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Developmental Momentum toward Substance Dependence: Natural Histories and Pliability of Risk Factors in Youth Experiencing Chronic Stress

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Abstract

BACKGROUND—Mitigation of substance use (SU) disorder (SUD) risk factors is a common goal of prevention. Research has clarified much about risk factors including their prediction of SU/SUD, associations with other etiological variables and mediation of SU outcomes. Greater understanding of the emergence of risk factors themselves may improve prevention. For example, in lieu of experimental data, the level of resistance to change of a risk factor (its pliability) could inform "dosage" of intervention needed to reduce the risk.

METHODS—Two attributes of 22 previously-documented predictors of SU/SUD were quantified: natural history (average age-related trend) and pliability (quantified using correlations between intercepts and growth parameters of hierarchical linear modeling trajectories). The longitudinal sample of 1,147 8- through 16-year-olds were recruited from a northeastern summer camp for youth experiencing chronic stress due to one or more stressors ($\bar{X}$ = 2.2 stressors, SD=1.41) which typically last at least one year. Half were male, 69.3% were European-American, 8.5% were African-American, and the remaining were small proportions each of other or mixed races/ethnicities.

RESULTS—Average trajectories of 21 predictors correspond to increasing SUD risk with age. Predictor pliability varied greatly, ranging from extremely high for *School Commitment* to extremely low for *Peer Pressure Susceptibility*.

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Conflict of Interest: The ALEXSA and the software used to administer the ALEXSA are available from a company, *Assessments Illustrated*, created by the first author's wife. For more information regarding the ALEXSA, contact the first author or e-mail: AssessmentsIllustrated@msn.com.

CONCLUSIONS—Results suggest different intervention strategies may be needed to manage risk factors over the long-term. To illustrate, maintaining a high school commitment appears to require boosters whereas reducing peer pressure susceptibility appears to require high initial "dosage" with less need for boosters.

Keywords

development; growth trajectories; behavior problems; substance use disorder; children; adolescents; risk factors; chronic stress; etiology; pattern mixture models; natural history

1. Introduction

Prevalence of using illegal drugs, alcohol and tobacco (excluding inhalants) increases from late childhood through adolescence, eventually reaching normative levels (Chassin et al., 2002; Johnston et al., 2010). Similar trends occur for other behavior problems including antisocial behavior, gambling and risky sex, all of which antedate or correlate with substance use disorder (SUD) (Loeber et al., 1998; Moffitt, 1993). Liability (overall level of risk for an outcome, usually a disorder) and etiologies (developmental processes) of behavior problems are often researched in terms of the characteristics that statistically predict them (e.g., liability components or risk factors). Falconer (1965) introduced the term "liability" for human genetics as an unobserved phenotype that encompasses the effects of all factors which influence the probability of a disorder. Improved knowledge of these factors (herein termed "predictors") themselves thereby sheds light on how proclivity for behavior problems develops.

A characteristic's natural history (its natural course over time, such as average trajectory with age) can be as etiologically informative as understanding the characteristic's causal factors (Bhopal, 2002). For example, natural histories of risk factors can inform assumptions that underlie many prevention programs, such as whether increases in a risk factor antedate increased SU prevalence or that subgroups (e.g., ages, genders, cultures) do not differ in risk factor levels or trajectories (Odgers et al., 2008; Ridenour and Feinberg, 2007). The natural history of a risk factor also provides information for applied uses, such as being able to determine how aberrant an individual's trajectory is compared to the population average trajectory.

Individual differences around a population average trajectory can occur not only in terms of level (as standard deviation is to mean) but also in shape. The notion of homeorhesis was introduced for biological development by Waddington (1940). Within human development, homeorhesis describes a return to steady growth following a disturbance (similar to homeostasis, which denotes a return to a steady state following a perturbation; Kenny et al., 1973). Growth in height illustrates homeostasis; in spite of a growth spurt during puberty (departure from steady growth), height follows such a predictable trajectory that an individual's adulthood height can be predicted within about 2" from height as a toddler (Baby Center, 2010). Although individual differences occur in level of height (e.g., rank order), trajectory shapes are by and large equivalent across the development of the entire population. Thus, growth in height has little pliability (e.g., it is difficult to alter and little oscillation occurs around its trajectory), notwithstanding drastic environmental events such as severe malnutrition or loss of limbs. In contrast to height, trajectories of weight are more pliable (greater oscillation, less predictable over time) and more easily altered (e.g., via malnutrition, exercise or diet), in spite of the so-called weight "set point" (Leibel et al., 1995). In prevention terms, weight requires less "dosage" of intervention than height to incur change but also requires repeated intervention to maintain change (e.g., lifestyle change to avoid "yo-yo" dieting).

1.1 Risk Factor Trajectories and Common Liability

Common liability theory posits and evidence demonstrates that one's propensity for addiction to one drug (e.g., alcohol) also largely reflects his or her liability to other SUDs (e.g., illegal drugs; Ridenour et al., 2011; Vanyukov et al., 2003) as well as other behavior problems (Krueger et al., 2007). Common liability also is complex, comprised of manifold risk factors, which vary among persons and vary over time within persons. Tarter et al. (1994) provided a conceptual framework for delineating an individual's SUD liability and ontogeny (see Vanyukov et al., this issue, Figure 1), by defining overall SUD liability as an aggregate of his/her (a) risk factors, (b) compensatory skills (e.g., skills attained during intervention), and (c) the relative influences of each risk factor and skill on overall liability in terms of size and direction either toward or away from an outcome of SUD (termed "vectors" of influence).

One's future liability can thus be forecast using an aggregate of his/her present SUD liability plus the aggregate of expected changes (e.g., due to age or intervention) in his/her risk factors and compensatory skills. Accordingly, identification and mitigation of the risk factors having the greatest influence on an individual's forecasted SUD epigenetic trajectory maximizes the potential effectiveness of intervention for that person. To accurately forecast unobservable SUD liability and devise effective strategies to ameliorate it, SUD risk factors must be quantified (as liability can subsequently be measured as their aggregate), their population average and individual differences in developmental trend must be plotted, and the effort needed to mitigate them (e.g., pliability) must be known.

A critical step toward forecasting SUD liability, overall and in terms of its contributing factors, is to quantify how accurately a risk factor level at one time point forecasts the subsequent *trajectory* for years thereafter, thereby also estimating how pliable that risk factor is to naturally occurring influences (i.e., not as a result of intervention). This approach is in contrast to a "stability" estimate of a characteristic, which is a correlation in rank order between two time points. Greater absolute values of correlations (i.e., closer to 1.0 or −1.0) between the intercepts and growth parameters of trajectories correspond to less pliability whereas lesser correlations (closer to 0.0) correspond to greater pliability and developmental individuation as well as the need for more idiographic-oriented research and intervention.

The importance of individual differences in ontogeny of SUD liability is illustrated by research on chronic stressors (e.g., social exclusion, poverty, childhood trauma), which are widely known to correlate with mental, emotional and physical pathology (McMahon et al., 2003). Stressors that impact the life course (rather than being temporally proximal to risk factors) had greater association with SU (Fishbein et al., 2011). Moreover, adolescence is characterized by stressful experiences (McLaughlin and Hatzenbuehler, 2009; Windle et al., 2008). Not surprisingly, long-term stressors during and prior to adolescence presage SU and other behavior problems (Brady and Sonne, 1999; Fishbein et al., 2011; Kassel et al., 2003). This evidence may suggest that developing universal interventions for adolescents to cope with chronic stress could reduce risk for SUD. While such an intervention probably could greatly benefit some persons and provide some benefit to most persons, adolescents experiencing chronic stress who have adept emotional regulation or cognitive skills (e.g., executive functioning) are unlikely to develop psychopathology in the absence of the intervention (McLaughlin et al., 2009; Windle et al., 2008). Moreover, stress occurs in response to specific circumstances that may vary within persons over time whereas a universal approach is unlikely to include components to focus on specific needs arising from particular stressors. So, whereas stress arising from residential relocation may often be mitigated through involvement with leisure time organizations, stress arising from a learning disability or incarcerated parent typically requires greater and more protracted intervention.

