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# Developmentally Informed Research on the Effectiveness of Clinical Trials: A Primer for Assessing How Developmental Issues May Influence Treatment Responses Among Adolescents With Alcohol Use Problems

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## ABSTRACT

The goal of this article is to familiarize readers with the adolescent developmental issues and processes most likely to affect responses to treatment for alcohol use problems. Although the need for research that blends developmental science and treatment outcome research is widely acknowledged, scant information exists about developmentally informed approaches to treatment research with alcohol-abusing teens. Exactly how developmental issues may influence treatment responses among adolescents with alcohol use problems remains an open question. In the hope of moving developmentally informed research forward, this article reports findings from a literature review regarding the degree to which developmental issues and processes have been considered in adolescent alcohol treatment research. Moreover, promising concepts and methods from applied developmental science are discussed, as are various developmental processes and transitions that may influence adolescent risk behavior. Finally, guidance is provided regarding how applied developmental science conceptualizations and methods may be incorporated successfully into randomized, clinical trials with adolescents with alcohol use problems.

THE EXTANT EMPIRICAL literature indicates that treatments for adolescent drinking problems (1) can succeed for teens with alcohol and other drug (AOD) use problems, (2) produce outcomes comparable to those found among adults with alcohol use problems, (3) yield varied improvement across different domains of functioning (eg, school performance, emotional distress, and family relationships), and, (4) with the possible exception of outpatient family therapy, do not differ substantially from one another in their likelihood of success.<sup>1-5</sup> Moreover, studies of treatment responses among adolescents with drinking problems indicate that youths with greater substance abuse problem severity at intake are just as likely to reap short-term benefits from treatment as are youths with lesser problem severity.<sup>6-8</sup> However, the literature also indicates that 1 of every 2 teenagers treated for AOD use problems experiences relapse within 3 months after the completion of treatment and two thirds experience relapse within 6 months after the completion of treatment.<sup>6,9,10</sup> Although treatment can be effective for teenagers with AOD use problems, relapse rates remain high, with most treated adolescents returning to AOD use between 3 and 6 months after the completion of treatment.

The limited success of treatments for adolescent drinking problems may be at least partly attributable to a lack of attention to developmental issues that putatively influence treatment responses. Despite growing enthusiasm for developmentally informed investigations of treatment effectiveness, little research has been conducted to date. Although adolescent alcohol abuse treatment experts increasingly are calling for research on how developmental factors may influence treatment responses,<sup>4,11,12</sup> currently we know almost nothing about how developmental issues may influence treatment responses among adolescents with substance use problems. It is important to recognize that relationships between developmental levels and treatment responses are speculative, awaiting direct evaluation in rigorous studies of adolescents undergoing treatment for alcohol use problems.

There are additional compelling reasons for investigating possible associations between developmental levels and treatment responses among alcohol-abusing teenagers. As Ramo et al<sup>13</sup> pointed out, although there may be similarities between adolescents and adults in the personal and environmental factors that influence responses to substance abuse treatment, developmental dynamics determine how and to what extent each of these factors influences the clinical course for substance-abusing youths. Moreover, it is important to recognize that the normative developmental processes and transitions characteristic of adolescence (eg, puberty, individuation, identity formation,

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### Key Words

adolescent, alcohol, development, treatment

### Abbreviations

AOD—alcohol and other drug  
DSM-IV—*Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*

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and entering middle or high school) are quite distinct from those characteristic of adulthood and produce shifting patterns of influence on drinking behavior as a teenager matures.<sup>14,15</sup> Such developmental variables have been shown to affect the patterns of AOD involvement, the prevalence of various problems arising from use, and the means by which teenagers make and maintain behavioral changes.<sup>16</sup> These observations underscore the importance of considering the impact of developmental dynamics on the effectiveness of treatment for teenage drinking problems.<sup>4</sup>

Unfortunately, the treatment of alcohol use problems among adolescents began to take developmental issues into account only recently. During the 1970s and 1980s, most adolescents receiving treatment for problems with alcohol use were treated in programs developed with and designed for adults.<sup>17</sup> During the past 2 decades, a more enlightened and developmentally sensitive approach to treating adolescent alcohol use problems has taken hold in the United States. Adolescents with alcohol use problems currently are viewed as distinctly different from their adult counterparts, and treatment programs increasingly take these differences into account in their design and implementation.<sup>18</sup>

