated with gambling. Results from a general growth mixture model evidenced two distinct trajectories: a high impulsivity trajectory (41% the sample) and a low impulsivity trajectory (59% of the sample). Despite its non-significant association with any gambling, heterogeneity in impulsivity development was significantly associated with gambling problems. Specifically, being in the high impulsivity trajectory doubled the odds of meeting criteria for at-risk or problem gambling (OR= 2.09[1.02, 4.27]) and tripled the odds of meeting criteria for problem gambling (OR=2.84[1.02, 7.91])

Conclusions—Development in impulsivity is strongly associated with problem/at-risk gambling in adolescence among urban male youth. Findings highlight the importance of distinguishing gambling problems from any gambling when evaluating programs aimed at reducing youth gambling problems through reducing impulsivity.

Keywords

Impulsivity; Gambling; Problem gambling; Conventional growth model; General growth mixture model

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Youth problem gambling is widespread and associated with a broad range of high-risk behaviors such as delinquency and substance use [1], and thus is a public health concern. Research has focused on examining the developmental antecedents (such as impulsivity, depression, and anxiety) of gambling in late adolescence/early adulthood [2]. Impulsivity has received the most attention [3–6]. Many scholars have taken note on the multifaceted nature of impulsivity as well as the heterogeneity in its manifestation [7–10]. Despite the difficulty in defining a single trait of impulsivity, two elements must be present, i.e. an impulse or an urge to act and a lack of inhibition or restraint of that urge [11]. Thus, impulsivity is defined as a tendency towards making rush decisions without carefully considering potential negative consequences [12]).

Despite evidence that impulsivity is not stable during adolescence [13–15], most studies evaluating the impulsivity-gambling association have only measured impulsivity at a single point-in-time and gambling either concurrently or at a later time-point. Longitudinal links between the development of impulsivity and late adolescent gambling have not been adequately explored. Most studies were based on samples of French Canadian, predominantly Caucasian adolescents [3,5], leaving low socio-economic status (SES), minority, urban youth understudied. Such oversight is problematic as this population is disproportionately more likely to exhibit both higher levels of impulsivity [16] and problem gambling (e.g. [17–22]).

Characterized by an imbalance between a reasonably-developed reward and punishment processing system and an underdevelopment of impulse control [23], adolescents are vulnerable to risk-taking behaviors including problem gambling [24]. Such vulnerability, together with easy access of gambling opportunities, has resulted in most North American adolescents engaging in gambling activities [25]. The prevalence of gambling problems among adolescents (3–8%) is significantly higher than that among adults (1–3%; [25]).

Several theories make the impulsivity-gambling association plausible. Jacobs' general theory of addictions [26] proposes that highly stimulating activities, such as gambling, are often pursued as means to relieve stress. Individuals with a greater propensity for risk taking and sensation seeking, both important components of impulsivity [27], tend to be more exposed to excessive chronic stress resulted from a hypo-aroused psychological state [28], and, in turn, are more likely to engage in addictive behavior such as gambling. Jessor and Jessor's problem behavior theory [29] posits problem behaviors, such as gambling, substance use, and criminal offending often co-occur in a problem behavior syndrome, and individuals' likelihood of engaging in such behaviors is strongly associated with their levels of impulsivity.

Research examining the development of impulsivity during adolescence, shows a general downward trend (e.g. [13]) as well as interindividual heterogeneity in that trend [30,31]. To date, Betancourt et al. [30] is the only study that related developmental heterogeneity in impulsivity to gambling (although not as the main focus of the study): the authors found three longitudinal profiles in impulsivity among a sample of predominately middle-class Caucasian youth followed from age 10 to 15: low (6%), moderate (57%), and high (37%) trajectories. Youth in the high impulsivity trajectory were twice as likely to engage in gambling by age 15, compared to those in the moderate and low impulsivity groups.

While Betancourt and colleagues' findings [30] are informative, impulsivity and gambling were measured during the same time periods, blurring the directionality of the association. The authors only studied any involvement in gambling without distinguishing problem gamblers from those who did not meet criteria for problem gambling. Not making such a

distinction hinders the ability to study what distinguishes gambling problems from any gambling which is very relevant from an etiological as well as a prevention perspective.

