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Developmental Trajectories of Impulsivity and Their Association With Alcohol Use and Related Outcomes During Emerging and Young Adulthood I

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Abstract

Background—Research has documented normative patterns of personality change during emerging and young adulthood that reflect decreases in traits associated with substance use, such as impulsivity. However, evidence suggests variability in these developmental changes.

Methods—This study examined trajectories of impulsivity and their association with substance use and related problems from ages 18 to 35. Analyses were based on data collected from a cohort of college students ($N = 489$), at high and low risk for AUDs, first assessed as freshmen at a large, public university.

Results—Mixture modeling identified five trajectory groups that differed in baseline levels of impulsivity and developmental patterns of change. Notably, the trajectory group that exhibited the sharpest declines in impulsivity tended to display accelerated decreases in alcohol involvement from ages 18 to 25 compared to the other impulsivity groups.

Conclusion—Findings highlight the developmental nature of impulsivity across emerging and young adulthood and provide an empirical framework to identify key covariates of individual changes of impulsivity.

Keywords

Personality Change; Impulsivity; Alcohol Use Disorders; Maturing Out; Prospective Study

Although several personality characteristics have been associated with alcohol use and associated outcomes, including alcohol use disorders (AUDs), the most robust and consistent relation appears to exist between alcohol involvement and traits associated with impulsivity (see Sher and Littlefield, 2008; Sher et al., 1999; for reviews). Impulsivity, which is sometimes used interchangeably with the term behavioral undercontrol and in this context refers to a range of interrelated behaviors that suggests difficulty in inhibiting behavioral impulses (Elkins et al., 2006), has been linked to alcohol use and AUDs both

cross-sectionally (e.g., Bennett et al., 1999; McGue et al., 1997; Trull et al., 2004) and longitudinally (e.g., Caspi et al., 1998; Elkins et al., 2006; Schuckit, 1998; Sher et al., 2000).

Impulsivity, like other personality constructs, has been traditionally considered an immutable trait (e.g., McCrae et al., 2000), although research over the past decade has documented normative (i.e., mean-level) change in several personality traits, with the most pronounced changes occurring during emerging (i.e., roughly ages 18 to 25, Arnett, 2000) and young adulthood (e.g., Caspi et al., 2005; McCrae et al., 1999; Roberts et al., 2006; Robins et al., 2001). These mean-level changes are in the direction of what is typically viewed as greater psychological “maturity” (i.e., the “maturity principle”; Caspi et al., 2005), such as increases in traits thought to be antithetic to impulsivity (i.e., conscientiousness, constraint; Blonigen et al., 2008; Donnellan et al., 2007; Vaidya et al., 2008; see Blonigen, 2010).

Further, there are substantial individual differences in personality change (i.e., interindividual differences in intraindividual change) and these differences appear to relate significantly to a range of outcomes (see Roberts and Mroczek, 2008). For example, Littlefield and colleagues (2009) recently found that decreases in impulsivity and neuroticism were associated with decreases in alcohol problems from ages 18 to 35 and that this relation held even when controlling for the influence of reported adult role statuses, such as marriage and parenthood.

Identifying Longitudinal Trajectories of Impulsivity: Mixture Modeling

A potentially helpful method to both characterize individual differences in personality-trait change as well as examine covariates of individual differences in change is longitudinal mixture modeling. Briefly, this framework allows for classes (or clusters) of individuals who exhibit similar patterns of personality stability and change to be identified and then compared on both time-invariant and time-varying covariates. For example, similar approaches have been used to distinguish individuals characterized by “adolescence-limited” endorsements of antisocial behavior from individuals that exhibit more chronic “life-course-persistent” patterns of externalizing behaviors (Moffitt, 1993). Similarly, longitudinal mixture modeling involving impulsivity may distinguish individuals that show relatively high but developmentally limited levels of impulsivity (i.e., individuals that undergo substantial decreases in impulsivity across time) from individuals characterized by relatively high and relatively stable levels of impulsivity. These distinct groups of individuals could then be compared on a number of outcomes, including differences in *developmental changes* in alcohol involvement. As recently discussed by researchers that have utilized similar methodology to study personality development (Johnson et al., 2007), the purpose of this statistical methodology is not to “carve nature at its joints” but rather provide an empirical framework for indentifying individual differences in the pattern of stability, change, and level of a given construct (e.g., impulsivity) across important developmental periods (e.g., emerging and young adulthood). As Johnson and colleagues (2007) note, once trajectory groups have been identified, the utility of the classes can be tested by examining the relations between group membership and important outcomes (e.g., alcohol use).

