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Childhood Cognitive Measures as Predictors of Alcohol Use and Problems by Mid-Adulthood in a Non-Western Cohort

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Abstract

This study examined the relationship between childhood cognitive functioning and academic achievement and subsequent alcohol use and problems in a non-Western setting. We examined longitudinal data from a birth cohort sample (n = 1,795) who were assessed at age 11 years on cognitive measures and then approximately 25 years later on lifetime alcohol use and alcohol use disorder symptom count. The sample is from Mauritius (eastern Africa), which allowed us to examine these relationships in a non-Western society with a different social structure than is typical of prior cognitive studies on primarily Caucasian samples in Western societies. Poorer performance on the Trailmaking Test in childhood predicted being a lifetime drinker, even after covarying for gender, childhood psychosocial adversity, and Muslim religion. Lower academic achievement and verbal IQ, but not performance IQ, were predictive of subsequent alcohol problems after including demographic covariates; the relationship between verbal IQ and alcohol problems was stronger in females than males. A non-linear relationship emerged for Trails, suggesting that only more extreme impairment on this measure was indicative of later alcohol problems. Results of this study provide evidence that verbal deficits and poor academic performance exist in a general cohort sample by age 11 years (when 99% were non-drinkers) for those who go on to develop alcohol problems.

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Keywords

Joint Child Health Project; Indian; African; intelligence; prospective research design

Developmental models of the etiology of alcohol problems have proposed several pathways for how childhood cognitive deficits relate to later alcohol problems. Deviance proneness models purport that underlying behavioral disregulation manifests in part as cognitive deficits and poor academic performance in childhood and later as alcohol problems in adulthood (see Gorenstein & Newman, 1980; Sher, 1991; Zucker, Chermack, & Curran, 2000). Alternative models have proposed more direct paths—that high intelligence and academic success can lead to both increased likelihood of being a lifetime drinker by placing individuals in heavier drinking environments (e.g., college) as well as decreased likelihood of developing alcohol problems via better opportunities in adulthood that may buffer against problems (see Johnson, Hicks, McGue, & Iacono, 2009). Conversely, pressure to maintain academic achievement may result in distress (e.g., Stoeber & Rambow, 2007), which in turn can lead to alcohol use and problems (Crum et al., 2006; Schulenberg, Bachman, O'Malley, & Johnston, 1994). It is also possible that multiple processes are involved, with both behavioral undercontrol and contextual factors contributing to the link between early cognitive deficits and later alcohol involvement.

General population sample studies have demonstrated that relatively higher IQs are typically found among low-to-moderate drinkers compared with abstainers and heavy drinkers (see Anstey, Windsor, Rodgers, Jorm, & Christensen, 2005; Müller et al., 2013 for reviews). In longitudinal studies, higher childhood IQ has been positively associated with alcohol use and higher consumption levels in early and later adulthood (Johnson et al., 2008; Kanazawa & Hellberg, 2010). For example, in a U.S. national sample of young adults assessed over a 5-year interval, higher verbal IQ predicted increased risk for subsequent drinking and decreased risk for problems among drinkers even after covarying for socioeconomic status (Windle & Blane, 1989). This is consistent with a prospective study of a general Scottish sample that found higher verbal IQ at 11 years was associated with alcohol problems 40 years later after covarying for socioeconomic position (Batty, Deary, & Macintyre, 2006). Taken together, these studies suggest that higher IQ, and in particular verbal IQ, is predictive of increased likelihood of being a lifetime drinker and decreased likelihood of alcohol-related problems later in life, and that these associations are not accounted for by sociodemographic correlates of higher verbal abilities.

Academic achievement is also a potential childhood cognitive predictor of subsequent alcohol involvement. Support for poor academic achievement associated with subsequent alcohol use and problems also has been found in longitudinal studies and general samples with varying ranges of follow-up (see, e.g., Duncan, Duncan, Biglan & Ary, 1998; Hawkins, Catalano, & Miller, 1992; Schulenberg et al., 1994). For example, Hayatbakhsh et al. (2011) demonstrated that poorer school performance at age 14 years predicted alcohol problems 21 years later in a general sample of Australian students, although already at age 14 over 60% of the sample indicated drinking in the past week. Studies that examine academic

achievement in younger samples are needed to help clarify if poor academic achievement is a predictor of subsequent alcohol involvement or just a consequence of early alcohol use.