Based upon theories that make the impulsivity-gambling association plausible [26–29], the present study aims to explore the association between impulsivity development in early adolescence and gambling in late adolescence using growth modeling. First, we examine whether the starting point and change of impulsivity during early adolescence (ages 11–15) are related to subsequent gambling among a sample of high-risk urban males. Second, we explore whether there are distinct patterns (i.e. population heterogeneity) of impulsivity development among the study sample. Third, we further investigate whether these distinct trajectories are differentially related to subsequent gambling. We explore whether different trajectories are associated with engaging in any gambling, meeting criteria for at-risk gambling or problem gambling, and meeting criteria for problem gambling in late adolescence.

Methods

Sample

In 1993, 678 urban first-graders from 27 classrooms in nine elementary schools in western Baltimore, Maryland participated in the Johns Hopkins University Preventive Intervention Research Center (PIRC) Second Generation Intervention Trial [32]. Details about the sample design and the trial are described elsewhere [32]. Out of the 362 males enrolled we selected a sample of 310 males according to the following criteria: a) the individual had a valid impulsivity assessment upon entering school (i.e. fall of first grade), b) the individual had at least one of the five impulsivity assessments from ages 11 to 15 and c) the individual had valid information on all covariates included in the analyses. Attrition analysis showed that selected cases resembled the unselected cases on all variables included. Among the 310 selected males, most were African American (87%), and 13% were Caucasian. Over 70% originated from low SES families.

Measures

Impulsivity (ages 11 to 15)—Impulsivity was assessed yearly from ages 11 to 15 as part of the Teacher Report of Classroom Behavior Checklist (TRCBC; an adaptation of the Teacher Observation of Classroom Adaptation-Revised (TOCA-R; [33])), a structured interview used in grade one to three. The impulsivity subscale included three items: “waits for turn”, “interrupts or intrudes on others”, and “blurts out answer before question is complete”. Ratings range from 1 (never) to 6 (always). The total item average scores were used and treated as continuous variables. The Cronbach's alpha coefficient for reliability ranged from 0.73 to 0.81 across the five years. Similar teacher-rated impulsivity measures have been widely used and found to predict self-reported gambling behavior in past studies (e.g. [34]).

Covariates—*SES*: receiving free or reduced-cost lunch or low-SES (1) and not receiving free or reduced-cost lunch or high-SES (0) [35]. *Race*: African American (1) and Caucasian (0). *Age in fall of first grade*: 7 years or younger (0) and older than 7 years (1). *Impulsivity in fall of first grade*: TOCA-R impulsivity subscale. *Intervention status in fall of first grade*: intervention (1) and control (0).

Gambling in late adolescence—To better capture the prevalence of meeting criteria for gambling problems during late adolescence, study participants were interviewed about their past-year gambling at ages 17, 19 and 20, and the highest score was taken. The interview used the South Oaks Gambling Screen-Revised for Adolescents (SOGS-RA; [1]), an

instrument adopted from the adult- oriented SOGS [36] with wording of questions and responses modified to reflect age-appropriate adolescent gambling behavior [37]. Respondents were first asked about their involvement in gambling during the past 12 months. For those who reported involvement, a list of 12 yes/no questions were asked based on the DSM-III-R criteria for pathological gambling, and a SOGS-RA score was created as the sum of these 12 items, ranging from 0 to 12, with higher scores indicating more gambling problems. The internal consistency reliability was satisfactory ($\alpha=0.71$).