Improved treatment effectiveness means reducing the high relapse rates that have characterized the treatment of adolescent alcohol abuse, and increased developmental sensitivity may be an especially promising avenue toward improving treatment effectiveness. Unfortunately, most experts agree that there remains a shortage of effective, evidence-based interventions to treat AOD use disorders among adolescents.<sup>19</sup> Moreover, despite the growing availability of developmentally informed treatments for adolescent AOD use problems, most adolescent AOD abusers do not receive treatment. Estimates suggest that only 1 of every 10 adolescents with an AOD use problem receives treatment.<sup>20,21</sup> This is especially true for ethnic minority and economically disadvantaged teenagers, who are even less likely than their non-Hispanic white and wealthier counterparts to use available services.<sup>22-24</sup> The fact that most adolescents in need of substance abuse treatment do not receive it has led some clinical researchers to recommend community- and school-based treatment approaches, which have been suggested to be more developmentally congruent than conventional, clinic-based treatments.<sup>25-27</sup>

There is considerable interest in using developmentally informed approaches to conduct treatment research with adolescents with alcohol use problems. Unfortunately, the existing literature offers little in the way of guidance for pursuing such approaches. As Weisz and Hawley<sup>28</sup> pointed out, "developmental research and clinical research with adolescents have traditionally been rather distinct insular enterprises." This has been the case especially for clinical research with AOD-abusing teenagers, which predominantly has relied on models and methods borrowed from the adult substance abuse treatment literature (rather than on models and methods borrowed from the adolescent development literature).

Given the potential benefits from but scant informa-

tion about developmentally informed approaches to treatment research with alcohol-abusing teens, the goal of this article is to familiarize readers with the adolescent developmental issues and processes most likely to affect responses to treatment for alcohol use problems. In addition, concepts and methods from applied developmental science are discussed, with explicit attention to how they may be integrated into research on the effectiveness of treatments for adolescent alcohol use problems. It is hoped that this information will increase interest and enthusiasm among clinical researchers for conducting developmentally informed research on the effectiveness of clinical trials, that is, to take a more direct approach to understanding how developmental issues may inform treatment and influence treatment responses among adolescents with alcohol use problems.

### AGE AND GRADE AS PROXIES FOR DEVELOPMENTAL LEVEL

To gauge the degree to which developmental issues and processes have been considered in adolescent alcohol treatment research, a literature review of recent clinical trials was conducted. Articles were identified through a broad literature search using the PsychInfo and Social Services Abstracts databases from Cambridge Scientific Abstracts. The literature search was conducted by using the key words "adolescen\* or youth or teen\*" and "treatment or intervention" and was restricted to English-language journal articles and chapters published from 1990 through the present. From the identified articles, publications that reported empirical findings from clinical trials (controlled or otherwise) with adolescents with alcohol use problems were selected. From the selected publications, any information on the developmental levels of study participants or analyses that considered developmental levels with respect to treatment effects was gathered. Each study also was examined by keeping in mind the distinct age groups used by the National Institute on Alcohol Abuse and Alcoholism Underage Drinking Initiative to organize the knowledge base about alcohol and development (ie, <10 years of age, 10-15 years of age, and 16-20 years of age).

The results of the literature review were predictably disappointing. In the best of cases, the only information provided on the developmental levels of study participants was the mean, the SD, and the range of ages of participants included in the sample. For example, Kelly et al<sup>29</sup> reported a mean age 16.11 years (SD: 1.16 years) and an age range of 14 to 18 years in a study of post-treatment 12-step program attendance among 99 adolescents completing AOD treatment. On the basis of the mean and SD, the majority of participants (84%) in that study were  $\geq 15$  years of age.

The predominance of older teenagers in the study by Kelly et al<sup>29</sup> is typical of treatment studies with adolescents with drinking problems. For example, Tait et al<sup>30</sup> reported a mean age of 16.7 years (SD: 1.8 years) and an age range of 12 to 19 years in a study of the effectiveness of emergency department AOD abuse intervention among 127 adolescents, with 86% of the participants being  $\geq 15$  years of age. Similarly, Winters et al<sup>8</sup> reported an age range of 12 to 18 years in a study of the effec-

tiveness of Minnesota Model treatment among 179 adolescents, with 60% of the participants being  $\geq 16$  years of age. Therefore, it seems that findings from many, if not most, published studies of adolescent alcohol abuse treatment are derived primarily from the oldest of the National Institute on Alcohol Abuse and Alcoholism Underage Drinking Initiative groups, namely, youths 16 to 20 years of age. Children  $< 15$  years of age constituted only approximately 1 of every 6 participants in those studies, and children  $< 12$  years of age were not included in any of the treatment studies reviewed.

