ORIGINAL ARTICLE

Behavior of Boys in Kindergarten and the Onset of Substance Use During Adolescence

Louise C. Mâsse, PhD; Richard E. Tremblay, PhD

Background: The purpose of this study was to assess the usefulness of personality dimensions measured at ages 6 and 10 years in predicting early onset of cigarette smoking, alcohol abuse, and other drug use in boys. In addition, the stability of the prediction between the measurements at ages 6 and 10 years was investigated.

Methods: Data from a large longitudinal study of boys were used to assess the relation between childhood personality and the onset of substance use from 10 to 15 years of age. Childhood personalities were assessed by teachers' ratings of behaviors. Self-reports of smoking cigarettes, getting drunk, and using other drugs provided the measurement of substance use. Discrete-time survival analysis was used for the statistical analyses.

Results: High novelty-seeking and low harm avoidance significantly predict early onset of substance use (eg, cigarettes, alcohol, and other drugs), but reward dependence was unrelated to any of the outcomes studied. The results also indicated that either set of predictors (ie, the personality dimensions measured at ages 6 and 10 years) could be used to predict onset of cigarette smoking, getting drunk, and other drug use, because the power of prediction was similar between the measurements at ages 6 and 10 years.

Conclusions: High novelty-seeking and low harm avoidance lead to early onset of substance use in boys. The stability of the prediction between ages 6 and 10 years suggests that the kindergarten assessments may be used for preventive efforts at school entry instead of waiting until early adolescence.

Arch Gen Psychiatry. 1997;54:62-68

From the School of Public Health, Center for Health Promotion Research and Development, University of Texas–Houston (Dr Mâsse); and the Research Unit of Children's Psycho-Social Maladjustment, University of Montréal, Montréal, Québec (Dr Tremblay).

U NDERSTANDING early onset of substance use has important implications for the development of effective prevention programs, mainly because early onset is often a marker for other persistent problems.[1-8] In recent longitudinal studies, the effects of childhood behaviors and family characteristics have been shown to predict onset of substance use among adolescents.[9-12] Although disruptive behavior and family environment have been linked to substance abuse, it has recently been suggested that basic personality dimensions are the underlying link between disruptive behavior and substance abuse.[1,13,14] In this perspective, the basic personality dimensions are hypothesized to be indirectly linked to some genetic components that may be related to the onset of substance use. Cloninger,[15] for example, suggested that alcoholism characterized by early onset of alcohol-seeking behavior (ie, type 2 alcoholism), would be predicted by a specific pattern of personality dimensions and that this pattern would differ for those who have late onset of alcohol-seeking behavior (ie, type 1 alcoholism). In Cloninger's theory, 3 personality dimensions—referred as to novelty-seeking, harm avoidance, and reward dependence—are hypothesized to be related to the behavioral activation, inhibition, and maintenance systems, respectively. More specifically, the novelty-seeking dimension refers to a heritable tendency toward exploratory activity and exhilaration that is activated by novel or appetitive stimuli. The harm avoidance dimension refers to the heritable tendency to react intensively to aversive stimuli, therefore controlling the learning mechanisms that facilitate inhibitive behaviors. Finally, the reward dependence dimension is assumed to condition the brain system responsible for onset of reward or relief of punishment. In Cloninger's

SUBJECTS AND METHODS

SUBJECTS

The subjects (N = 1034) for this study were obtained from an ongoing longitudinal study[19] that began collecting data when the boys were at the end of their kindergarten year (mean [±SD] age, 6.23±0.30 years). Subjects in this cohort were all white boys who attended 53 low socioeconomic French-speaking schools in Montréal, Québec. Subjects were retained only if both parents were born in Canada and were French-speaking. This yielded a sample that was culturally homogeneous (ie, white, French-speaking, nonimmigrant boys living in low socioeconomic areas of a large urban city). Most of the boys (67%) in this sample lived with both parents when they attended kindergarten. The mean (±SD) number of school years completed by the parents was 10.5±2.8 for the mothers and 10.7±3.2 for the fathers. At the birth of their sons, mothers were mean (±SD) 25.4±4.8 years old and fathers were 28.4±5.6 years old. Informed consent was obtained from the parents when the boys were younger than 14 years. When the boys were 14 years and older, parents and boys had to give informed consent. This study was approved by the review board for human subjects at the University of Montréal.