1.2 Risk Factor Momentum and Pliability

Points raised thus far imply that over time risk factors both escalate on average (corresponding to increasing SU prevalence with age) and ebb and flow (according to within-person variance over time). Why estimate the average developmental course of risk factors if individual levels vary greatly over time? As physics quantifies momentum of objects for predicting their future location, so a risk factor's rate of change, ages of accelerated change, and pliability can illuminate aspects of an individual's risk factor (e.g., its expected trajectory, degree of aberrancy and tractability for potential reduction in future liability). Herein, use of the term "momentum" in the developmental context is intended only to convey the notion of the amount of force (e.g., the aggregate of Tarter and Vanyukov's 1994 vectors) behind ontogeny toward (or away from) a clinical outcome. A factor that is largely unchangeable over time (e.g., I.Q.) has little pliability and thus contributes constant momentum to overall liability. More pliable characteristics contribute time-varying momentum to liability. Clearly, developmental momentum involves more factors, more sophisticated measurement and less accurate forecasting than physical momentum which consists of velocity and mass. Nevertheless, a potentially practical use for quantifying a concept analogous to physical momentum is that this information could help tailor SUD prevention to meet individual needs (e.g., by targeting one's most salient and pliable risk factors; CDC, 2010).

A similar strategy is employed by pediatricians using growth charts for infants and toddlers. During routine pediatric appointments, certain physical attributes (e.g., BMI, head circumference) are compared to age-normed growth charts. Monitoring these attributes permits pediatricians to plot a patient's expected growth trajectory. "At risk" status is generally designated when these attributes fall outside of the 5^{th} to 95^{th} percentiles, indicating heightened liability to malnutrition, obesity or underlying chronic illness (e.g., congenital heart disease). The usually low pliability of height described earlier thus permits pediatricians to detect with a single measurement whether height deviates from an expected trajectory. For infants found to be at risk, further evaluation and intervention can be employed to prevent potentially devastating outcomes. Likewise, if SU/SUD risk factor trajectories could be forecast from individuals' childhood levels, then screening age-standardized risk levels could detect a need for further evaluation and intervention to divert an at-risk individual's trajectory away from behavior problems. In fact, screening for risk of problematic SU is sanctioned by the American Association of Pediatrics, although no empirically-based procedures for doing so have been developed for children (AAP, 2010; Knight et al., 2010).

Pliability and predictability of risk factors can be quantified from certain features of age-related trajectories. Within a hierarchical linear modeling approach, normative rate of change and ages of accelerated change can be determined using the beta coefficient(s) that quantifies the "effect" of age (due to maturation factors such as puberty, graduating from middle- to high-school and increasing freedoms and responsibilities; Windle et al., 2008). As mentioned, in lieu of experimental data, a risk factor's pliability may be estimated from a correlation between scores at one time point (e.g., an intercept) with the ensuing trajectory parameters (i.e., linear, quadratic slope). This correlation ranges from 1.0 (or −1.0) for very low pliability traits like height or I.Q. to 0.0 for highly pliable and time-varying (situation-specific or highly environmentally-influenced) characteristics such as state anxiety. Because highly pliable risk factors likely are at least partly responsive to environmental causes (e.g., a phobia), mitigation by intervention is potentially easier, but also may require repeated efforts (e.g., boosters) to stave off new risk circumstances.

1.3 Present Study

This study elucidated the average trajectories of 22 previously-documented predictors of SU/SUD and other behavior problems (Clark and Winters, 2002; Ridenour et al., 2009). Three hypotheses were tested. First, average trends of risk factors increase from late childhood through adolescence. Analyses to test this hypothesis provided estimates of normative growth in risk factors. Next, using hierarchical linear modeling, pliability was quantified in terms of correlations between intercepts and growth parameters (linear, quadratic or cubic), indicating how predictable trajectories are from scores at one time point (based on degree of within-person variability over time). The second hypothesis was that for each risk factor correlations between individuals' intercepts and their trajectory parameters exceed 0.50. Given the limited to no extant evidence relevant to this hypothesis, the correlation of 0.50 was selected to serve as a guidepost which corresponds to Cohen's (1988) large-sized correlation. Third, correlations between individuals' intercepts and trajectory parameters are less than 0.75, such that large within-person variability (nearly 50% of variance) also occurs over time. Hypotheses two and three serve as heuristics for comparisons of relative pliability among risk factors.

As mentioned, adolescence is characterized by stress and chronic stress is associated with liability to SU/SUD and other behavior problems. Hypotheses were accordingly tested in youth whose ages spanned the period of accelerated growth in SU and behavior problems (later childhood through middle adolescence) and who were experiencing one or more stressors that typically last at least one year (Chassin et al., 2002; Fishbein et al., 2011; Johnston et al., 2010).

2. Methods

2.1 Sample

The sample consisted of 1,147 youth (half females), ages 8 to 16, who between 2004 and 2009 attended a summer camp designed for youth experiencing chronic stress. IRB approval was for data to be transferred to the first author in de-identified format. Reports of participant stressors were maintained in camp records in terms of applicant responses to open-ended questions. Thus, the research team was unable to inspect participant records or contact participants to quantify their stress. Nevertheless, because camp funding was contingent upon the attendees experiencing significant long-term stressors, camp staff used several steps to screen for youth experiencing chronic stress. An adult applied for camp attendance on a youth's behalf and described the source(s), duration and negative impact on functioning of the youth's stressor(s). Information also was collected from the youth's school personnel (e.g., teacher, psychologist) to corroborate the application and obtain additional information regarding his or her functioning (e.g., academic performance, receiving mental health services, social functioning). Camp exclusion criteria consisted of physical and mental handicaps, history of arson and history of physical aggression; however, on self-reports collected for this study, 35.8% admitted to starting fights, 19.0% admitted to bullying and 13.3% admitted to "starting a fire where a fire was not supposed to be."

Annually, about 60% of applications result in a youth attending the camp. About 70% of campers from one year also attend camp the subsequent year. Sources of chronic stress were categorized by program staff as: low family income (i.e., poverty), serious family problems (e.g., an incarcerated or drug-addicted parent), social problems (e.g., severe peer rejection), poor academic performance, or emotional problems (e.g., a mood disorder, although diagnoses were not made as part of this study). To illustrate how one category was rated, social problems ratings were based on research literature (Spangler and Gazelle, 2009) and scaled from one to seven with the worst severity consisting of having "few, if any,

friendships and child is actively disliked by peer group." Participants were from urban, suburban and rural settings (although not measured per se) of a Northeastern U.S. state. Participation rate of campers in the current investigation was 99.91% (one camper refused the 2004 assessment).

2.2 Instrumentation

One challenge in research on children is that in addition to psychometric adequacy, data collection must be pragmatic (e.g., requiring as little time as possible) and developmentally appropriate. Youth are the best reporters of many of their own characteristics and their perspective provides unique information not available from others such as parents or teachers (de los Reyes and Kazdin, 2005). So, much etiology and prevention research of behavior problems has utilized youth self-reports, but using written instruments. Many at-risk youth are poor readers or illiterate and are more likely than others to discontinue or erroneously complete a written survey due to reading frustration, inattention or fatigue (Bennett et al., 2003). Reading deficits presage antisocial behavior and SU (Barkley et al., 2004; Moffitt, 1993) making data from poor readers especially informative. This subpopulation also is large; 38% of U.S. 4th graders (51% in urban regions) read below basic levels (Lutkus et al., 2005). Thus, evaluation of elementary school-aged children cannot rely solely on reading. Moreover, greater prevalence of risky and problem behaviors usually are found using computer surveys compared to paper surveys (Turner et al., 1998).