Examining Trajectories of Dynamic Covariates of Personality

One advantage of a longitudinal mixture approach has over traditional growth curve analysis is that it allows for relations between personality trajectories and their etiologically relevant time-varying covariates, or dynamic covariates, to be more precisely explored in an empirical framework (Sher et al., 2004). Dynamic covariates of a given construct may exhibit a range of developmental patterns (see Nuechterlein and Dawson, 1984; Sher et al., 2004). For example, changes in alcohol use may exhibit patterns of covariation with impulsivity designated as a *course tracker*. Under this pattern of covariation, individuals that decreased in impulsivity would also exhibit corresponding decreases in alcohol use; whereas, individuals that failed to make normative decreases/made shallower decreases in impulsivity would not display reductions in alcohol use. Conversely, failures to make normative decreases in impulsivity may be more accurately depicted as *developmental lag* markers of alcohol use. This pattern of covariation would be reflected by slowed or inhibited normative developmental changes in alcohol use by individuals that exhibited shallower or nonnormative decreases in impulsivity. For example, under this pattern in the current dataset that spans ages 18 to 35, individuals that undergo relatively significant decreases in impulsivity from ages 18 to 25 would also demonstrate substantial decreases in alcohol involvement during the same time span. However, individuals characterized by shallower decreases in impulsivity from ages 18 to 25 would instead exhibit relatively higher levels of alcohol involvement during this period but would then show more normative levels of alcohol involvement at ages 29 and 35.

Distinguishing patterns of both stability and change in impulsivity, as well as relevant covariates, have both important conceptual and applied implications (Sher et al., 2004). For example, these distinctions can provide clues of the functional relations of covariates of impulsivity change. This approach can also facilitate a better understanding of covariates of impulsivity development, such as alcohol use.

Current Study

Using the same data that will be analyzed in this study, we have previously shown that changes in impulsivity correspond to changes in alcohol problems (Littlefield et al., 2009). However, those analyses were based on a variable-centered approach (i.e., latent growth curve analysis) that precluded person-centered inferences based upon specific patterns of developmental courses of impulsivity. That is, these prior analyses demonstrated a strong relation between changes in impulsivity and changes in drinking but at a fairly global level. If there are different trajectories that vary in their basic form beyond their intercept and simple slope, such parallel, bivariate growth models will fail to resolve this potentially important source of developmental differences. An important next step is to characterize developmental patterns of stability and change in impulsivity to further explore individual differences in impulsivity development and to facilitate the further identification of factors relevant to the developmental course of impulsivity. Thus, the current project has three goals: (i) empirically characterize patterns of developmental trajectories of impulsivity; (ii) examine differences in impulsivity development among the identified trajectory groups; (iii)

test the utility of the trajectory groups by exploring patterns of the dynamic covariates of alcohol use and related outcomes.

Method

Participants and Procedure

Data were drawn from a longitudinal study on family history of alcoholism (FH) and other correlates of alcoholism (see Sher et al., 1991; for a full description of the study). The baseline sample comprised of 489 first-year college students (46% men, mean age = 18.2) from a large Midwestern university. Half (51%) of the respondents were classified as FH positive (FH+; see Sher et al., 1991, for more details). Respondents were prospectively assessed seven times over 16 years (roughly at ages 18, 19, 20, 21, 25, 29, and 35) by both interview and paper-and-pencil questionnaire. Overall retention was good, with over 84% of participants retained over the first 11 years of the study, and over 78% retained through year 16 (mean age = 34.5).