In this study, we present longitudinal data from a birth cohort sample who were assessed at age 11 years on measures of cognitive and academic ability (prior to the typical age of onset of alcohol use) and then approximately 25 years later on lifetime alcohol use and alcohol use disorder (AUD) symptoms. The sample is from the island of Mauritius (a middle-income eastern African nation), allowing for the examination of these relationships in a non-western society that values education and academic performance (the population has an 89% literacy rate and public primary and secondary education are free; CIA Factbook, 2014; SACMEQ, 2012), but where childhood cognitive performance is not linked to heavy drinking environments as it often is in Western societies (e.g., college; Slutske et al., 2004). However, as in Western societies, both intelligence and school success in Mauritius may enable individuals to obtain financial and personal resources that increase the likelihood and opportunities for social drinking, even if buffering against risk for alcohol problems (see Johnson et al., 2009; Müller et al., 2013). Such contextual factors may affect relationships between childhood cognitive performance and subsequent alcohol involvement; thus, examining these associations in novel societies such as Mauritius will help determine the generalizability of the developmental models that have been generated using data primarily from Western societies (see Luczak et al., 2014). Given our prior findings with this sample that found gender and an index of psychosocial adversity (based on familial, housing, and environmental variables) were associated with IQ (Liu, Raine, Venables, & Mednick, 2003; Lynn, Raine, Venables, Mednick, & Irwing, 2005), and that being Muslim was protective for lifetime drinking but not for alcohol problems among drinkers (Luczak et al., 2014), we recognize the importance of including gender, psychosocial adversity, and Muslim religion when examining the link between cognition and alcohol use in this sample.

Method

Data are from the Joint Child Health Project (JCHP), a longitudinal study in Mauritius that has a followed a birth cohort of 1,795 children since 1972 when they were 3 years old (see Raine, Liu, Venables, Mednick, & Dalais, 2010). The original sample was 51% male and, similar to the population of the island, 69% were of Indian heritage, 26% Creole (admixture of primarily African descent), and 6% other (primarily of Chinese and French heritage); 17% were Muslim.

Childhood data collection phase—At age 11 years, participants were assessed on cognitive ability and home environment (see each scale for *n*s, which differ across scales due to a cyclone bringing this testing phase to an early end). The 11-year-old sample did not significantly differ from the 3-year-old sample on gender, ethnicity, or psychosocial adversity (see Raine, Reynolds, Venables, Mednick, & Farrington, 1998).

All instruments were administered to children individually by trained research staff. The official language of Mauritius is English and schooling is conducted primarily in English, but since the common spoken language on the island is Kreol, instructions were given in Kreol. Seven subtests of the Wechsler Intelligence Scale for Children (WISC; Wechsler,

1974) were administered to 1,258 children. These subtests were used to create estimates of Performance IQ (PIQ; Picture Completion, Block Design, Object Assembly, Coding, and Mazes) and Verbal IQ (VIQ; Similarities and Digit Span). Scores were standardized and normalized within the sample (see Lynn et al., 2005 and Raine, Yaralian, Reynolds, Venables, & Mednick, 2002, for details).

The Trail Making Test (Trails; U.S. Army, 1944) was administered to 1,157 of the children. The two components of this task (Trails A and B) assess visuomotor tracking, motor speed, and attention, and Trail B also contains a working memory component requiring mental flexibility (Lezak, 1995; Reitan, 1958). The difference score for Trail B versus Trail A, an indicator of complex divided attention and sequencing (Strauss et al., 2006), was calculated and corrected for age (M = 11.1 years, SD = 0.70) by residualization (see Raine et al., 2002).