Accordingly, although several written, standardized child-report instruments are available to measure certain aspects of youth problem behaviors, the *Assessment of Liability and EXposure to Substance use and Antisocial behavior* (ALEXSA; Ridenour, 2003) was used to overcome the challenges of reading abilities, pragmatic limitations of assessing many characteristics, youth inattention and perceived confidentiality. The ALEXSA is a cartoon-based, audio computer-assisted self-interview (ACASI), youth report assessment of predictors and early forms of behavior problems, originally designed for pre-high school ages (Ridenour et al., 2011a; Ridenour et al., 2009; Ridenour et al., 2007). ALEXSA subscales were based on a thorough literature review and selected to measure constructs from etiology research that (a) account for SU or antisocial behavior variance over and above demographics, (b) have at least adequate psychometrics in previously-created measures, (c) could consist of a few brief items, (d) are developmentally appropriate for 8-to-13-year-olds and (e) could be illustrated. Its ACASI format and synchronized presentation of questions and response options with audios and illustrations permit even illiterate children to complete it. More detailed descriptions of the ALEXSA, its subscales, reliability and validity appear elsewhere (Ridenour et al., 2011b; Ridenour et al., 2009; Ridenour et al., 2007).

ALEXSA subscales measure characteristics commonly termed risk and protective factors, vulnerabilities, buffers, resiliencies, mediators, moderators, determinants or antecedents. Herein they are termed predictors based on the extant evidence, which generally does not explicate their associations with SU beyond documenting their probabilistic forecasting of SU and other behavior problems. Lesser or greater scores of ALEXSA subscales may represent heightened risk (e.g., low *Problem Solving* and high *Thrill Seeking* scores both represent risk for behavior problems).

In a previous study of 9- to 12-year-old students from regular and remedial education programs, factor analyses of ALEXSA subscales derived nine factors representing behavioral problem liability that is internal (Disinhibition, Self Management, Sensation Seeking, School Protection) or external (Parent Fortification, Family Discord, Social Contagion, Social Support, Neighborhood Risks) to an individual (Ridenour et al., 2009). Of the ALEXSA subscales which summer camp staff selected for their evaluation, seven of

these nine factors were represented. For each subscale, Table 1 presents the factor onto which it loads, its number of items, a brief description and one key reference to its background literature.

Time allotted during the camp for ALEXSA administration was 35 minutes. To ensure that all subscales could be completed by all participants, some items of certain subscales were omitted. Thus, also appearing in Table 1 are certain results from the previous study of students (Ridenour et al., 2009): correlations between the abbreviated and full subscales, subscale test-retest reliabilities and factor loadings of subscales onto their respective factor.

One-week, test-retest reliabilities in the previous study of students were estimated using the intraclass correlation, ICC, which partitions variance into between-person differences vs. change over time, corrects for chance agreement and requires consistent scores (not only consistent rank order), making ICC more conservative than traditional test-retest estimates (e.g., Pearson *r*; Cicchetti, 1994). Cronbach argued that, rather than using alpha, reliability ought to be estimated by partitioning a measure's variance into its sources (Cronbach and Shavelson, 2004) as with ICC (Shrout and Fleiss, 1979). ICCs of 0.40 or less are low; 0.40 to 0.59 are fair; 0.60 to 0.74 are good; 0.74 or greater are excellent. The one-week test-retest ICCs of subscales investigated herein ranged from high fair/good to excellent (Table 1).

The following subscale descriptions are organized by factors on which they loaded in the study of students (Ridenour et al., 2009). Factor loadings (Table 1) demonstrate that subscales summarize well their respective factors. Test-retest reliabilities and Cronbach's alpha (α) of these ALEXSA factors are good to excellent as are the test-retest reliabilities of the subscales (Ridenour et al., 2009). A pragmatic constraint on the original creation of ALEXSA subscales was that they each had to consist of few items so that individual children could fill out surveys that measure many predictors. Thus, subscale items were designed to gauge distinct aspects of the subscale characteristic. Consequently, subscale designs intentionally lead to reduced internal consistencies compared to other instruments both because items are distinct and most subscales contain fewer than seven items (which is penalized by alpha regardless of the inter-item correlation). Alpha and mean interitem correlation ($\bar{r}$), from data of participants' first year in the present study, appear next with descriptions of subscales.

2.2.1. Internal Predictors—Certain ALEXSA subscales were designed to measure predictors that are mostly internal to youth (e.g., environmental influences on and interactions with the predictor notwithstanding). The Disinhibition factor measures volatility and poor regulation of emotional and behavioral impulses; its *Anger Coping* (α=0.80; $\bar{r}$ =0.40), *Distractibility* (α=0.76; $\bar{r}$=0.38) and *Impulsivity* (α=0.73; $\bar{r}$=0.32) subscales were used. The Self Management factor measures learned skills that reduce the probability of and consequences from mistakes or disinhibition; its *Planning and Concentration* (α=0.57; $\bar{r}$ =0.21) and *Problem Solving* (α=0.67; $\bar{r}$=0.25) subscales were used. Sensation Seeking measures the Zuckerman sensation seeking constructs that correlate with behavior problems in youth; the *Social Disinhibition* (α=0.57; $\bar{r}$=0.31) and *Thrill Seeking* (α=0.68; $\bar{r}$=0.29) subscales were used. School Protection measures confidence in, liking of and motivation for good academic performance; its *Academic Competency* (α=0.62; $\bar{r}$=0.22), *School Bonding* (α=0.67; $\bar{r}$=0.33) and *School Commitment* (α=0.44; $\bar{r}$=0.28) subscales were used.

2.2.2 External Predictors—Other ALEXSA subscales were designed to measure predictors that are mostly external to youth (e.g., factors such as individual differences in perception notwithstanding). The Family Discord factor measures how chaotic family life is in terms of dysfunctional interactions during disputes and parent and sibling SU and problems with the law; its *Family Conflict* subscale was used presently (α=0.77; $\bar{r}$=0.36).

Parent Fortification measures caretaker nurturance, knowledge of a youth's life outside of the family and caring affect and behavior between the youth and caretaker; its *Parental Monitoring* subscale (α=0.74; $\bar{r}$=0.35) was used. Social Contagion measures youth exposure and vulnerability to imitating peer problem behaviors; its *Friends' Conduct Disorder Criteria* (α=0.79; $\bar{r}$=0.48), *Peer Pressure Susceptibility* (α=0.74; $\bar{r}$=0.42) and *Violence Exposure* (α=0.65; $\bar{r}$=0.32) subscales were used. (Although *Peer Pressure Susceptibility* loaded onto the Social Contagion factor with ALEXSA subscales that reflect mostly external risk factors, it is considered to measure an internal predictor.)

2.2.3 Other Measures—Drug-specific risk indexes query proximal predictors of using alcohol, caffeine, cannabis, "hard drugs" collectively, inhalants or tobacco. Four of these items were used presently because they best facilitated comparisons among 8- to 16-year-olds: *Alcohol Availability*, *Tobacco Availability, Known Alcohol Users* and *Known Tobacco Users*. Perceived *Safety of Drugs* (specifically beer, cigarettes, cocaine, inhalants and marijuana; α=.87, $\bar{r}$=.57) was developed after the test-retest reliability study. For the camp evaluation, two additional items queried the number of past occasions on which alcohol and tobacco had been consumed.

Four additional subscales, which either do not load on any factor (*Tolerance of Deviance*) or are considered outcomes (*Conduct Disorder Criteria, Depression, Gambling*) were used. *Tolerance of Deviance* is based on the corresponding measure from Problem Behavior Theory. *Conduct Disorder Criteria* consists of DSM-IV diagnostic criteria (APA, 1994). Item content for *Depression* was based on the *Child Depression Inventory* and *Center for Epidemiologic Studies – Depression* instruments. *Gambling* measures experience with gambling and desire to gamble in the future. For these subscales, α and $\bar{r}$ were, respectively, 0.84 and 0.58 for *Tolerance of Deviance*, 0.81 and 0.32 for *Conduct Disorder Criteria*, 0.88 and 0.39 for *Depression* and 0.69 and 0.53 for *Gambling*.

2.3 Procedure

During camp registration, campers and their parents were informed of the assessment, research and opportunity to decline participation. Campers also could withdraw before the evaluation or respond "Don't Know" or "Refuse to Answer" to any item. None of the parents declined participation and one out of 1,148 campers did. On the 3rd camp day, ALEXSAs were completed in groups of 20 to 30. Computers were spaced to obscure participant observation of another's responses; headphones prevented audios being heard by others.