ATTRITION AND MISSING DATA

Subjects with incomplete data sets were eliminated from the analyses. The alcohol analyses had 784 subjects; 199 were eliminated because of missing information about alcohol abuse and 51 because of missing data on the personality variables. For the drug use analyses, 772 subjects were used, because 209 had missing information about initiation to drug use and 53 had missing information on at least 1 of the personality variables. For the cigarette analyses, the sample was reduced to 656 subjects, because 335 had missing information about cigarette use and 43 had missing information on at least 1 personality variable. The cigarette data analyses had more missing information, because questions pertaining to cigarette use started only at age 13 years.

The attritional bias was assessed by comparing the personality characteristics of the subjects included in the analyses with those who were excluded from the analyses. Because subjects had incomplete information about substance use, multiple χ^2 analyses were computed for each personality variable and substance instead of using a log-linear analysis. The results of these χ^2 analyses indicated that the subjects who were excluded from the original analyses did not differ significantly from those included in the original analyses. This finding was generalized across personality dimensions (ie, novelty-seeking, harm avoidance, and reward dependence), substances (ie, alcohol, drugs, and cigarettes), and ages (ie, personality dimensions measured at ages 6 and 10 years). These analyses indicated that the sample analyzed in this study did not differ significantly from the original sample.

INSTRUMENT

Personality Dimensions

Cloninger's personality dimensions were inferred from 2 teacher-rated questionnaires aimed at measuring childhood behavior, namely the Preschool Behavior Questionnaire[21] and the Prosocial Behaviour Questionnaire.[22] Harm avoidance, described by Cloninger as being cautious, apprehensive, and inhibited, was assessed with the following items: worries about many things, fears or is afraid of new things or new situations, and cries easily. The novelty-seeking dimension, which Cloninger defines as impulsive, excitable, and exploratory behaviors, was a composite of the following items: restless, runs about or jumps up and down and does not keep still, squirmy, and fidgety. The reward dependence dimension is defined by Cloninger as being warm, sympathetic, and sentimental, was a composite of the following 10 items: praises others, shows sympathy, helps sick child, helps hurt child, helps child in a difficult task, helps clean up mess, invites bystander, stops quarrels, helps pick up objects, and comforts upset children. Cronbach α values at age 6 years for the studied sample were as follows: .72 for harm avoidance, .89 for novelty-seeking, and .91 for reward dependence. To verify that each construct reflects these independent dimensions, the correlations among the dimensions were assessed in kindergarten. As expected, all 3 correlations ($r = 0.12$ at age 6 years and 0.11 at age 10 years for harm avoidance and novelty-seeking, $r = 0.10$ at age 6 years and -0.01 at age 10 years for harm avoidance and reward dependence, and $r = -0.13$ at age 6 years and -0.07 at age 10 years for novelty-seeking and reward dependence) were low and indicated that the dimensions were independent. To assess the stability of the personality dimensions, early childhood personality dimensions were assessed when the boys were 6 years old, and later childhood personality dimensions were measured when the boys were 10 years old.

theory,[13,15,16] persons with high novelty-seeking, low harm avoidance, and low reward-dependence scores are hypothesized to predict type 2 alcoholism. This pattern was of specific interest in the present study because it is characterized by early onset of alcohol-seeking behavior.

Evidence supporting Cloninger's theory has been found in a sample of 431 Swedish males, which indicated that the 3 personality dimensions, measured at age 11 years, predicted type 2 alcoholism at age 27 years.[14] Although this study focused on alcohol intake, the theory has been used to predict other types of substances used and abused in adolescents and adults.[17,18] For example, in a cross-sectional sample of 12- to 15-year-olds, Wills et al[17] found that high novelty-seeking, low harm avoidance, and low reward dependence were significantly related to cigarette smoking and alcohol and marijuana use. In contrast, in a sample of 240 adult smokers, Pomerleau et al[18] found that persons whose scores were high on novelty-seeking and low on harm avoidance had high scores on a measure of smoking addiction. Their results, however, did not show a relation between low reward dependence and smoking addiction.