Measures

Impulsivity—A sum of ten items was used to assess impulsivity at baseline (age 18) and subsequently at ages 25, 29, and 35, respectively. Six of these items (e.g., *I often follow my instincts, hunches, or intuition without thinking through all the details*) were drawn from the short-form of the Tridimensional Personality Questionnaire (Short-TPQ; Sher et al., 1995) and the remaining four items (e.g., *I often do things on the spur of the moment*) were taken from the Eysenck Personality Inventory (EPI; Eysenck and Eysenck, 1968). Internal consistency, as measured by coefficient alpha (α), was 0.79 at age 18, 0.81 at age 25, 0.75 at age 29, and 0.75 at age 35 for the impulsivity scale.

Alcohol Quantity/Frequency—An alcohol quantity-frequency composite was calculated at each wave (for this analyses, corresponding assessments to the impulsivity measure were utilized at approximately ages 18, 25, 29, and 35) by averaging two measures of alcohol consumption: (i) total quantity/frequency (QF) of alcohol consumption, calculated from individual QF estimates for beer, wine, wine coolers, and hard liquor during the past 30 days; (ii) QF of alcohol consumption per week based on the past year. Both past-month and past-year estimates were utilized because the former are less likely to be influenced by recall bias, whereas the latter are less likely to be affected by ephemeral variability in drinking patterns.

Heavy Drinking Composite—A heavy drinking composite was calculated at each wave (approximately ages 18, 25, 29, 35) by averaging three items that assessed frequency of heavy drinking in the past 30 days at each assessment. Two items measured heavy drinking in terms of alcohol's subjective effects: (i) "How many times did you get a little high or light-headed on alcohol?" and (ii) "How many times did you get drunk (not just a little high) on alcohol?" The third items assessed heavy drinking: "How many times have you had five or more drinks at a single setting?"

Alcohol Problems—A count of 27 items consisting of both number of past year negative consequences associated with drinking and symptoms related to alcohol dependence (consistent with the alcohol-dependence syndrome described by Edwards and Gross, 1976) was calculated at each wave (approximately ages 18 to 35). Items based on items from the Michigan Alcohol Screening Test (MAST; Selzer, 1971) as well as other items were created to produce a broad list of negative consequences of alcohol consumption and dependence symptomatology (see Sher et al., 1991; items available upon request).

Analytic Procedure

Trajectories of impulsivity from ages 18 to 35 were classified using finite mixture models (McLachlan and Peel, 2000) rather than the default standard of growth mixture modeling (e.g., Muthén, 2004). The primary difference between these frameworks is that the former does not explicitly include time in the modeling process, resulting in a benefit of not having to specify a structure for the relationship between time and the outcome. That is, the mean profiles that are extracted from the data are equivalent to a model that includes time in the model but does not impose a shape on the curve (e.g., comparatively, if viewed from a structural equation modeling perspective, the loadings corresponding to the time construct would be “free”). To allow for the greatest flexibility for discovering the most appropriate mean profiles, nine different correlation structures (see Martinez and Martinez, 2004) for 1 to 9 class solutions (resulting in 81 potential solutions) were investigated with Matlab version 7.1.0.124 (The Mathworks, 2005). Model fit was evaluated by comparing Bayesian information criteria (BIC) among the 81 potential mixture model solutions. To allow for missing data, the solution that best fit the data was then estimated in Mplus version 5.1 (Muthén and Muthén, 2007) using full information maximum likelihood, which assumes that data are missing at random.¹

Results

Mixture Models

Comparison among the BICs across all mixture models suggested that the 5-class solution that constrained variation in impulsivity to be equal within class but allowed variation to be different across classes (see Martinez and Martinez, 2004) best fit the data. Mean-level changes in impulsivity by trajectory group are displayed in Fig. 1. All classes except Class 1 and Class 5 exhibited significant decreases in impulsivity between ages 18 and 25. Notably, Class 3 exhibited striking decreases in impulsivity from ages 18 to 25 (see Fig. 1) and demonstrated the sharpest reductions in impulsivity compared to all other impulsivity classes across this time span, suggesting Class 3 may represent a “developmentally limited”