2.4 Analyses

Analyses were conducted using Mplus (Muthen and Muthen, 1998–2009). Following descriptive analyses, latent class pattern mixture models were used to compute the unconditional, average age-related trajectory of each ALEXSA predictor while accounting for patterns of missingness among study participants. An important feature of longitudinal data analysis is characterizing and, if needed, accounting for missing data (Hedeker and Gibbons, 1997). Missing data in longitudinal studies most commonly result from attrition, whereby differences between persons who dropout vs. complete a study can be tested and accounted for while using traditional statistical models, such as regression (Hedeker et al., 1997). Ideally, dropouts do not differ from completers on observed variables (missing completely at random or MCAR) or at least on variables that cannot be observed after they drop out (missing at random or MAR).

In samples recruited from programs for at-risk populations, attrition must be assumed to result in part from systematic causes, thereby leading to data that are not missing at random

(NMAR; Hedeker et al., 1997; Morgan-Lopez and Fals-Stewart, 2007). Several techniques for analyzing NMAR data have been developed (Hedeker et al., 1997), including a latent class pattern mixture model for rolling participation. In this model, missing observations may occur before, after or even between study participation times (Morgan-Lopez et al., 2007; Roy, 2003), as had occurred with the present study participants (see Results). Presently, this model was simplified because latent growth was estimated for a single group rather than for testing between experimental and control groups.

In the latent class pattern mixture model used presently (Figure 1), latent class analyses identified classes of missingness patterns. In effect, latent classes were derived from dichotomous (0/1) variables indicating (non)participation at each study year (lower half of Figure 1). The number of latent classes was determined and class membership was assigned prior to estimating unconditional trajectory parameters (Morgan-Lopez et al., 2007). Then, for each predictor, a single, unconditional trajectory (upper half of Figure 1) was computed by averaging trajectory estimates across latent classes (weighted by class size) using equality constraints.

Each risk factor trajectory consisted of two-level hierarchical models (within-individual observations at the lower level) with maximum likelihood estimation; robust estimates were used for specific parameters and their standard errors (with a sandwich estimator). Results are available on-line when these analyses were conducted without accounting for the missing data patterns (i.e. hierarchical modeling of unconditional trajectories without aggregating across latent classes of missing data patterns). Mplus provides correlations between intercepts and trajectories (cf. the corresponding latent traits from the mixture model of Figure 1), providing estimates of risk factor pliability.

Analyses were conducted first with only youth having three or more observations (n=330) and repeated with the entire sample (n=1,147) to inspect for robustness of results. Three or more observations are needed to detect curvilinear trajectories. However, as implied by the assumption that data may be NMAR, youth who participated only once or twice may differ systematically from those having three or more observations.

Three unconditional trajectory models were tested (linear, quadratic and cubic) using forward selection. Fit of competing models to observed data was determined using likelihood-ratio χ^2, Akaike's Information Criterion (AIC) and sample-size adjusted Bayesian Information Criterion (BIC). When fit statistics identified different models as having best fit to the data, the model indicated by two of the statistics was chosen. For selection of the latent class model, entropy also was used to assess fit.

3. Results

To characterize the sample at study entry, participants were 49.9% male, 69.3% European-American, a mean 11.2 years old (SD=1.85) and over 90% lived with one or both biological parents (details in Table 2). The most prevalent chronic stressor (Table 2) was low family income (poverty); prevalence of each of the other stressor categories was at least 40%. Participants had a mean 2.2 (SD=1.41) stressors. The subsample resembled the full sample in terms of demographics and distributions of stressors across age (Table 3). Distributions of all ALEXSA predictors were approximately normal (available from the first author).

The assumption that the present sample is at heightened risk for behavior problems compared to the general population is validated in comparisons between 9- to 12-year-olds at study entry vs. 9- to 12-year-olds (N=225) in the previous study of students in regular and remedial education from the same region (Ridenour et al., 2009). The present sample had greater lifetime alcohol (17.4%) and tobacco use (7.9%) compared to the students (13.5%,

2.2%, respectively; p<0.001 in each χ^2 test) as well as conduct disorder criteria ($\bar{X}$=1.42, SD=1.77 vs. $\bar{X}$=1.01, SD=1.58, respectively; p<0.001). The present sample mean *Gambling* score ($\bar{X}$=0.65, SD=0.68) statistically equaled the students' ($\bar{X}$=0.58, SD=0.69) (p=0.18). Compared to the 2009 8th grade subsample of the national Monitoring the Future survey (Johnston et al., 2010), greater prevalence (p<0.01) was observed in the present sample (age 14) for lifetime use of alcohol (57.6% vs. 36.6%) and tobacco (33.5% vs. 20.1%). Similar results were observed when comparing 16 year olds of the present sample to 10th graders in Monitoring the Future (60.7% vs. 59.1% for alcohol, 54.2% vs. 32.7% for tobacco).

Number of occasions on which alcohol (tobacco) had been consumed increases with each year of age (Table 4) with a few exceptions due to not always having the same participants in contiguous years as well as a smaller sample for certain ages. SU is greater for alcohol than tobacco at all ages, both of which accelerate in slope from age 12 to 14. Conduct disorder criteria also accelerate in growth between ages 12 and 14. By age 14, the average participant has at least 2 conduct disorder criteria (3 are required for diagnosis), suggesting that many participants are at risk for adulthood antisocial personality (Ridenour et al., 2002). Levels of SU and conduct disorder criteria are similar between the full sample and subsample. Finally, the full sample and subsample are similar on *Gambling* scores, which increase slightly between ages 11 and 14.

3.1 Classes of Missing Data Patterns

Prior to conducting latent class pattern mixture models in the subsample, the best fitting number of latent classes of study participation was determined (Table 5). All fit statistics indicated that patterns of missing data are best summarized using a four-class model. In the full sample, a six-class solution best summarizes missing data patterns.

3.2 Age-Related Trajectories of Predictors

Parameters of estimated trajectories for ALEXSA subscales for the subsample appear in Table 6 and are plotted as solid lines in Figures 2 (internal predictors) and 3 (external predictors). Also appearing in Figures 2 and 3 are dashed lines with hollow markers summarizing trajectories estimated from the full sample. Results for the same risk factor in the full sample and subsample are indicated using the same shaped markers (e.g., *Anger Coping* results appear in the same plot with solid / hollow square markers for the subsample / full sample, respectively). One finding that spans all predictors is that accelerations or decelerations in non-linear change occur between ages 10 and 14.

3.2.1 Internal Predictors—Trajectories of the Disinhibition subscales (*Anger Coping*, *Distractibility*, *Impulsivity*) slightly increase with age. However, the inclines of *Impulsivity* and *Distractibility* are linear whereas slight quadratic growth occurs for *Anger Coping*, leveling off after age 14. The age-related declining average trajectories of the Self Management subscales (*Planning and Concentration*, *Problem Solving*) are highly similar. Sensation Seeking subscales trajectories change more with age than Self Management or Disinhibition. After age 12, increasing trajectories of *Social Disinhibition* and *Thrill Seeking* are nearly parallel; prior to age 12, the incline is steeper for *Social Disinhibition*. The average trajectory of *Depression* is cubic, but nevertheless changes little from age 8 to 16; it declines slightly from age 8 to 14 and thereafter inclines. School Protection subscales trajectories each decline slightly on average from age 8 to 16, with *School Bonding* having a slight quadratic decline that levels out after age 14. Trajectories for *Tolerance of Deviance* and *Safety of Drugs* nearly parallel; with age, the incline of each predictor accelerates. In only one predictor, *Social Disinhibition*, does a marked difference occur between the full sample and subsample.