To distinguish between any gambling and gambling problems, a four-level ordinal variable was then created according to the recommended criteria [38] and to reflect the clear ranking of the four levels of gambling involvement. Those who did not report past-year gambling were considered as non-gamblers (NG). Among those who reported past-year gambling, a score of 0 or 1 indicates social gambling (SG), a score of 2 or 3 indicates meeting criteria for at-risk gambling (AG), and a score of 4 or more indicates meeting criteria for problem gambling (PG). This four-level ordinal gambling variable captures a continuous underlying propensity of gambling, that is the latent propensity is only partially observed by the four categories. The different thresholds or cut points presented in this variable provide a unique opportunity to test the tipping point of the impulsivity-gambling association, i.e. it allows us to study the cumulative probabilities of engaging in any gambling (i.e. being in the category of SG, AG, or PG), meeting the criteria of at-risk or problem gambling (i.e. being in the category of AG or PG), and meeting the criteria of problem gambling (i.e. being in the category of PG), given different levels of impulsivity. Two-thirds of the sample (67%) has engaged in any gambling, 20% met criteria for at-risk gambling or problem gambling, and 9% met criteria for problem gambling. The estimate for problem gambling is considerably higher than those in previous studies using population representative data from the U.S. (in which the percentage for problem gambling ranges from 3–6%; [17, 22, 38, 39]), but lower than the estimates for boys in a study conducted by Wickwire and colleagues [40] among inner-city mainly minority youth in Memphis, providing added support for the general evidence that urban minority youths are more vulnerable to gambling problems compared to their Caucasian counterparts.

Analytical plan

Conventional growth modeling (CGM) and general growth mixture modeling (GGMM; [41]) were used to describe impulsivity development and to identify distinct developmental trajectories of impulsivity from ages 11 to 15. Missing data on impulsivity measures over time were accounted for by using the full information maximum likelihood (FIML) estimation, a widely accepted method to handle missing data [42,43]. Among the 310 males, 60% had valid information on all five measures of impulsivity, 22% missed only one measure, and the remaining 18% missed two or more measures. The bivariate coverage¹ ranged from .70 to .89.

While a CGM is used to describe the functional form, i.e. the starting point and change (i.e. growth factors) in impulsivity allowing for individual variation, GGMM formally explores the heterogeneity in individual variation, i.e. whether the study population consists of two or more discrete classes of individuals with varying growth trajectories. In this study, we used CGM to empirically demonstrate the advantage of using longitudinal measures by examining the extent to which growth factors influence the outcome while taking into account the entire developmental period. CGM is also a necessary step to determine the

¹Bivariate coverage measures the coverage of the data points between two variables. For example, a bivariate coverage of 0.826 between impulsivity measure at age 11 and impulsivity measure at age 12 indicates that 83% of the sample has valid measures of impulsivity at both time points. A bivariate coverage higher than 10% is necessary for efficient FIML estimation. In this sample the bivariate coverage ranged from .70 to .89, which indicates reasonably high coverage.

measurement model that feeds into GGMM. GGMM was then used to determine the optimal class membership for each individual and to empirically classify individual impulsivity profiles, such as “high” and “low” rather than relying on expert knowledge or information from previous studies. GGMM specifies class membership in a probabilistic fashion, i.e. it allows for the uncertainty of individuals being in each of the latent classes.

Model building proceeded in a stepwise fashion [44]. For the CGM, nested models with fixed and random intercept, linear and nonlinear slopes were compared using a Likelihood Ratio Test and other structural equation model selection criteria, such as Comparative Fit Index (CFI), Tucker-Lewis Index (TLI) and Root Mean Square Error of Approximation (RMSEA). Then, we investigated whether the starting point and growth of impulsivity during ages 11–15 were both associated with the gambling outcome by regressing the four-level ordinal gambling variable on growth factors (e.g. intercept and slope) via ordered logistic regression [45] (see **conceptual** model in Figure 1a).

We explored heterogeneity in the longitudinal development of impulsivity by performing class enumeration tests on the best fitting CGM [44], based on theoretical reasoning as well as fit statistics used to compare non-nested models, e.g. Bayesian Information Criterion (BIC) and Lo-Mendell-Rubin likelihood ratio chi-square test (LMR; [46]). The model that achieved an optimal balance between fit and parsimony was selected as the best GGMM model. Class membership was regressed on covariates, such as race and SES, via categorical logistic regression [45]. Additionally, gambling was regressed on class membership via ordered logistic regression [45] (see **conceptual** model in Figure 1b). Analyses were conducted using Mplus version 6.11 [47] and the clustering of students within classrooms was accounted for by computing robust standard errors using a sandwich estimator [48]. Data can be obtained through Johns Hopkins University Prevention Intervention Research Center at www.jhsph.edu/prevention.