The absence of children  $< 10$  years of age from treatment studies is hardly surprising. Given that the average age at first alcoholic drink among adolescents in the general population in the United States is 15.6 years,<sup>31</sup> it is unlikely that many children  $< 10$  years of age have sufficient experience with alcohol to develop drinking problems. Moreover, children who will and will not demonstrate drinking problems by age 21 do not differ in their alcohol behaviors in the elementary school period, which suggests that problematic drinking trajectories are not discernable until later in adolescence.<sup>32</sup> The scarcity of children 10 to 15 years of age in treatment studies is more surprising and more troublesome, because those who will and will not develop drinking problems begin to demonstrate key behavioral differences in alcohol use patterns in middle school. Alcohol use behaviors associated with the development of drinking problems include (1) progression from being a nonuser to being a current user during the elementary school to middle school transition, (2) current drinking in middle school, and (3) heavy episodic drinking in high school.<sup>32</sup>

Although nearly every study of treatment for adolescent alcohol use problems reported age data, virtually no studies conducted analyses examining how age affects treatment responses. Only 3 published investigations directly examined the association between age and treatment outcomes. Kelly et al<sup>29</sup> reported that "initial univariate analyses" found no relationship ( $P > .16$ ) between age and substance use outcomes. Winters et al<sup>8</sup> compared the drug use frequency outcomes of younger (12–15 years of age) and older (16–18 years of age) teenagers by using  $\chi^2$  analyses and found no significant associations. In a study of pretreatment variables predicting treatment retention among 132 adolescent substance abusers, Blood and Cornwall<sup>33</sup> used  $\chi^2$  analyses and found no significant differences in age between those who did and did not complete treatment. Although these 3 studies suggest that age may bear little relationship to adolescent AOD treatment responses, restriction-of-range issues (ie, the predominance of older adolescents in the study samples) and low statistical power (ie, small samples and insensitive data analyses) might have contributed to an inability to document age-related differences. Moreover, it is important to remember that findings concerning associations between age and treatment responses may not be generalizable to associations between developmental level and treatment responses. At best, chronological age is a crude marker for developmental level, because it is positively associ-

ated but not isomorphic with developmental processes and transitions.

Grade level has also been used to represent developmental level, primarily in school-based studies and typically accompanied by age data.<sup>25,34</sup> For example, Brown et al<sup>25</sup> reported the grade and age distributions of the sample they recruited in their study of school-based intervention with 1249 ninth- through 12th-graders. Both age and grade were predictive of lifetime alcohol involvement at baseline, with older teenagers and those in the upper grades reporting more-extensive use. Grade was somewhat more strongly related to lifetime alcohol experience than was age ( $P < .0001$  vs  $P = .001$ ), which suggests that grade may be a better proxy for developmental level than is age. Finally, as is typical of adolescent alcohol treatment studies, neither age nor grade was examined as a predictor of responses to intervention.

In summary, adolescent alcohol treatment studies routinely collect and report age data but only very rarely examine these data as predictors of treatment responses. The 3 studies that did examine the association between age and treatment responses found no relationship. However, those studies, like the vast majority of adolescent alcohol treatment studies, had predominantly older samples (ie,  $> 80\%$  of participants were  $\geq 15$  years of age). Finally, although both age and grade have been used as proxies for developmental level in school-based studies, grade may be a better proxy than age in such situations. It is important to recognize that developmentalists have noted that an inherent risk in relying on developmental demarcations such as grade is that they can lead to a failure to assess core issues of continuity and change in developmental processes.<sup>35</sup> Moreover, age is probably a better proxy for developmental level than is grade in samples with large proportions of dropouts or students who have been held back.

#### DEVELOPMENTALLY APPROPRIATE OUTCOMES

Many predictors and most outcomes of interest in the treatment of adolescent alcohol use problems demonstrate developmental variation. By using hierarchical linear modeling and latent growth curve modeling techniques, Schulenberg and Maggs<sup>36</sup> demonstrated that susceptibility to peer pressure to misbehave, exposure to peer alcohol use and misuse, and personal alcohol misuse increased generally linearly across adolescence. In addition, predictors and outcomes described by Schulenberg and Maggs<sup>36</sup> covaried positively within and across time, which suggests a mutually reinforcing web of influence among these variables. On the basis of those findings, the researchers suggested that an important goal of intervention efforts should be altering the web of influence, such that trajectories of risk are disengaged from the trajectories of targeted behaviors. The main point here is that developmental levels influence patterns of risk, patterns of alcohol use, and interactions between patterns of risk and alcohol use.