3.2.2 External Predictors—Trajectories for both family-related subscales suggest slightly increasing risk for behavior problems from age 8 to 16 on average, quadratic for *Parental Monitoring* and linear for *Family Conflict*. Each Social Contagion subscale exhibited quadratic change with age. However, whereas average trajectories for *Peer Pressure Susceptibility* and *Friend Conduct Disorder Criteria* both suggest increasing risk, the overall trend in *Violence Exposure* suggests little change with age. The greatest similarity in average trajectories between predictors occurs between *Alcohol Availability* and *Tobacco Availability*; each has slight quadratic growth beginning at age eight, when intercepts = 0 on average. *Known Tobacco Users* exhibits the steepest incline of all predictors with *Known Alcohol Users* exhibiting the next steepest incline. Only slight differences occur between the full sample and subsample among external predictors trajectories, except for *Known Alcohol Users* and *Known Tobacco Users*. For both predictors, not-as-steep linear growth occurs in the full sample (corresponding to less risk with age).

3.2.3 Correlations between Intercepts and Trajectories—Correlations between intercepts and growth parameters appear in Table 6. For 14 of 22 predictors, at least one such correlation falls in the hypothesized range (0.50–0.75). *Peer Pressure Susceptibility*, *Social Disinhibition*, *Tolerance of Deviance* and *Safety of Drugs* subscales all have correlations greater than 0.75 between intercepts and a trajectory parameter. All four of these predictors putatively measure internal characteristics. Correlations less than 0.50 occur for *Family Conflict*, *Problem Solving*, *School Commitment*, *Impulsivity*, *Thrill Seeking*, *Depression* and *Tobacco Availability*, suggesting large within-person variability over time. Five of these seven predictors with the greatest within-person variability over time putatively measure internal characteristics.

4. Discussion

The natural histories of 22 previously-documented predictors of behavior problems were obtained for youth experiencing chronic stress. Results were consistent with the first hypothesis; unconditional trajectories of all but one predictor, *Violence Exposure*, corresponded to increasing risk on average for behavior problems from ages 8 to 16. Moreover, average trajectories were highly similar among ALEXSA subscales that load onto the same risk domain factor.

Seventeen of 33 correlations fell between 0.50 and 0.75. These results suggested that risk factor measures in late childhood could reasonably predict their trajectories through middle adolescence. Nevertheless, large proportions of within-person variability remained unaccounted for. The range in these correlations was broad, from −0.01 for *School Commitment* to 0.96 for *Peer Pressure Susceptibility* suggesting that considerably different degrees of pliability exist among SUD risk factors. This result implies that growth charts akin to what pediatricians use for height might eventually be developed for risk factors such as susceptibility to peer pressure (those with low pliability). However, due to poor predictability of future trajectories, it would not be possible to develop charts of expected growth for risk factors with high pliability.

Different intervention strategies (e.g., high one-time dosage vs. multiple booster sessions) may thus be more effective among risk factors. To illustrate, large correlations between intercept and trajectories for *Peer Pressure Susceptibility* (consistent with past reports for adolescents; Steinberg and Monahan, 2007) suggest that to lower this risk factor, dosage that is greater than traditional universal programs may be required. Tailored intervention is potentially necessary with high-scoring individuals (e.g., avoidance of placing youth into settings with high-risk peers such as in-school detention; Dishion et al., 1999). If peer

pressure susceptibility can be reduced, beneficial outcomes may be more robust to naturally-occurring (e.g., non-intervention) influences compared to other risk factors. In contrast, results for *School Commitment* imply that school factors and settings can mitigate this risk factor with relatively little effort, but that intervention targeting *School Commitment* may require frequent booster sessions to maintain efficacy.

4.1 Study Limitations

Results should be considered in light of four study limitations. First, an improved sampling design might be to recruit the entire sample at age 8 with annual assessments to age 16. The design herein was chosen because of the greatly reduced expense and logistical constraints (e.g., extensive screening to recruit 1,147 youth experiencing chronic stress, efforts to minimize attrition over an eight-year period). Alternatively, an accelerated-cohort design might better manage participant attrition. Second, stress per se, including individual differences in reaction to stress, was not measured. Results may be clarified by closer examination of the role(s) of stress as a risk factor. Sampling a breadth of chronic stressors offers the advantage of generalizability to the population experiencing chronic stress; however, results may differ as a function of the type of stressor. To begin addressing this limitation, analyses are planned to compare trajectories of the predictors among youth with different sources of chronic stress (e.g., family vs. academic). The third limitation is that subgroups of trajectories likely exist, which also could be identified in follow-up analyses.

A fourth limitation is the need for replication. The subsample and full sample were similar in terms of age, gender, types of parents, sources of chronic stress, race/ethnicity, age-distributions of observations, prevalence of alcohol and tobacco use, conduct disorder criteria, gambling and 19 of 22 predictor trajectories. Even so, differences in trajectories of *Known Alcohol Users*, *Known Tobacco Users* and *Social Disinhibition* implied greater risk for behavior problems in the subsample. Future analyses, including time-varying covariant analyses between predictors and SU, should clarify how much of an increased risk for SU (if any) is associated with the trajectories of these three risk factors. In addition to population generalizability, results should be replicated to test their generalizability from subscale scores that consist of the means of items (current ALEXSA scoring scheme) to sums of items. Use of mean item scores may have fortuitous effects on certain results because of ceiling and floor effects compared to the greater variability in scores afforded by summing items. Future analyses also will clarify the contribution of specific risk factors to liability (and thus to developmental momentum of SUD).

Three specific considerations in the results illustrate the many additional research questions raised by these results. First, an unexpected finding was the similarity between both the trajectories and intercept-parameter correlations of *Tolerance of Deviance* and *Safety of Drugs*. Both subscales gauge a youth's perception of socially-deviant behaviors. Yet to be determined are whether they represent one factor and whether (or for whom) these constructs antedate behavior problems or change as a result of experiencing the behaviors (Ridenour et al., 2011). A second consideration is the need to clarify why youth might rate themselves worse on disinhibition and self-management as they age. Possibilities include: increasing responsibilities and expectations on their self-control, increasingly serious consequences for disinhibition, greater demands on the ability to plan ahead and solve problems, and maturing insight. Third, accelerations in risk factor growth (from age 10 to 14) preceded accelerated behavior problems (age 12 to 14). This apparent forewarning of problem behavior by risk factors ought to be tested directly, for specific age ranges and in light of age of onset of SU.

4.2 Implications for Common Liability

As described in other contributions to this special issue, most of the constructs studied herein forecast multiple behavior problems (Clark et al., 2002). The slopes of nearly all predictors corresponded to increasing liability with age. In fact, based on the results herein, among youth experiencing chronic stress from early to middle adolescence a sizable growth in SU and other behavior problems could be considered normative.

An important next step to this study will be to determine how to best aggregate risk factors to measure overall liability and momentum toward SUD and other behavior problems. In a separate line of research, overall liability has been quantified using *Transmissible* and *Nontransmissible Liability Indexes* by aggregating items from risk factors that best predict SUD outcomes and load onto the same latent trait (Kirisci et al., 2009; Ridenour et al., 2011; Vanyukov et al., 2009). Similar methods could be used with ALEXSA items. Clinically, it also would be useful to be able to identify which factors are most salient for individuals. A well-replicated finding is that a count of risk factors (dichotomized into high vs. low levels) logarithmically predicts future behavior problems in spite of high collinearity (Deater-Deckard et al., 1998; Rutter, 1979). Thus, more extensive and specialized intervention may be needed for persons at greatest risk than can be provided by a universal approach.

4.3 Implications for Developmental Momentum

The result of the collective age-related increase among risk factors suggests growing momentum toward behavior problems with age that has received little direct research (Deater-Deckard et al., 1998; Rutter, 1979). In physics, accumulating forces acting collectively upon an object generates greater physical momentum which requires greater effort to alter that momentum. Analogously, increasing numbers of risk factors biasing development toward behavior problems likely require increased effort (e.g., dosage, prolonged intervention that addresses multiple factors) to meaningfully reduce overall liability, even if the risk factors are collinear. Thus, this study represents an important step toward clarifying the developmental forces acting upon etiology of behavior problems.