Cloninger[13] argues that the 3 personality dimensions are in part genetically determined and that these dimensions appear early in the child's development and remain stable over time. Recent studies[19,20] confirm this hypothesis: personalities at age 6 years were found useful to predict antisocial behavior[19] and personalities at

Substance Use

Information pertaining to the boys' level of substance use was assessed with a self-report questionnaire. Self-report use was obtained because it has proved to be a valid assessment of delinquent behaviors in previous studies.[23,24] This information was gathered at ages 11, 12, 13, 14, and 15 years during visits to the schools the boys attended. The questionnaire had questions pertaining to alcohol, drug, and cigarette use or abuse. To assess alcohol abuse, the boys were asked if they had been drunk in the past 12 months. The drug use questions assessed if the boys had used any drugs (ie, marijuana, crack, or other drugs) in the past 12 months. Finally, tobacco use was measured by asking the boys if they had smoked cigarettes in the past 12 months, at ages 13, 14, and 15. Because we anticipated that some boys might have experimented before we started to question them about substance use, the boys were asked each year to report when they first started to smoke cigarettes, to get drunk, or to use other drugs. This information also served to cross-validate the information provided by the boys and to identify inconsistency in the data.

STATISTICAL ANALYSIS

Discrete-time survival analyses were carried out to assess which personality variables influenced the onset of substance use. To compute the discrete-time survival analyses, the data had to be transformed. First, one variable measuring the age of the particular record (last period) had to be created as well as one that identified whether the event of interest had occurred (censored). The censored variable was a dichotomous variable that indicated whether the event occurred for the period recorded. For example, if the subject started to abuse alcohol at age 12 years, the last period would indicate the age of initiation to be 12 years for this subject and the censored variable would indicate that this subject started to abuse alcohol (ie, censored=1). For subjects unavailable for follow-up, the last period indicated the last record of this subject and the censored variable was coded as zero if the event did not occur. When these 2 variables were created, the data were converted using the Singer and Willet[25] procedure to prepare the data for computing discrete-time survival analyses with standard logistic regression software. Logistic regression analyses were computed on the transformed data, and they served to estimate the parameters of the discrete-time hazard model. These parameters were then used to recapture the fitted hazard and survival functions. The SAS[26] procedure LOGIST was used to calculate the parameters estimate. For more information on how to use this procedure see Singer and Willet.[25,27] Six discrete-time survival analyses were computed, 1 for each set of personality variables (kindergarten and later childhood personality dimensions) and each type of substance (alcohol, drugs, and cigarettes) used. The response variable for these analyses was dichotomous and measured the use or nonuse of substances and the time at which the subjects reported using or abusing the substance. The 3 personality variables (harm avoidance, novelty-seeking, and reward dependence) were evaluated as potential moderators for the risks of abusing or using substances. A hierarchical procedure was used to select the dimensions that significantly moderate the risk of substance use. The significance of the dimensions was evaluated by the Wald χ^2 statistic with the overall adequacy of the model judged by the model χ^2 statistic, and a P value less than .05 was considered significant. The accuracy of the prediction was also assessed with the Somers D_{yx} rank correlation.[28] The Somers D_{yx} rank correlation was used to determine the relation with the substance used and each of the personality dimensions. This index has a similar interpretation as the multiple correlation in linear regression, but it is a better measure of association when the dependent and independent variables are ordinal.

RELIABILITY OF RISK PREDICTION

The reliability of the kindergarten and childhood personality dimensions to predict risk of onset for use of substances was evaluated by assessing the proportion of predicted use for each substance. The number of correct, incorrect, and tied observations assessed the reliability of the tridimensional personality structure in predicting the onset of substance use and comparing the stability of the prediction. The validity of the kindergarten personality dimensions in predicting onset of substance use was assessed by comparing the contingency table from the kindergarten predictors with those of later childhood predictors. Log-linear analyses assessed whether the classification significantly differed for the 2 sets of predictors (ie, kindergarten vs later childhood personality dimensions) and verified whether the strength of the relation was the same across substances. Akaike Information Criteria,[29] in which a lower value indicates a better fit, also were used to compare overall fit between models.

age 3 years to predict adult psychiatric disorders.[20] Although the usefulness of the early personality dimensions has been shown for predicting antisocial behavior and psychiatric disorders, the stability of these predictions over time for the onset of substance use remains to be investigated.