¹As discussed elsewhere (Jackson & Sher, 2003; Sher et al., 2004), attrition at later waves in this sample appear to relate to higher levels of both dependence symptoms and negative consequences from alcohol at the first assessment (roughly age 18), although other indices of alcohol involvement (e.g., levels on the heavy drinking composite) do not appear to relate to later attrition (see Sher et al., 2004). These patterns of attrition suggest, broadly, that the estimated relations between alcohol involvement and other outcomes represent conservative estimates (see Jackson & Sher, 2003). However, later attrition did not appear to relate to impulsivity levels at the first assessment. Additionally, the mixture solution (see Banfield and Raftery, 1993) using complete-case data in MatLab yielded a nearly identical solution compared to the solution estimated in Mplus. Parallel repeated measures analyses using complete-case data (using SAS PROC GLM, SAS Institute Inc., Cary, NC) yielded results consistent with the findings presented in the article.

impulsivity group. Between ages 25 and 29, Class 4 and 5 displayed modest, though significant, decreases in impulsivity.²

Developmental Differences in Alcohol Involvement by Impulsivity Class

A series of repeated measures analyses (trajectory class $\times$ wave) were then conducted (using SAS PROC MIXED, SAS Institute Inc., Cary, NC) to compare developmental differences among the impulsivity classes in three separate indices of alcohol involvement. Participants who reported abstaining from alcohol across all assessments ($n = 6$) were excluded from all analyses. Sex was modeled as a fixed covariate in all analyses. Of particular interest were comparisons of the developmentally limited impulsivity class (Class 3) to the other impulsivity classes (especially the relatively high and steady impulsivity classes 4 and 5; see Fig. 1). Thus, mean changes (as well as cross-sectional differences at each wave) in alcohol involvement and related outcomes were compared among impulsivity trajectory groups at each successive wave (i.e., between ages 18 to 25, 25 to 29, and 29 to 35). To reduce skew, all alcohol variables were square-root-transformed prior to analysis (Tabachnick and Fidell, 2001).

Alcohol Quantity/Frequency—For alcohol QF, a significant time by impulsivity trajectory group interaction was found, $F(12, 476) = 2.37, p < 0.01$. Follow-up contrasts suggested that Class 3, versus all other impulsivity groups, made the steepest decreases in alcohol QF between the ages of 18 to 25 [$F(1, 476) = 8.93, p < 0.01$; see Fig. 2]. Further, Class 3, compared to Class 4, exhibited significantly sharper decreases across this timeframe [$F(1, 476) = 4.81, p < 0.05$; see Fig. 2]. Between the ages of 25 to 29, Class 4 and 5, compared to Class 3, made steeper decreases in alcohol QF [$F(1, 476) = 6.25, p < 0.05$], suggesting that Class 4 and 5 “developmentally lagged” in making reductions in alcohol QF compared to Class 3.

Consistent with these findings, cross-sectional tests indicated that the developmentally limited impulsivity class (Class 3) exhibited significantly *higher* levels of alcohol QF at age 18 compared to Class 1 ($p < 0.01$) and Class 2 ($p < 0.01$) but was not significantly different in alcohol QF at this age compared to Classes 4 and 5 (see Fig. 2). However, at age 25, Class 3 was significantly *lower* in alcohol QF compared to Class 4 ($p < 0.05$) and Class 5 ($p < 0.05$) and was not significantly different in alcohol QF compared to Classes 1 and 2. Class 3 did not differ significantly from the other impulsivity classes in alcohol QF at either age 29 or 35 (see Fig. 2).

Heavy Drinking Composite—Regarding the heavy drinking composite, a significant time by impulsivity trajectory group interaction was found, $F(12, 476) = 1.78, p < 0.05$. As with the alcohol QF findings, follow-up contrasts suggested that compared to all other impulsivity classes, Class 3 exhibited the steepest decreases in heavy drinking from ages 18 to 25 [$F(1, 476) = 8.92, p < 0.01$; see Fig. 2]. Additional contrasts suggested that Class 3,

²The prevalence of family history by impulsivity trajectory class was the following: Class 1, 47%, Class 2, 45%, Class 3, 51%, Class 4, 58%, and Class 5, 65%. Notably, Class 2 differed significantly ($p < 0.05$) from Class 4 and exhibited a nonsignificant statistical trend ($p < 0.10$) difference from Class 5. No other impulsivity trajectory groups significantly differed by family history status.

versus Class 4, displayed significantly steeper decreases in heavy drinking from ages 18 to 25 [$F(1, 476) = 4.33, p < 0.05$; see Fig. 2].