Results herein highlight the need to explicate developmental parameters that characterize within-person change in risk factors and how they are altered by prevention programs. Traditional efficacy methods do not epitomize well the range of responses to an intervention (e.g., for tailored approaches; Tarter et al., 1994; Bauer and Curran, 2003). Alternative innovative methods for unveiling within-person change in response to intervention which have received little use in prevention science include idiographic methods (Molenaar et al., 2009) and adaptive designs (Murphy et al., 2007). The results herein support expanding prevention science to include such research.

In sum, the natural histories of 22 predictors of problem behaviors were elucidated in 8- to 16-year-olds experiencing chronic stress. Rates of age-related change and within-person variability differed considerably among predictors. Consistent age-related growth occurred among predictors of the same risk domain. When growth in a predictor accelerated, it began between ages 10 and 14, an apparently a critical period for prevention, especially considering that behavior problems accelerated from ages 12 to 14. The degree of within-person variability also differed considerably among predictors, demonstrating high variability in individual differences, pliability and predictability as well as the need for varied intervention approaches according to what is required to change the targeted risk factor.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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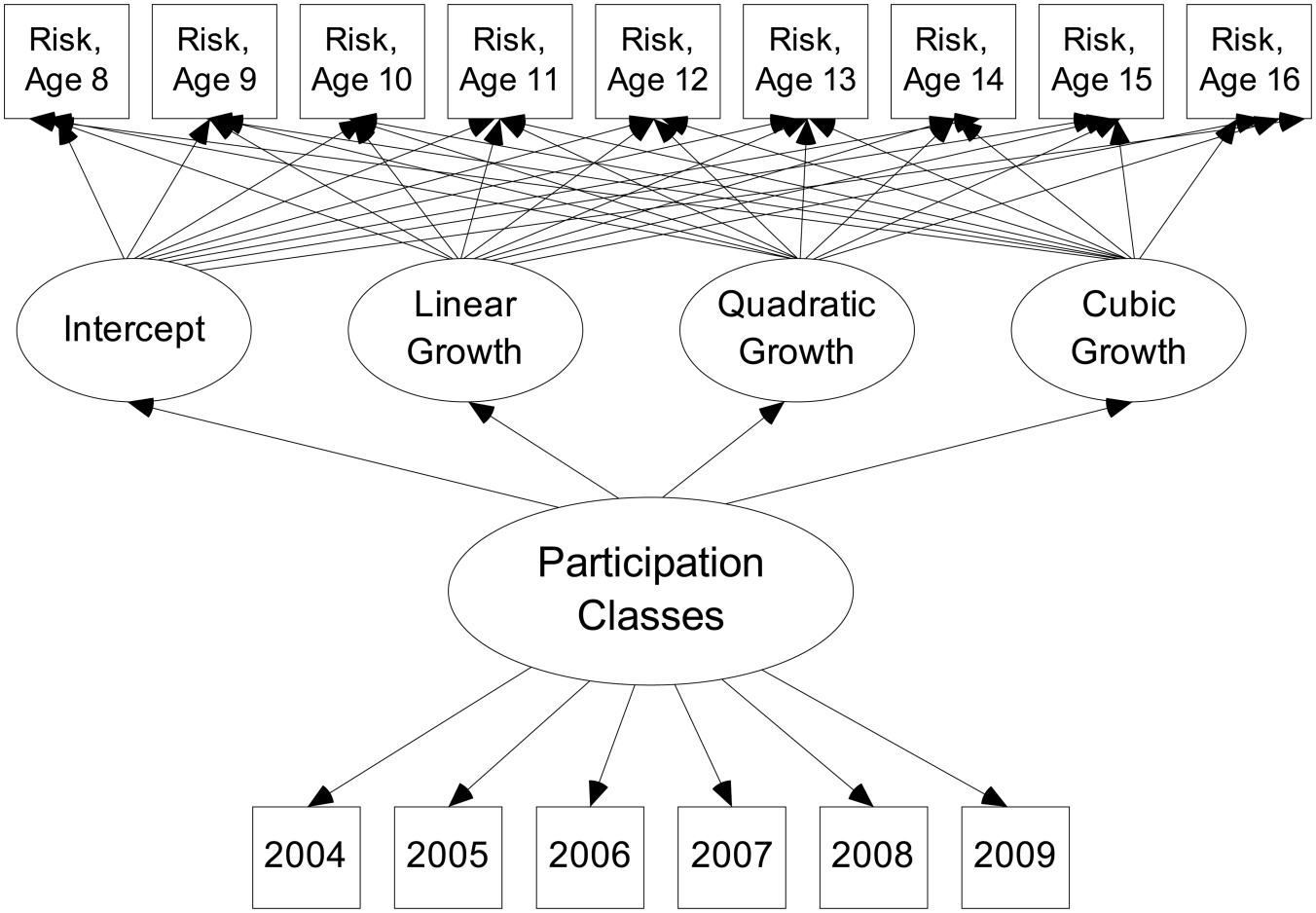

Figure 1.
Latent Class Pattern Mixture Model Used to Estimate Change in Risk Factors with Age
Note: Based on models developed by Morgan-Lopez et al. (2007) and Roy (2003) for data not missing at random (NMAR) in longitudinal studies.

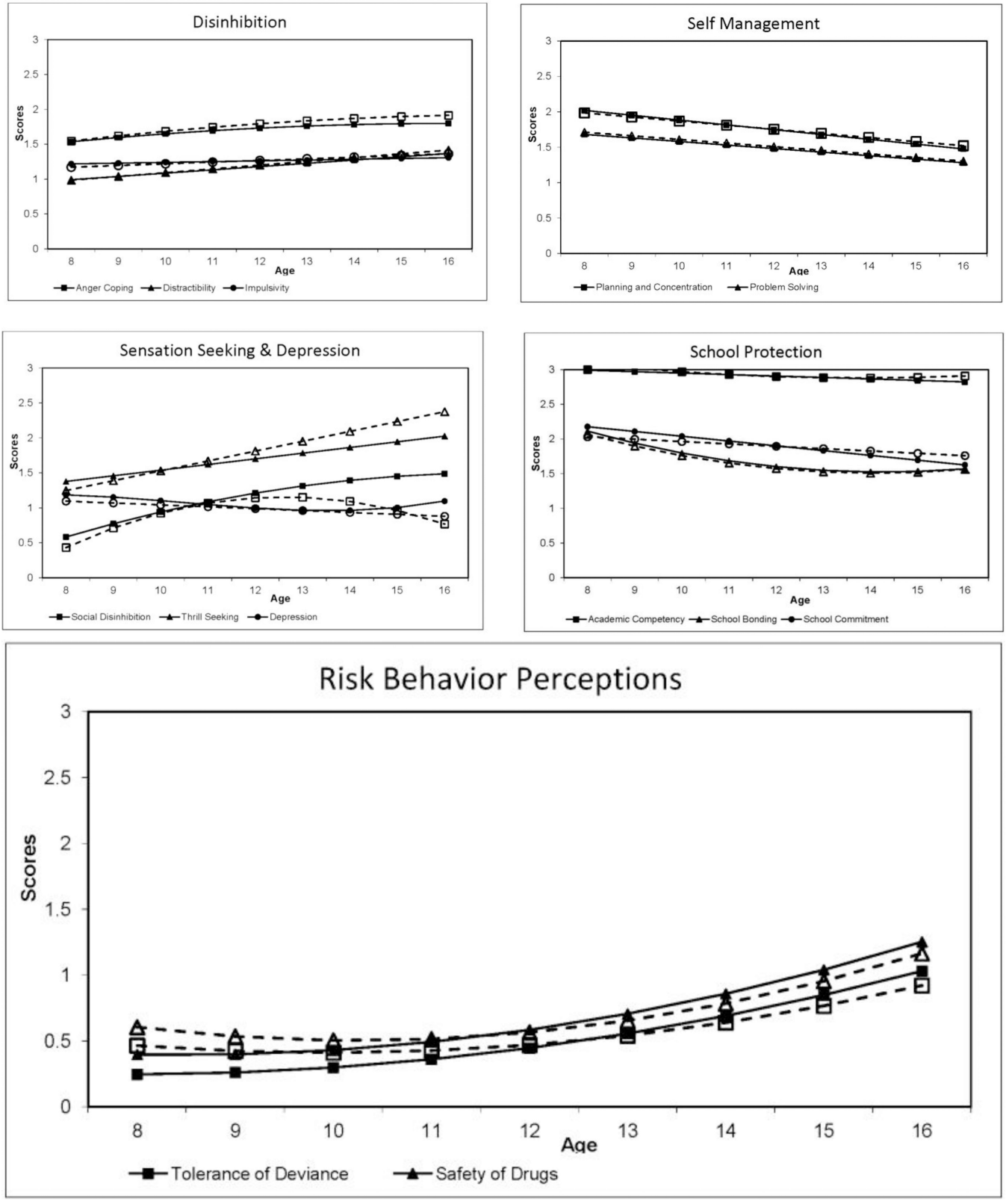

Figure 2.