Results

Conventional growth model

Nested model comparisons² suggested that a model with random intercept, random slope and fixed quadratic slope achieved optimal fit ($LL=-1782.12$ (11), $CFI=0.94$, $TLI=0.94$, $RMSEA=0.08$ [0.05, 0.12]; see Table 1). While the overall trend is downward, significant individual variation around the starting points as well as in the linear change factor exist, i.e., some individuals display an increase or decrease, and others experience no change in impulsivity over time.

The association between growth factors and gambling—It was found that the intercept, but not the slope, was significantly associated with later gambling at the conventional .05 level (intercept: logit coefficient=0.32, $p=.018$; slope: logit coefficient=2.07, $p=.058$). The three cumulative probabilities of gambling are presented for the three conditions in Figure 2, i.e. when growth factors are a) at the mean level, b) at one standard deviation below the mean, and c) at one standard deviation above the mean. The probabilities of gambling in each category increased with increasing level of intercept and slope, indicating that individuals were more likely to engage in gambling and develop gambling problems when starting at a higher level on impulsivity development. These

²“Nested models” within the growth model framework can be understood in the same fashion as nested models in a regular regression, that is, two models are nested when both contain the same number of terms and one has one additional term. The one with the additional term is named “full model” and the one with one less term is named “reduced model”. In a growth model context, for example, a model with an intercept only is nested within a model with an intercept and a linear slope, and a model with an intercept and a linear slope is nested within a model with an intercept, a linear slope, and a quadratic slope.

effects can also be interpreted on an odds ratio scale, using those who have an intercept and slope at one standard deviation below the mean as the reference group. Those at the mean level of intercept and slope had 1.77 the odds, and those with an intercept and slope at one standard deviation above the mean had 2.46 the odds of engaging in any gambling, compared to those with an intercept and slope at one standard deviation below the mean.

GGMM and covariate effects

Class enumeration was performed based on the above selected CGM to explore the heterogeneity in development patterns of impulsivity [44]. Fit indices for these models are presented in Table 2. Based on statistical criteria as well as substantive considerations, a 2-class model with the slope variance fixed to 0 for the low class (i.e. 2-class (b)) was chosen as the best measurement model (LL=-1756.67 (14), BIC=3593.65). While the CGM reasonably captures the mean of the individual trajectories, the 2-class GGMM provides further improvement in fit by capturing the non-normal variability of individual trajectories around the mean³.

Two distinct impulsivity trajectories identified were: a high class that consists of 41% of the sample and a low class that consists of 59% of the sample (Figure 3). When regressing class membership on covariates, the only covariate significantly related to class membership was first-grade impulsivity, with a one unit increase in first-grade impulsivity increasing the odds of being in the high class by 2 folds (OR=2.34[1.26, 4.34]).

The association between class membership and gambling

We investigated the extent to which gambling in late adolescence varied as a function of latent class membership by regressing gambling on class membership. Pr (SG/AG/PG), Pr (AG/PG), and Pr (PG) for both classes are presented in Table 3. Differences in these probabilities between classes vary by thresholds. While there is virtually no difference between the predicted probabilities of engaging in any gambling between the two classes (0.68 vs. 0.66), males in the high class were substantially more likely to meet criteria for problem gambling (0.14 vs. 0.06).

The effects of class membership on gambling behavior are also presented as odds ratios with 95% confidence intervals and p-values. Although males in the high impulsivity class were slightly more likely to engage in any gambling than those in the low class, the effect is not statistically significant (OR=1.10[0.63, 1.92]). Males in the high impulsivity class had on average twice the odds of meeting criteria for at-risk or problem gambling (OR=2.09[1.02, 4.27]) than those in the low impulsivity class. Additionally, being in the high impulsivity class increased the odds of meeting criteria for problem gambling by nearly three folds (OR=2.84[1.02, 7.91]).