At the end of primary school (6th year of school), students take the Certificate of Primary Education (CPE) achievement examination that covers a range of academic topics (English, French, Mathematics, Environmental Studies; see SACMEQ, 2012). Scores on the CPE range from 0 to 20 and represent an overall index of academic achievement. CPE scores were obtained from official records for 1,415 of the sample.

Mid-adulthood data collection phase—In mid-adulthood (M = 36.9 years, SD = 1.39), all available participants (n = 1,209; 67%) were assessed for lifetime alcohol use and problems (other 9% abroad, 4% refused, 2% deceased, and 18% unable to contact). Written informed consent was obtained, and the research was approved by the University of Southern California Institutional Review Board. The sample assessed in adulthood did not significantly differ from the 3-year-old sample on ethnicity or psychosocial adversity, but were more likely to be male (55% vs. 51%; see Luczak et al., 2014).

Trained research staff interviewed participants about their drinking histories in Kreol. Lifetime drinkers were defined as those who had ever consumed at least one standard drink (~14 grams of alcohol), and the age when first standard drink was consumed was obtained. Lifetime drinkers were assessed for lifetime DSM-IV AUD symptoms (American Psychological Association, 1994) using the Structured Clinical Interview for DSM-IV Diagnosis (Spitzer, Gibbon, & Williams, 1994. Only 15 (1.2%) participants reported they had consumed a standard drink and none (0%) endorsed having an AUD symptom as of age 11 years.

Final analytic sample—We removed four participants who were developmentally delayed, resulting in a final analytic sample of 1,107 participants with childhood cognitive and adult alcohol data (see Table 1). This sample was 72% Indian, 21% Creole, and 7% other; 55% were male and 22% Muslim. Scores on the cognitive measures and psychosocial adversity did not significantly differ from the full sample assessed at age 11 years. Lifetime drinker (66%) and AUD (16%) prevalence were similar to those previously reported for the full sample assessed in mid-adulthood (67% and 16%, respectively; Luczak et al., 2014). In those who endorsed an AUD symptom (n = 205), mean symptom count was 3.7 (SD = 2.46, range 1–11).

Data Analyses

We ran logistic regression models to examine cognitive predictors and covariates of being a lifetime drinker. We used zero-inflated negative binomial (ZINB) regression models to examine cognitive predictors and demographic covariates of AUD symptom count. ZINB is a two-part parametric mixture model for count data that have a large proportion of zero values and a highly skewed distribution of nonzero values, as is typically found for AUD symptoms in general populations samples (see Pardini, White, & Stouthamer-Loeber, 2007). ZINB models are also appropriate when there is heteroskedasticity in the count, which may occur if one covariate group (e.g., males, Muslims) produces different counts than another (Neelon & O'Malley, 2013).

We first modeled each cognitive predictor alone, then with demographic covariates (gender, childhood psychosocial adversity, Muslim religion). All predictor variables were normally distributed (skew < |.90|, all kurtosis < |1.76|; note that we divided IQ variables by 10 to put all predictors on similar scales to yield more interpretable betas). We ran a final set of models that simultaneously entered the cognitive measures that were significant individual predictors of AUD symptoms to examine these cognitive variables in concert. Models with significant quadratic or interaction terms (created through cross-multiplication based on centered predictors) are presented beyond those including main effects only when one of these terms was significant.

Results

Table 1 shows basic associations among the predictors in our models. Consistent with our prior publications (Liu et al., 2003; Lynn et al., 2005; Yarnell et al., 2013), being male was correlated with higher PIQ, childhood psychosocial adversity was correlated with poorer cognitive performance, and the three demographic variables were not correlated with one another.

Predictors of Lifetime Drinking

Logistic regression models found that those performing better on Trails were more likely to be lifetime drinkers even after the addition of covariates in the model ($b = -2.48$, $p = .017$). A significant association of PIQ ($b = 0.14$, $p = .005$) with lifetime drinking in the univariate model was reduced to non-significant with the addition of covariates ($p = .73$). Neither VIQ nor CPE scores were significantly associated with lifetime drinking with or without covariates.

Predictors of AUD Symptoms

Table 2 shows results of the symptom count portion of the ZINB models for each cognitive predictor alone and with the three demographic covariates.