Trajectories of Predictors of Behavior Problems that are Primarily Internal to Youth
Note: Equation coefficients corresponding to these trajectories appear in Table 6. Solid lines represent results for the subsample having three or more observations (n=330). Corresponding shapes that are hollow and their dashed lines present results for the entire sample (N=1,147).

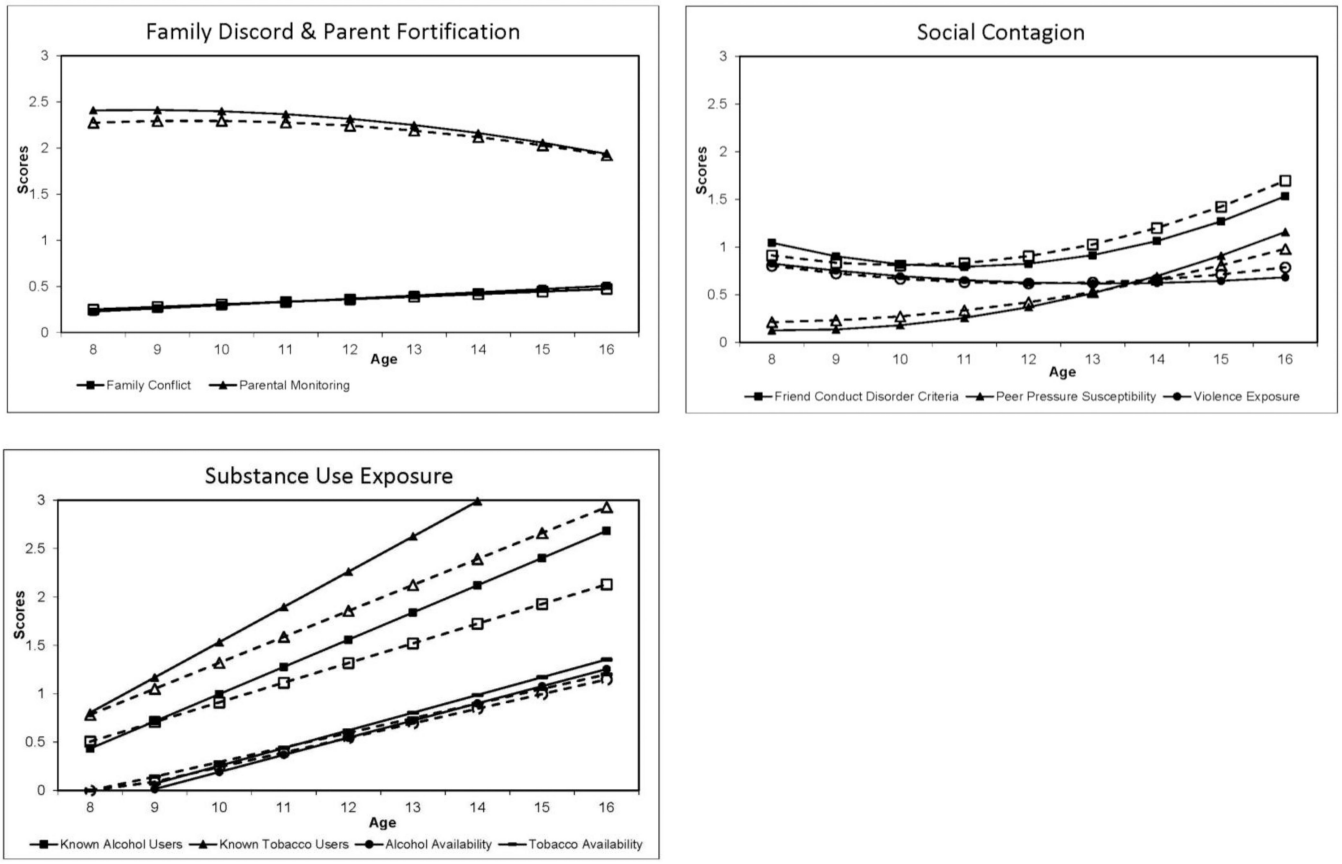

Figure 3.

Trajectories of Predictors of Behavior Problems that are Primarily External to Youth

Note: Equation coefficients corresponding to these trajectories appear in Table 6. Solid lines represent results for the subsample having three or more observations (n=330). Corresponding shapes that are hollow and their dashed lines present results for the entire sample (N=1,147).

Table 1

ALEXSA Subscales: Summary of Reliability and Factor Analyses in 9- to 12-year-old School Students

ALEXSA Subscale	One-week, ICC retest reliability	Factor	Loading	# Items in Full, Current Forms	r bx Full, Current Forms	Description and Key Reference (s)
Family Conflict	0.78	Family Discord	0.72	10, 6	0.92	Dysfunctional tactics used to resolve family disputes (Straus et al., 1998)
Parental Monitoring	0.74	Parent Fortification	0.78	6, 5	0.97	Parental knowledge of youth's behavior when apart (Capaldi et al., 1989)
Friends' Conduct Disorder Criteria	0.82	Social Contagion	0.85	8, 4	0.92	Number of friends exhibiting conduct disorder criteria (Dishion et al., 1999)
Peer Pressure Susceptibility	0.75	Social Contagion	0.74	4, 4	n / a	How much peer requests influence behavior (Loveland-Cherry et al., 1999)
Violence Exposure	0.71	Social Contagion	0.85	8, 4	0.76	Number/types of violence incurred upon respondent (Cooley et al., 1995)
Planning and Concentration	0.66	Self Management	0.88	5, 5	n / a	Ability to focus on completing a single task (Wills et al., 1999)
Problem Solving	0.70	Self Management	0.88	6, 6	n / a	Types of problem solving strategies used (Wills et al., 1999)
Academic Competency	0.76	School Protection	0.67	5, 5	n / a	Perceived competence at academic tasks (Harter et al., 1984)
School Bonding	0.79	School Protection	0.76	4, 4	n / a	Liking of different aspects of school (Catalano et al., 1996)
School Commitment	0.57	School Protection	0.56	2, 2	n / a	Motivation to academic success (Jackson et al., 1997)
Anger Coping	0.58	Disinhibition	0.85	6, 6	n / a	Degree of frustration felt and expressed (Wills et al., 1999)
Distractibility	0.74	Disinhibition	0.80	5, 5	n / a	Distractibility and its impact on functioning (Wills et al., 1999)
Impulsivity	0.60	Disinhibition	0.84	6, 6	n / a	Impulsivity and its impact on functioning (Wills et al., 1999)
Conduct Disorder Criteria	0.69	[outcome measure]	n / a	12, 9	0.95	Conduct disorder criteria experienced (APA, 1994)
Gambling	0.82	Sensation Seeking	0.76	2, 2	n / a	Desire to and experience of gampling (Winters et al., 2000)
Social Disinhibition	0.84	Sensation Seeking	0.82	5, 3	0.92	Disregard of social norms in favor of fun (Russo et al., 1993)
Thrill Seeking	0.83	Sensation Seeking	0.81	7, 5	0.96	Enjoyment of risky or thrilling activities (Russo et al., 1993)
Tolerance of Deviance	0.76	None	n / a	7, 4	0.98	Perceived wrongness of rule-breaking behavior (Loveland-Cherry et al., 1999)
Depression	0.60	[outcome measure]	n / a	13, 11	0.99	Depressed mood (Kovaks, 1980/1981; Radloff, 1991)
Perceived Safety of Drugs	n / a	n / a	n / a	5, 5	n / a	Perceived safety of using substances (Chassin et al., 2002)
Known Alcohol Users	0.65	Alcohol Risk Index	n / a	1, 1	n / a	Number/types of known alcohol users (e.g., parent, peer) (Taylor et al., 2004)
Known Tobacco Users	0.59	Tobacco Risk Index	n / a	1, 1	n / a	Number/types of known tobacco users (Taylor et al, 2004)
Alcohol Availability	0.63	Alcohol Risk Index	n / a	1, 1	n / a	Ease by which alcohol could be obtained (Chassin et al., 2002)
Tobacco Availability	0.58	Tobacco Risk Index	n / a	1, 1	n / a	Ease by which tobacco could be obtained (Chassin et al., 2002)

Note. From Ridenour et al., 2009. ICC = Intraclass correlation coefficient. Factor loadings are reported in their standardized form (e.g., analogous to a correlation coefficient rather than a covariance).

n/a=not applicable.