A similar pattern of cross-sectional findings for those observed for alcohol QF emerged for heavy drinking. At age 18, cross-sectional analyses suggested that Class 3 displayed significantly higher levels of heavy drinking compared to Class 1 ($p < 0.01$) and Class 2 ($p < 0.05$) but was not significantly different from Class 4 or Class 5. At age 25, Class 3 was significantly lower in heavy drinking compared to Class 4 ($p < 0.01$) but not Classes 1, 2, or 5 (see Fig. 2).

Alcohol Problems—Regarding alcohol problems, although the overall time by impulsivity trajectory group interaction suggested a nonsignificant statistical trend [$F(12, 477) = 1.58, p < 0.10$], further contrast analyses suggested that Class 3, compared to all other impulsivity classes, displayed the steepest decreases in alcohol problems from ages 18 to 25 [$F(1, 477) = 5.17, p < 0.05$; see Fig. 2]. Further, cross-sectional analyses suggested that Class 3, compared to Class 1, was significantly higher in alcohol problems at age 18 ($p < 0.05$) but not significantly different from classes 2, 4, or 5. At age 25, Class 3 was significantly lower in alcohol problems compared to Class 4 ($p < 0.05$) and Class 5 ($p < 0.05$) but not classes 1 or 2. Class 3 did not differ significantly from the other impulsivity classes in alcohol problems at either age 29 or 35 (see Fig. 2).

Discussion

Although impulsivity has long been thought as an important covariate of alcohol use and AUDs, it is only recently that impulsivity has been considered and empirically investigated as a dynamic covariate to developmental changes in problematic alcohol involvement. To further advance the extant understanding of the developmental nature of impulsivity, analyses from this article identified five impulsivity trajectory groups characterized by differences in level, stability, and change in impulsivity across critical developmental period associated with peak hazards and prevalence for pathological alcohol involvement as well as “maturing out” (Winick, 1962) of these patterns for a large proportion of individuals.

Providing external support for the validity and importance of these classes, membership in the impulsivity trajectory groups appeared to correspond meaningfully with changes in alcohol use and related outcomes. Taken together, these findings provide further support that impulsivity should be viewed as a dynamic construct and developmental covariate of alcohol involvement and, perhaps of utmost importance, establishes an empirical framework for further investigations into the determinants of factors influencing the developmental course of impulsivity across the life span.

Developmental Trajectories of Impulsivity

Building on a number of studies that have documented mean-level changes in traits related to impulsivity and individual differences in these normative changes (e.g., Blonigen et al., 2008; Donnellan et al., 2007; Vaidya et al., 2008), the current study is the first to our knowledge to identify distinct trajectory groups of impulsivity across emerging and young adulthood (i.e., ages 18 to 35). Although these groups tended to exhibit modest, normative

declines in impulsivity across time and maintain their initial rank-order positions, a nontrivial proportion of the current sample (9%) showed prominent decreases in impulsivity and marked changes in rank-order status in impulsivity. These findings further highlight the need of methodology that adequately models individual differences in change, as analyses that merely focused on rank-order consistency (see Roberts and Delvecchio, 2000) or mean-level changes of personality (see Roberts et al., 2006) would have “masked” the findings of marked and important developmental changes in impulsivity illustrated in this article (see Edmonds et al., 2007; Roberts and Mroczek, 2008, for more details regarding the implications of types of personality change).

Characterizing Developmental Patterns of Dynamic Covariates of Impulsivity

Notably, the trajectory group characterized by developmentally limited levels of relatively high impulsivity tended to exhibit accelerated declines in alcohol use and outcomes compared to other classes characterized by high and relatively stable levels of impulsivity across time, although these differences in alcohol involvement tended to become nonsignificant at later time points. This pattern of covariation between impulsivity trajectory groups and alcohol involvement may be best labeled as developmental lag markers (see Sher et al., 2004). That is, it appears that individuals who exhibit relatively high and stable levels of impulsivity also show delayed normative decreases in alcohol involvement compared to classes that are characterized by relatively low levels of impulsivity by age 25 (see Fig. 2).