Intellectual ability—In univariate models, lower scores on each IQ scale predicted AUD symptoms ($ps < .04$), but only VIQ remained a significant predictor with covariates (PIQ reduced to $p = .09$). We found one significant interaction of VIQ X Male ($b = .05$, $p = .017$), which we probed by re-running the model separately for each gender. Lower VIQ was a

stronger predictor of AUD symptoms for females (b = −.53, p < .001) than for males (b = −.08, p = .07).

Trails—Models including nonlinear terms revealed a significant negative effect of Trails Squared on AUD symptoms (b = .07, p < .05). We probed this effect by re-estimating the model with the Trails distribution trichotomized into three groups (Fast = < −1 *SD*, Mid-range = between −1 and +1 *SD*, Slow = >1 *SD*). The relationship of Trails with AUD symptom count differed in both direction and magnitude across the three groups, (Fast b = −1.13, p = .79, Midrange b = .94, p = .55, and Slow b = 2.61, p = .05). Only for those in the Slow range was there indication of Trails being predictive of AUD symptoms.

Academic achievement—Lower CPE scores were predictive of higher AUD symptoms, with (p = .029) and without (p = .012) covariates included in the model.

Multiple cognitive predictors—Lastly, we entered the two cognitive variables that were significant in linear models, VIQ and CPE scores, simultaneously in ZINB models with and without covariates. When entered together, neither predicted AUD symptoms (ps > .24), indicating the portion of each of these associated with AUD symptoms may be shared.

Discussion

This study examined cognitive abilities and academic achievement in a general cohort, non-Western sample of 11-year old youth as predictors of alcohol involvement over approximately the next 25 years. Lifetime drinking was predicted only by better childhood performance on Trails once demographic covariates were taken into account. Lower verbal abilities and academic achievement were linearly associated with subsequent alcohol problems, whereas the relationship between poorer performance on Trails and alcohol problems only emerged at the lower end of the performance range. All of these associations were found prospectively in a general sample of youth tested prior to the typical onset of drinking in this society (99% of the sample had not consumed a full drink), indicating these associations existed prior to alcohol use and were not merely consequences of consumption.

Being a lifetime drinker was not strongly linked to childhood cognitive measures in this Mauritian sample after accounting for demographic covariates. Studies of twin samples have found that initiation of alcohol use is more strongly influenced by environmental factors than genetic factors (e.g., Heath, Meyer, Eaves, & Martin, 1991; Rhee et al., 2003), and thus factors associated with lifetime drinking status may vary more across cultures. One environmental explanation that has been proposed for the higher levels of drinking seen among those with higher intellectual ability and achievement in Western societies is that this increases the opportunity for alcohol use (e.g., Johnson et al., 2009; Slutske et al., 2004). On Mauritius, however, higher academic achievement does not typically place young adults in a more risky drinking environment given that higher education is not linked to moving away from one's family of origin, nor does high academic achievement necessarily allow one to pursue higher education. Thus, our findings are consistent with the idea that exposure to drinking environments contribute to the link between childhood cognitive performance and lifetime drinking. Additional examination of differences in drinking norms, contexts, and

accessibility across societies may further elucidate unique environmental components of this relationship.

On the other hand, both childhood verbal intelligence and academic achievement were predictive of lifetime alcohol-related problems even after accounting for gender, childhood psychosocial adversity, and Muslim religion in this Mauritian sample. These results are consistent with other prospective cohort studies in Western societies (e.g., Batty et al., 2000; Windle & Blane, 1989), providing further evidence that poor cognitive performance in childhood is a robust predictor of later alcohol problems across cultures.

In our sample, verbal intelligence was a stronger predictor of lifetime alcohol problems in females than in males. The specificity of the relationship of lower verbal abilities with alcohol problems in our female sample suggests the possibility of a pathway to alcohol problems that is distinct from the deviance proneness pathway (which is more associated with behavioral undercontrol in males; Sher, 1991) that may operate more through other factors such as social skills and judgment (see Maggs, Patrick, & Feinstein, 2008; Windle & Batty, 1989). Further examination of gender differences in models that include social, peer, and situational factors may help explain the association between verbal abilities and alcohol-related problems.