Discussion

This study investigated the relationship between developmental trajectories of impulsivity in early adolescence and subsequent gambling in late adolescence. Consistent with past studies [15], we found a general downward trend of impulsivity in our sample. We further identified a high impulsivity class (41% of the sample) and a low impulsivity class (59% of the sample). Impulsivity in first grade significantly predicted class membership during adolescence, providing evidence for the construct validity of the latent classes and the continuity of impulsivity between childhood and adolescence.

³The univariate skewness and kurtosis values for the five repeated outcomes were estimated more accurately by the 2-class GGMM model than the CGM that assumes multivariate normality of the observed outcomes (data available upon request).

When comparing our findings regarding impulsivity trajectories with Betancourt et al.'s [30] work we attribute the differences (in terms of number of classes) to the different samples used in the two studies. While their study sample consisted of both males and females, the sample used in our study consisted of males only. Females tend to exhibit lower levels of impulsivity and show a different pattern of development than males [14, 15, 31]. Thus, it may not be appropriate to analyze them together, assuming the same measurement model for both genders. While Betancourt et al.'s [30] study is based on a sample of predominately Caucasian, middle-class youths, the sample in this study consists of predominately urban African American and low SES males. Different sources of impulsivity measures may also contribute to the different findings in the two studies. Specifically, Betancourt et al.'s study [30] used study participants' self-reported measures of impulsivity, while teacher-reported measures were utilized in the current study. Despite that teacher ratings of youth impulsivity may potentially be influenced by various factors such as children's demographic information [49], evidence has suggested that both teacher- and parent-reports of adolescent psychological adjustment (such as hyperactivity-inattention and conduct problems) have higher internal consistency and test-retest reliability, and can better predict future psychiatric disorder diagnosis than adolescent self-reports [50].

Heterogeneity in the development of adolescent impulsivity was found to be strongly associated with subsequent gambling in late adolescence among the study sample, a finding consistent with past studies (e.g. [3, 30]). Our study went beyond Betancourt et al.'s [30] study in three important ways: 1) we ensured the proper temporal order by only considering gambling behavior that occurred after impulsivity measures, 2) we demonstrated that the intercept of the impulsivity development (as measured by the repeated assessments of impulsivity across the entire developmental period) was significantly associated with gambling outcome, 3) we not only studied the association between impulsivity development and gambling, but also raised the important question of whether impulsivity development is equally associated with engaging in any gambling activities and problem gambling by using a widely-used and age-appropriate measure of youth gambling, namely SOGS-RA. Heterogeneity of impulsivity development was only significantly related to at-risk and problem gambling but not any gambling. Being in the high impulsivity trajectory doubled the odds of meeting criteria for at-risk/problem gambling, and tripled the odds of meeting criteria for problem gambling.

This study is not without limitations. First, the study sample consisted primarily of urban, minority participants. While this may be viewed as strength of the study given the relative lack of research on impulsivity-gambling association among urban minority populations, the findings of this study may not be generalizable to the general population and thus should be extrapolated with caution. Second, although we have ensured the logical temporal order of events, the observed significant association between heterogeneity in impulsivity development and gambling behavior does not necessarily indicate a causal relationship. Third, given that only an extremely small percentage (less than 1%) of females in this sample met the criteria of problem gambling, we could not study the impulsivity-problem gambling association among females. Last, self-reports of gambling problems may be subject to reporting bias. However, given that the gambling and impulsivity measures were obtained from different sources, it is unlikely that the reporting bias is associated with impulsivity in a systematic fashion.