These findings build on previous results (Littlefield et al., 2009) in several ways. In our previous analyses that utilized a variable-centered approach (i.e., bivariate latent growth modeling; see Littlefield et al., 2009), we found evidence that changes in impulsivity corresponded with changes in alcohol problems from ages 18 to 35, suggesting that personality change may be an important mechanism in the so-called “maturing out” (Winick, 1962) of heavy alcohol involvement (see O'Malley, 2004/2005). Providing further support, clarity, and precision to these results, these findings illustrate a more nuanced relation between dynamic changes in impulsivity and the developmental course of alcohol involvement. For example, these results suggest that individuals high and relatively stable in impulsivity are at an especially increased risk to maintain elevated levels of problematic alcohol involvement during emerging adulthood. Further, although the current data are correlational in nature and thus causal relations between impulsivity and alcohol cannot be adequately resolved, the patterns of covariation among these constructs suggests that alcohol use appears to be a trailing (i.e., occurs as a result of) indicator of impulsivity development (as opposed to leading, etiologic predictors of developmental course; see Sher et al., 2004, for more details).

Limitations

Several limitations of this study should be noted. The sample from the current study was initially drawn from first-time college freshman entering a large university, which limits generalizability of findings to noncollegiate populations. In addition, the sample is predominately White (93%) and thus caution should be taken in generalizing these findings to other racial/ethnic groups who may show different developmental trends in impulsivity.

Additionally, our impulsivity assessment failed to resolve the multidimensionality of this broad construct and so this project could not address as to whether specific differences in impulsivity development occur depending on the facet utilized for study. Notably, when correlated (in a separate sample) with the recently identified five facets of impulsivity (see Cyders et al., 2007; Whiteside and Lynam, 2001), our impulsivity measure correlated strongest ($r = 0.56$, $p < 0.0001$) with the (lack of) premeditation subscale.

As aptly noted by other researchers recently examining developmental trajectory groups of personality (Johnson et al., 2007), mixture analysis is a methodology to allow for potentially useful categorizations of heterogeneous patterns of development rather than a method to “carve nature at its joints.” We explicitly reject common misconceptions of trajectory groups, such that individuals “belong” to a trajectory group, that the number of trajectory groups is absolute, and trajectories of group members follow the group-level trajectory in lock step fashion (see Nagin and Tremblay, 2005; for more details). Rather, as with Nagin and Tremblay (2005), we view trajectory groups as a useful statistical device to make appropriate comparisons on important outcomes among meaningful classifications of individuals. Despite the limitations of mixture modeling, the impulsivity trajectory solution estimated and discussed in this article has numerous strengths, including a rigorous and empirically driven model selection procedure, the “free” estimation of developmental patterns across time (i.e., changes in impulsivity were not forced to occur in “straight lines” as in typical linear growth mixture modeling), and empirical tests of theoretically meaningful associations between impulsivity trajectory groups and several indices of alcohol involvement.

Future Directions

Building on the findings from this article and consistent with the recent suggestions (e.g., Roberts and Mroczek, 2008) regarding the study of personality change, the next important step will be to determine *why* individuals exhibit individual differences in impulsivity. Changes in personality have been previously linked to several life and work experiences, including relationship and work satisfaction (e.g., Scollon and Diener, 2006). Thus, future work utilizing the impulsivity trajectories presented in this article could examine the link between marital and parental status as well occupational attainment with impulsivity trajectory groups. Additionally, a number of other potentially important time-invariant covariates of developmental changes in impulsivity could be considered, including sex, family history of alcoholism, childhood life events, and age of onset of heavy alcohol use. Finally, a number of time-varying covariates, including variables relevant to alcohol involvement, could also be considered, such as drinking motives, reasons for not drinking, and drinking expectancies.

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Fig. 1.
Mean-level changes in impulsivity by trajectory group ($N = 483$).

Fig. 2.
Mean-level changes in the square-root of alcohol quantity/frequency, heavy drinking, and alcohol problems by impulsivity trajectory group. Q/F = quantity/frequency.