Thus, the first aim of this study was to test, in a sample of high-risk boys, the hypothesis that high novelty-seeking, low harm avoidance, and low reward dependence measured at ages 6 and 10 years will predict early onset of cigarette use, alcohol abuse, and other drug use. The second aim of this study was to compare the effectiveness of the personality measurements at ages 6 and 10 years in predicting early onset of substance use. This latter comparison was of interest for preventive purposes, because the sooner we can identify children at risk the earlier we can implement preventive efforts.

RESULTS

AGE AT ONSET

The **Figure** shows the age at onset for getting drunk, using other drugs, and cigarette smoking. As expected, the proportion of substances used increased with age. By age 15 years, 47.5% of the boys reported being drunk in the last year, but only 30.5% said that they had used some other drugs in the last 12 months.
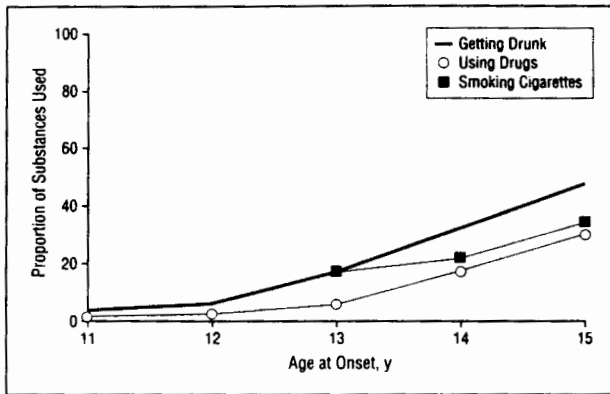
Onset of smoking cigarettes, getting drunk, and using drugs.

PERSONALITY DIMENSIONS AS PREDICTORS

The usefulness of the personality dimensions to predict substance use is shown in **Table 1**. The novelty-seeking and harm avoidance dimensions were found to predict onset of getting drunk, using drugs, and smoking cigarettes, but reward dependence was unrelated to the substances studied. The results also indicate that the predictions were the same regardless of the age at which the predictor variables were measured (ages 6 and 10 years). The parameter estimates indicate that high novelty-seeking and low harm avoidance were significantly related to the onset of use of the substances investigated. Although personality may change with experience and age, these results seem to indicate that some stability exists with these personality dimensions over time. This stability is further confirmed by the significant correlations that are found between the kindergarten and later childhood measurements (novelty-seeking, n=896, $r=0.38$, $P<.01$; harm avoidance, n=901, $r=0.24$, $P<.01$; and reward dependence, n=900, $r=0.18$, $P<.01$).

STABILITY OF PERSONALITY DIMENSIONS

The reliability of the age 6- and 10-year personality dimensions to predict onset of substance use is given in **Table 2**. These reliabilities are computed for the models, including only the significant dimensions (ie, novelty-seeking and harm avoidance). For all substances, the results indicate that the prediction of use or nonuse did not differ between the kindergarten and later childhood predictors. The percentage of correct, incorrect, and tied classifications were almost identical for the 2 sets of predictors. The Somers D_{yx} correlations also showed a similar relation between the kindergarten and age 10 years predictors. To further assess the usefulness of the personality dimensions, the reliability of the null model (ie, a model without the 3 personality dimensions but including the time indicator variables) also is given in Table 2. The results indicate that adding novelty-seeking and harm avoidance as predictors of substance use increased in all cases the accuracy of the prediction, regardless of the time at which the personality characteristics were measured. Adding these dimen-

Table 1. Hazard Models Predicting Onset of Alcohol Abuse, Drug Abuse, and Cigarette Smoking