Table 2

Sample Demographics

	Full Sample	Subsample[A]
Age; mean (SD)	11.2 (1.85)	10.8 (1.65)
Male	49.9%	47.1%
Parents[B]		
Both biological parents	30.5%	30.6%
Biological and step parent	19.4	22.5
Single biological parent	41.5	45.0
Other	8.6	1.9
Sources of Chronic Stress[C]		
Monetary	53.0%	57.9%
Familial	48.0	48.8
Social	44.9	48.5
Academic	40.6	39.4
Emotional	40.3	39.7
Number of Stressors; mean (SD)	2.2 (1.41)	2.3 (1.40)
Race/Ethnicity[B]		
African-American	8.5%	6.1%
Asian	0.5	0.0
European-American	69.3	69.7
Hispanic	2.2	0.4
Native American Indian	0.5	0.0
Mix of races/ethnicities	7.8	13.9
Other	9.1	9.7

Note: Full sample N=1,147.

[A] only participants having three to six observations (n=330).

[B] may not sum to 100% due to rounding error.

[C] categories are not mutually exclusive.

SD=standard deviation.

Table 3

Distributions of Observations

	Full Sample	Subsample*
By Age		
8 years old	86	35
9 years old	203	80
10 years old	356	155
11 years old	437	204
12 years old	503	244
13 years old	407	218
14 years old	291	168
15 years old	193	107
16 years old	60	32
Participants Providing One to Six Observations		
One	341	- -
Two	476	- -
Three	166	166
Four	92	92
Five	55	55
Six	17	17

Note:

* only participants having three to six observations (n=330). Full sample N=1,147.

Table 4

Behavior Problems by Age

Age in Years	Occasions had:		Conduct Disorder Criteria	Gambling
	Alcohol	Tobacco		
8	0.5, 1.2 (0.1, 0.4)	0.4, 1.1 (0.1, 0.3)	1.4, 2.0 (1.1, 1.4)	0.5, 0.6 (0.4, 0.6)
9	0.3, 0.8 (0.3, 0.6)	0.1, 0.3 (0.1, 0.3)	0.8, 1.3 (0.9, 1.3)	0.5, 0.7 (0.4, 0.6)
10	0.2, 0.5 (0.2, 0.6)	0.1, 0.3 (0.1, 0.3)	1.2, 1.7 (1.0, 1.5)	0.6, 0.7 (0.5, 0.7)
11	0.3, 0.7 (0.2, 0.7)	0.2, 0.9 (0.1, 0.6)	1.3, 1.7 (1.3, 1.8)	0.5, 0.6 (0.5, 0.6)
12	0.4, 0.8 (0.3, 0.7)	0.2, 0.8 (0.2, 0.8)	1.8, 1.9 (1.5, 1.7)	0.7, 0.7 (0.6, 0.6)
13	0.6, 1.2 (0.7, 1.3)	0.4, 1.1 (0.4, 1.3)	1.7, 1.9 (1.7, 1.8)	0.7, 0.7 (0.7, 0.7)
14	1.3, 1.6 (1.6, 1.8)	0.9, 1.6 (1.1, 1,8)	2.3, 2.1 (2.3, 2.2)	0.8, 0.7 (0.8, 0.7)
15	1.6, 1.8 (1.9, 2.0)	1.2, 1.9 (1.6, 2.1)	2.5, 2.2 (2.5, 2.2)	1.0, 0.7 (0.9, 0.7)
16	1.2, 1.5 (2.0, 2.1)	1.2, 1.8 (2.0, 2.4)	2.7, 2.4 (2.5, 2.4)	0.9, 0.7 (0.8, 0.7)

Note: Cell entries present means, SDs first for the entire sample (N=1,147), then parenthetically for the subsample having three to six observations (n=330).

Table 5

Fit Statistics of Latent Class Analyses of Missing Data Patterns in the Subsample

Number of Classes	Log likelihood [A]	df	Likelihood ratio χ^2	Akaike's Information Criterion [A]	Bayesian Information Criterion [A]	Entropy
One	−1083.459	57	n / a	2178.918	2182.112	n/a
Two	−833.492	50	499.93[B]	1692.985	1699.905	0.902
Three	−783.991	43	99.02[B]	1607.982	1618.630	0.893
Four	−768.120	36	*31.74[B]	*1590.240	*1604.614	*0.910
Five	−762.376	29	11.49	1592.751	1610.852	0.901
Six	−759.975	22	4.80	1601.951	1623.778	0.907

Note: n=330.

*The best fit to the data for the fit statistic. Likelihood ratio χ^2 tested improve fit to the data compared to having one fewer classes.

[A]Smaller values indicate better fit.

[B]p<0.05. Entropy: a value of 1.0 indicates perfect certainty about class assignment of participants.

Table 6

Risk Factor Trajectories: Subsample with Three or More Observations

ALEXSA Subscale	Coefficients of Age-related Trajectories				Correlations between Intercepts and Trajectory Coefficients		
	Intercept	Linear	Quadratic	Cubic	Linear	Quadratic	Cubic
			Disinhibition				
Anger Coping	1.535	0.065	−0.004		−0.72	0.63	
Distractibility	0.991	0.047			−0.56		
Impulsivity	1.218	0.011			−0.20		
			Self Management				
Planning and Concentration	2.02	−0.068			−0.70		
Problem Solving	1.681	−0.05			−0.43		
			Sensation Seeking				
Social Disinhibition	0.583	0.201	−0.011		−0.81	0.67	
Thrill Seeking	1.377	0.081			−0.13		
			School Protection				
Academic Competency	2.992	−0.021			−0.57		
School Bonding	2.113	−0.188	0.015		−0.71	0.75	
School Commitment	2.177	−0.069			−0.01		
			Family Discord and Parent Fortification				
Family Conflict	0.226	0.035			−0.16		
Parental Monitoring	2.408	0.013	−0.009		−0.71	0.34	
			Social Contagion				
Friend Conduct Disorder Criteria	1.044	−0.171	0.029		−0.50	0.30	
Peer Pressure Susceptibility	0.125	−0.007	0.017		−0.93	0.96	
Violence Exposure	0.826	−0.082	0.008		−0.66	0.42	
			Other				
Tolerance of Deviance	0.246	0.002	0.012		−0.92	0.75	
Safety of Drugs	0.396	−0.013	0.015		−0.86	0.64	
Depression	1.185	−0.019	−0.015	0.002	−0.03	−0.34	0.49
Known Alcohol Users	0.434	0.281			0.67		
Known Tobacco Users	0.804	0.364			0.65		

ALEXSA Subscale	Coefficients of Age-related Trajectories				Correlations between Intercepts and Trajectory Coefficients		
	Intercept	Linear	Quadratic	Cubic	Linear	Quadratic	Cubic
Alcohol Availability	−0.162	0.177			−0.52		
Tobacco Availability	−0.111	0.183			−0.43		

Note: n=330.