Findings have important implications for the prevention of problem gambling. The significant association of youth impulsivity development with subsequent gambling provides added research support for targeting impulsivity to prevent youth problem gambling. Past studies found evidence that lowering impulsivity may have promise in reducing positive attitudes toward gambling [51]. A brief school-based intervention with a teaching impulse

control component implemented among high school students in Canada reduced student's positive attitudes toward gambling, although there was no direct impact on gambling participation during the one week follow-up period [51]. Most gambling prevention efforts have targeted middle and high school students (e.g. [51–53]). The association between first grade impulsivity with impulsivity trajectories in adolescence suggests that teaching impulse control early in elementary school may have long-term benefit in decreasing the likelihood of youth following an elevated trajectory of impulsivity. Impulsivity was related only to at-risk and problem gambling but not any gambling indicating that although reduced level of impulsivity may not have any impact on engagement of gambling activities, it may reduce the likelihood of youth's meeting criteria for at-risk and problem gambling. Future evaluation of intervention trials aimed at reducing youth gambling problems through teaching impulse control should distinguish gambling problems from any gambling.

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Figure 1a.
Conceptual Model for the Conventional Growth Model*:

Figure 1b.**Conceptual Model for the Growth Mixture Model***

* We modeled the continuous underlying propensity of gambling via ordered logistic regression. Since the effect of covariates is originally presented on a logit scale, which is not directly interpretable, the cumulative probabilities of meeting each threshold in the four-level gambling variable (i.e. Pr (SG/AG/PG), Pr (AG/PG), and Pr (PG) for each of the three conditions specified in the manuscript and for each class, as well as the odds ratios comparing conditions or classes are presented.

#The second generation intervention trial combined the two interventions in the first generation trial, namely Good Behavior Game (GBG), in targeting early aggressive and disruptive behavior, and Mastery Learning (ML), in targeting early classroom learning problems[54], and included an additional family-school partnership (FSP) component aiming to enhance parents' participation in school-related activities and to enhance parent-teacher collaboration in facilitating children's learning and behavior.

Figure 2.
Predicted Probabilities of Gambling with Varying Levels of Intercept and Slope

Figure 3.
Heterogeneity in the Development of Impulsivity among Males from Age 11 to Age 15

Table 1

Growth Factors in the Best Conventional Growth Model for Impulsivity Development

	Intercept Mean (std. error)	Slope Mean (std. error)	Quadratic Slope Mean (std. error)
Mean	2.55 (0.07)	0.03 (0.05)	−0.04 (0.01)
Variance	0.78 (0.09)	0.02 (0.01)	0 (fixed)

Table 2

Fit indices for General Growth Models with 1–4 Classes

Model [†]	LL ¹	# of free parameters	BIC ²	VLMR-LRT ³
1-class	–1785.88	10	3629.13	NA
2-class	–1765.87	14	3612.06	0.00
3-class	–1741.53	18	3586.31	0.20
4-class	–1728.66	22	3583.52	0.57
1 class (a)	–1786.56	9	3624.75	NA
2-class (b)	–1756.67	14	3593.65	NA
3-class (b)	–1736.42	18	3576.09	NA

a. Fixing slope variance to 0 in order to avoid negative estimated variance

b. Fixing slope variance of the low class to 0 in order to avoid negative estimated variance

NA: non-applicable

¹Loglikelihood²Bayesian Information Criterion³Vuong-Lo-Mendell-Rubin Likelihood Ratio Test p-value

[†]Starting from the 1-class model, BIC decreases (indicating better fit). However, the reduction from a 1-class solution to a 2-class solution is much larger than from a 2-class solution to a 3-class solution (i.e. $(3624.75-3593.65) < (3593.65-3576.09)$). Although BIC continues to decrease for 4-class and 5-class models, these models are highly unstable, and the smallest class only contains less than ten percent the sample. In addition, the VLMR-LRT test indicates that a 1-class model is rejected in favor of a 2-class model, but a 2-class model cannot be rejected in favor of a 3-class model.

Table 3
The Association between Impulsivity Trajectory Class Membership and Subsequent Gambling

Gambling outcome	Est. prob. for the high class	Est. prob. for the low class	OR ^a	95% C.I	P-value
Any gambling	0.68	0.66	1.10	(0.63, 1.92)	0.730
At-risk/problem gambling	0.28	0.16	2.09	(1.02,4.27)	0.044
Problem gambling	0.14	0.06	2.84	(1.02, 7.91)	0.047

^aOdds (gambling | membership in the high class)/ Odds (gambling | membership in the low class)