Age, y	Parameter*	Parameter Estimates (SE)	Wald χ²
	Alcohol Abuse		
6	D1	−3.36 (0.22)	240.83†
	D2	−3.06 (0.20)	230.01†
	D3	−2.31 (0.17)	180.92†
	D4	−1.36 (0.15)	79.60†
	D5	−0.90 (0.16)	33.88†
	Novelty-seeking	0.14 (0.04)	13.96†
	Harm avoidance	−0.17 (0.04)	22.02†
	Reward dependence	0.01 (0.01)	0.11
10	D1	−3.30 (0.21)	246.58†
	D2	−3.08 (0.20)	237.23†
	D3	−2.24 (0.16)	186.64†
	D4	−1.40 (0.15)	91.91†
	D5	−0.90 (0.15)	38.23†
	Novelty-seeking	0.16 (0.04)	16.83†
	Harm avoidance	−0.13 (0.04)	12.64†
	Reward dependence	−0.01 (0.01)	0.04
	Drug Abuse		
6	D1	−3.81 (0.28)	192.13†
	D2	−3.88 (0.28)	183.99†
	D3	−2.99 (0.22)	183.79†
	D4	−1.80 (0.18)	103.93†
	D5	−1.22 (0.17)	51.96†
	Novelty-seeking	0.18 (0.04)	16.75†
	Harm avoidance	−0.16 (0.04)	14.46†
	Reward dependence	0.02 (0.01)	3.01
10	D1	−3.97 (0.28)	204.83†
	D2	−4.12 (0.30)	189.38†
	D3	−3.13 (0.22)	207.87†
	D4	−1.98 (0.17)	133.75†
	D5	−1.39 (0.16)	72.68†
	Novelty-seeking	0.18 (0.04)	16.85†
	Harm avoidance	−0.13 (0.04)	10.29†
	Reward dependence	−0.01 (0.01)	0.03
	Cigarette Smoking		
6	D1	−1.89 (0.16)	136.19†
	D2	−2.31 (0.18)	169.04†
	D3	−1.69 (0.17)	105.76†
	Novelty-seeking	0.10 (0.04)	6.80†
	Harm avoidance	−0.14 (0.04)	13.45†
	Reward dependence	0.00 (0.01)	0.00
10	D1	−1.95 (0.15)	160.09†
	D2	−2.40 (0.17)	194.36†
	D3	−1.76 (0.16)	127.07†
	Novelty-seeking	0.14 (0.04)	12.28†
	Harm avoidance	−0.09 (0.04)	6.42†
	Reward dependence	−0.00 (0.01)	0.00

*D1, D2, D3, D4, and D5 are the main effects of age indicators.
†Parameter is significant at an α of .05.

sions resulted in a decrease in tied predictions, which in turn resulted in a larger increase of correct predictions. Similar Akaike Information Criteria values between sets of predictors further indicate that either set of predictors may be used to predict early onset of substance use. In fact, the Akaike Information Criteria for drug use (kindergarten=1728.36 vs later childhood predictors=1730.21), cigarette smoking (kindergarten=1870.28 vs later childhood predictors=1872.82), and alcohol abuse (kindergarten=2307.61 vs later childhood predictors=2315.04) were quite similar and

Table 2. Reliability of Prediction for the Null (N) Model, the Kindergarten Predictors (K) Model, and the Later Childhood Predictors (L) Model

Substance	Model	Classification, %			Somers D_y Correlation	AIC*
		Correct	Reserved	Tied		
Alcohol	N	64.5	18.5	17.0	0.46	2336.43
	K	74.1	24.1	1.8	0.50	2307.61
	L	74.0	24.4	1.6	0.50	2315.04
Drugs	N	67.3	15.6	17.1	0.52	1750.05
	K	77.3	20.8	1.9	0.57	1728.36
	L	77.1	21.3	1.6	0.56	1730.21
Cigarettes	N	39.9	26.8	33.3	0.13	1884.91
	K	58.7	37.8	3.5	0.21	1670.28
	L	58.2	38.5	3.3	0.20	1872.82

*AIC indicates Akaike Information Criteria.[23]

Table 3. Survival and Hazard Functions for All Substances

Age, y	Survival*			Hazard†		
	Alcohol	Drugs	Cigarettes	Alcohol	Drugs	Cigarettes
11	.96	.98	. . .	.04	.02	. . .
12	.92	.97	. . .	.05	.02	. . .
13	.83	.93	.87	.10	.04	.14
14	.66	.81	.79	.21	.12	.09
15	.46	.65	.66	.30	.20	.16

* Probability of not using a substance
† Probability of starting to use or abuse a substance.

did suggest that both sets of predictors were useful to predict substance use.