Poor academic achievement in childhood was found to be a significant predictor of lifetime alcohol problems in both males and females. This relationship remained significant after covarying for psychosocial adversity, even though previous reports with this sample have shown psychosocial adversity to be associated with lower IQ scores (Liu et al., 2003). In Mauritius, primary education is mandated, and the children in our cohort had relatively uniform educational opportunities up through age 11 years regardless of psychosocial adversity. A mediational pathway cannot be established with these data, but our findings indicate that poor academic achievement by the end of primary school is a risk factor for subsequent alcohol problems that is not simply accounted for by concurrent psychosocial adversity.

The measure of Trails exhibited a curvilinear relationship with lifetime alcohol problems. More severe deficits served as a risk factor, but stronger performance did not add any protection against developing alcohol problems. Our findings suggest that within a general sample, the link between poor functioning on Trails in childhood and subsequent alcohol problems emerges only for those in the lowest performance range. The deviance proneness model hypothesizes that underlying behavioral disregulation manifests in childhood as attention and cognitive deficits; the Trails difference score, a measure of complex divided attention and sequencing (Strauss et al., 2006), may be assessing abilities that are indicators of this disregulation construct. Future research examining general samples that include individuals on the tail ends of performance will improve our understanding of the specificity of various cognitive measures as precursors to alcohol problems as well as their relationships with other measures of behavioral disregulation.

Our findings should be interpreted along with the limitations of the study, including the use of a limited number of measures to assess cognitive performance in a culture for which they

were not designed, attrition as is the case in any longitudinal study, and the inability to speak to mechanisms for how cognitive deficits in childhood lead to alcohol problems by adulthood. Despite these limitations, this study provides evidence that childhood cognitive performance is not strong a predictor of lifetime alcohol use in this society, indicating environmental specificity of previously-found relationships in Western societies, but that childhood cognitive deficits are risk factors for subsequent alcohol problems in this novel east African cultural context, providing further evidence of the generalizability of this relationship across societies.

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Table 1

Intercorrelations among Cognitive Measures and Demographic Covariates

Measure	*1*	*2*	*3*	*4*	*5*	*6*	*N*	*M*	*SD*
1. Verbal IQ	-						899	99.8	14.81
2. Performance IQ	.56*	-					899	100.2	14.64
3. Trails B-A	−.21*	−.28*	-				826	0.0	0.10
4. Certificate of Primary Education	.60*	.59*	−.33*	-			993	9.5	6.94
5. Childhood psychosocial adversity	−.14*	−.25*	.20*	−.26*			895	1.83	1.47
6. Male	.04	.24*	−.01	.02	.05	-	1,107	55%	
7. Muslim	−.02	−.04	.02	.00	.02	.03	1,107	22%	

Note. Correlations for continuous variables are Pearson and for dichotomous variables are point biserial. *N*s are of participants who have both the variable listed in the row plus mid-adulthood alcohol data and thus are included in the analyses (total *N* of 1,107). IQ scores were normalized and standardized within the sample, and Trails B-A was corrected for age by residualization (see Raine et al., 2002). Better performance on Trails B-A is indicated by lower scores, whereas for all other cognitive variables better performance is indicated by higher scores.

* $p < .001$, two-tailed

Table 2

Childhood Cognitive Predictors of Lifetime Alcohol Use Disorder Symptom Count with and without Covarying for Gender, Childhood Psychosocial Adversity, and Muslim Religion.

Predictor	Univariate *b* (*SE*)	With covariates *b* (*SE*)
Verbal IQ	−.11* (.04)	−.10 * (.04)
Performance IQ	−.10* (.04)	−.08 (.05)
Certificate of Primary Education	−.22* (.09)	−.26 * (.12)

Note. N = 898 and 802 for IQ models and 992 and 735 for Certificate of Primary Education models, with and without covariates, respectively.

* $p < .05$, two-tailed.