Table 2 also indicates that although the percentages of correct predictions were similar among the substances, the reliability of the predictions differed with the type of substance consumed. Indeed, the Somers D_y correlation was smaller for cigarette use than for the other 2 substances. Further log-linear analyses, assessing differences in the number of correct, incorrect, and tied observations among the substances studied, indicated that a model including only the main effects of "substance" adequately explained the observed frequencies ($\chi^2[df=6, n=600] = .06$, $P = .99$), thus suggesting that the reliability of the prediction was the same for the 2 sets of predictors and that the prediction differed with the substance consumed. The personality dimensions were more reliable in predicting onset of getting drunk and using other drugs than they were in predicting onset of cigarette smoking.

The survival and hazard functions estimated with the 2 significant dimensions (novelty-seeking and harm avoidance) are given in **Table 3**. As expected, the probability of using any substance increased with age, and children were more likely to experiment with alcohol first. Experimenting started at age 13 years for getting drunk, but it was delayed by 1 year for other drug use. Cigarette smoking was started by age 13 years. Cigarette smoking probably started earlier, but the lack of earlier data on this variable did not allow us to confirm this hypothesis.

COMMENT

The main objective of this study was to assess the usefulness of Cloninger's personality dimensions in predicting the onset of cigarette smoking, alcohol abuse (ie, getting drunk), and other drug use. The results suggested that novelty-seeking and harm avoidance significantly predicted the onset of cigarette smoking, getting drunk, and using drugs in adolescent boys. As expected from Cloninger's theory, boys who had a high score on novelty-seeking and a low score on harm avoidance were more likely to use substances at an early age. These results only partially confirmed Cloninger's theory, because we did not find that reward dependence significantly moderated the risk of early onset of substance use. Cloninger et al,[14] however, indicated that the level of prediction for the reward dependence dimension was not as high as the other dimensions, which was also observed by Tremblay et al.[19] It is unclear why reward dependence was not found to be a predictor of substance use. It is possible that because this study focused on early onset, we could not differentiate between the experimenters and abusers. Although reward dependence was not found to be significant, it may play an important role in identifying those who will persist and maintain these behaviors. Differences also were seen in the strength of the predictions for the novelty-seeking and harm avoidance dimensions. These differences were related to the outcome predicted and the age at which

the personality dimensions were measured. At age 6 years, low harm avoidance was observed to be the strongest predictor for the onset of smoking and getting drunk, but novelty-seeking was found to be a stronger predictor for the onset of other drug use. At age 10 years, novelty-seeking was found to be the strongest predictor for all outcomes studied. Because the interrelations between these 3 dimensions over time are not yet understood, future work in this area should focus on this aspect of the model.

Although novelty-seeking and harm avoidance were both found to predict the 3 outcomes studied, the prediction for cigarette use was the weakest. Our lack of data on smoking at ages 11 and 12 years might explain those differences. The most extreme cases of high novelty-seeking and low harm avoidance probably were those who started smoking before the data pertaining to smoking were first collected. It is also possible that the lower prediction may reflect that smoking is a less deviant behavior and may not be as well predicted with Cloninger's model. Further research on this issue may help clarify or interpret our findings.

This longitudinal data set also enabled us to compare the stability of the personality characteristics at ages 6 and 10 years in predicting the onset of substance use. The results indicate that early (6 years of age) and late (10 years of age) childhood personality dimensions had similar powers of prediction and that they both significantly predicted onset of substance use in adolescents. Although counterintuitive, these findings suggest that the personality traits are established as early as age 6 years. This would agree with Caspi et al,[20] who found that behavioral observations at age 3 years predict adult psychiatric disorders, and Tremblay et al,[19] who observed that personalities at age 6 years predict antisocial behaviors. From a practical point of view, these results suggest that preventive initiatives may use early childhood personality dimensions, rated by kindergarten teachers, to identify children at risk for early onset of substance use. Waiting for later or better predictions may be self-defeating, because the deviant pattern may be more crystallized and thus harder to change. Although most substance abuse prevention programs focus on early and middle adolescence,[30] there are some indications that substance abuse prevention experts are considering preschool interventions as an alternative strategy.[31] It is hoped that the findings of this study will stimulate more early interventions.

From a theoretical perspective, these results confirm that the extreme personality characteristics, which characterize most psychopathologic illnesses,[13,15] have taken form by school entry, and they seem to be stable over time.[19,32] Furthermore, the early crystallization of the personality dimensions supports the idea that they are genetically grounded.[13,15,33] Although the building blocks of the personality dimensions may be inherited, the social and mental health problems that develop from these personalities probably are influenced by the quality of the environment in the preschool years.[34] From our results, it is

clear that kindergarten boys who have high novelty-seeking and harm avoidance personalities are at risk of experimenting early with cigarettes, alcohol, and other drugs; however, not all kindergarten boys with these personality characteristics will initiate these activities early, and among those who do, some will desist. There is a need to conduct studies aimed at identifying the protective factors for initiators and desistors to understand better the environmental influences interacting with the personality characteristics.

The limitations of our study should not be overlooked. Because this study operationalized Cloninger's personality dimensions from questionnaires developed to measure children's social behaviors and thus were not specifically designed to measure these dimensions, the findings deserve to be replicated. One would expect that an instrument specifically designed to measure Cloninger's personality dimensions would lead to more powerful predictions, because our instrument may be less precise than Cloninger's. However, future study comparing our personality scales with those of Cloninger may clarify this issue. In addition, this study focused on white boys from low socioeconomic areas of a specific culture, so the generalizability of our findings remains to be determined for samples that include girls and other cultures. Finally, understanding the extent to which childhood personality dimensions will predict chronic use or abuse remains to be studied with this sample. A follow-up of these subjects through adulthood will be important to answer this question.

─────────────── ▇▇▇ REFERENCES ▇▇▇ ───────────────

1. Brier N. Predicting antisocial behavior in younsters displaying poor academic achievement: a review of risk factors. *J Dev Behav Pediatr.* 1995;16:271-276.
2. Brook JS, Whiteman M, Cohen P, Tanaka JS. Childhood precursors of adolescent drug use: a longitudinal analysis. *Genet Soc Gen Psychol Monogr.* 1992; 118:1995-2213.
3. Flemming JP, Kellam SG, Brown CH. Early predictors of age at first use of alcohol, marijuana, and cigarettes. *Drug Alcohol Depend.* 1982;9:285-303.
4. Friedman AS, Bransfield SA, Tomko LA, Katz S. Early childhood and maternal antecedents to drug use. *J Drug Educ.* 1991;21:313-331.
5. Gregory LW. The 'turnaround' processs: factors influencing the school success of urban youth. *J Adoles Res.* 1995;10:136-154.
6. McCord J. Relationship between alcoholism and crime over life course. In: Kaplan HB, ed. *Drugs, Crime, and Other Deviant Adaptations: Longitudinal Studies.* New York, NY: Plenum Publishing Corp; 1995:129-141. Longitudi-

nal Research in the Social and Behavioral Sciences: An Interdisciplinary Series.

7. Webb JA, Baer PE, Caid CD, McLaughlin RJ, McKelvey RS. Concurrent and longitudinal assessement of risk for alcohol use among seventh graders. *J Early Adolescence*. 1991;11:450-465.

8. White HR. Early problem behavior and later drug problems. *J Res Crime Delinquency*. 1992;29:412-429.

9. Brook JS, Cohen P. A developmental perspective on drug use and delinquency. In: McCord J, ed. *Facts, Frameworks, and Forecasts: Advances in Criminology Theory*. New Brunswick, NJ: Transaction Publishers; 1992;3: 231-251.

10. Dobkin PL, Tremblay RE, Mâsse LC, Vitaro F. Individual and peer characteristics in predicting boys' early onset of substance abuse: a 7-year longitudinal study. *Child Dev*. 1995;66:1198-1214.

11. Kellam SG, Brown CH, Rubin BR, Ensminger ME. Paths leading to teenage psychiatric symptoms and substance use: developmental epidemiological studies in Woodlawn. In: Guze SB, Earls FJ, Barrets JE, eds. *Childhood Psychopathology Development*. New York, NY: Raven Press; 1983:17-51.

12. McCord J. Alcoholism: toward understanding genetic and social factors. *Psychiatry*. 1988;51:131-141.

13. Cloninger CR. A systematic method for clinical description and classification of personality variants. *Arch Gen Psychiatry*. 1987;44:573-588.

14. Cloninger CR, Sigvardsson S, Bohman M. Childhood personality predicts alcohol abuse in young adults. *Alcohol Clin Exp Res*. 1988;12:494-505.

15. Cloninger CR. Neurogenetic adaptive mechanisms in alcoholism. *Science*. 1987; 236:410-416.

16. Cloninger CR. A unified biosocial theory for personality and its role in the development of anxiety states. *Psychiatr Dev*. 1986;3:167-224.

17. Wills TA, Vaccaro D, McNamara G. Novelty-seeking, risk taking, and related contructs as predictors of adolescent substance use: an application of Cloninger's theory. *J Subst Abuse*. 1994;6:1-20.

18. Pomerleau CS, Pomerleau OF, Flessland KA, Basson SM. Relationship of TPQ scores to smoking variables in female and male smokers. *J Subst Abuse*. 1992; 4:143-153.

19. Tremblay RE, Pihl RO, Vitaro F, Dobkin PL. Predicting early onset of male antisocial behavior from preschool behavior. *Arch Gen Psychiatry*. 1994;51:732-739.

20. Caspi A, Moffitt TE, Newman DL, Silva PA. Behavioral observations at age 3 years predict adult psychiatric disorders: longitudinal evidence from a birth cohort. *Arch Gen Psychiatry*. 1996;53:1033-1039.

21. Behar LB, Stringfield S. A behavior rating scale for the preschool child. *Dev Psychol*. 1974;10:601-610.

22. Weir K, Duveen G. Further development and validation in the Prosocial Behaviour Questionnaire for use by teachers. *J Child Psychol Psychiatry*. 1981; 22:357-374.

23. Hindelang MJ, Hirschi T, Weirs JG. *Measuring Delinquency*. Beverly Hills, Calif: Sage Publications Inc; 1981.

24. Klein MW. *Cross-national Research in Self-reported Crime and Delinquency*. Dordrecht, the Netherlands: Kluwer Academic Publishers Group; 1989.

25. Singer JD, Willet JB. It's about time: using discrete-time survival analysis to study duration and the timing of events. *J Educ Stat*. 1993;18:155-195.

26. SAS Institute Inc. *SAS/STAT User's Guide, Version 6*. 4th ed. Cary, NC: SAS Institute Inc; 1989:846.

27. Singer JD, Willet JB. Modeling the days of our lives: using survival analysis when designing and analyzing longitudinal studies of duration and the timing of events. *Psychol Bull*. 1991;110:268-290.

28. Siegel S, Castellan NJ. *Nonparametric Statistics for the Behavioral Sciences*. 2nd ed. New York, NY: McGraw-Hill Book Co; 1988.

29. Bozdogan H. Model selection and Akaike's Information Criteria (AIC). *Psychometrika*. 1987;52:345-370.

30. Botvin GJ. Substance abuse prevention: theory, practice, and effectiveness. In: Tonry M, Wilson JY, eds. *Drugs and Crime*. Chicago, Ill: University of Chicago Press; 1990:461-519.

31. Hawkins JD, Arthur MW, Catalano RF. Preventing substance abuse. In: Tonry M, Farrington D, eds. *Building a Safer Society: Strategic Approaches to Crime Prevention*. Chicago, Ill: University of Chicago Press; 1995:343-427.

32. Caspi A. Bem DJ. Personality continuity and change across the life course. In: Pervin LA, ed. *Handbook of Personality: Theory and Research*. New York, NY: Guilford Press; 1990:549-575.

33. Kagan J. Reznick JS, Snidman N. The physiology and psychology of behavioral inhibition in children. *Child Dev*. 1987:58:1459-1473.

34. Higley JD, Hasert MF, Suomi SJ, Linnoila M. Nonhuman primate model of alcohol abuse: effects of early experience. personality. and stress on alcohol consumption. *Proc Natl Acad Sci U S A*. 1991;88:7261-7265.