Brown<sup>16</sup> provided an excellent review of issues associated with the measurement of adolescent AOD treatment outcomes. She noted that developmentally sensi-

tive research requires the use of (1) psychometrically sound measures of predictors, processes, and outcomes and (2) assessment procedures appropriate to the developmental stage of participants. Although measurement strategies and techniques for assessing outcomes of alcohol treatment among adults have been well specified, relatively few measurement strategies and techniques for assessing outcomes among adolescents have been articulated. With respect to developmentally sensitive assessment procedures, Brown<sup>16</sup> recommended a somewhat informal and nonacademic style of questioning, given the strong likelihood of academic or interpersonal problems among teenagers undergoing school-based treatment for alcohol use problems. Moreover, she pointed out that, although self-reports of substance use by adolescents have been shown to be reliable, multiple contextual, personal, and substance-related factors can compromise the veracity of such reports. To combat these sources of potential compromise, Brown<sup>16</sup> advocated using either single instruments incorporating convergent formats of inquiry about alcohol involvement or multiple instruments using different formats.

In an attempt to understand better what constitutes developmentally appropriate outcomes for adolescents with alcohol use problems, Hays and Ellickson<sup>37</sup> recruited 10 experts on adolescent and adult alcohol use to provide opinions about different indicators of alcohol misuse (Table 1). Experts were asked to rate 3 different quantity-frequency criteria, 8 different high-risk drinking criteria (eg, binge drinking and driving after drinking), and 9 different negative-consequences criteria (eg, missed school or work and physical fighting), as well as to judge the appropriateness of these criteria for different ages. Results demonstrated considerable variability in opinions. Exact agreement was rare (levels of agreement

ranged from 19% to 90%), although there was generally good consensus about indicators representing high-risk drinking (mean agreement: 55.5%; range: 43%–74%) and negative consequences of alcohol use (mean agreement: 59.3%; range: 30%–90%). In contrast, there was poor consensus about quantity-frequency indicators (mean agreement: 23%; range: 19%–26%). Finally, there was agreement that cutoff points for distinguishing alcohol use from misuse should vary according to the age of the drinker, with higher cutoff points for older adolescents.

The findings of Hays and Ellickson<sup>37</sup> revealed that estimating adolescent alcohol misuse is far from an exact science, with considerable disagreement even among experts about what constitutes developmentally appropriate measurement. Remarkably, the greatest disagreement was for quantity-frequency indicators, which typically are the primary outcomes reported in adolescent alcohol treatment studies. Moreover, the findings of those investigators clearly and not surprisingly supported the use of age-graded cutoff criteria. It is worth noting that not a single adolescent alcohol treatment study in the literature used age-graded alcohol misuse diagnostic or outcome criteria. As observed by Hays and Ellickson,<sup>37</sup> their findings underscore the importance of future research concerning developmentally appropriate estimation of adolescent alcohol use problems.

Although the predominant outcomes reported in the adolescent alcohol treatment literature have been quantity-frequency indicators, other outcomes also have been used, including (1) categorical outcomes derived from quantity-frequency measures (eg, abstainers, minor lapsers, and relapsers), (2) categorical outcomes derived from a combination of quantity-frequency information and diagnostic criteria (eg, abstainers, current drinkers, alcohol abuse according to *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* [DSM-IV] criteria, and alcohol dependent according to DSM-IV criteria), (3) harm-reduction outcomes (eg, change from hazardous to nonhazardous alcohol use or reduction in drinks per drinking occasion), (4) specific high-risk drinking behaviors (eg, binge drinking), (5) scales measuring negative consequences of drinking (eg, Rutgers Alcohol Problem Index or the Problem Severity Index from the Drug Use Severity Inventory), (6) psychological correlates of alcohol use problems (eg, craving), and (7) health risk behaviors associated with alcohol misuse (eg, motor vehicle accidents, other drug use, or unprotected sex).<sup>8,30,34,38–42</sup>

Although each of these indicators has considerable face validity and is likely to be correlated significantly and positively with the other indicators, the extent to which each of these indicators is a developmentally appropriate representation of adolescent alcohol use problems remains unknown. With the exception of scales measuring negative consequences of drinking, which tend to emphasize developmentally relevant events such as “trouble at school” or “made excuses to your parents about your alcohol use,” the conventional outcomes used in alcohol treatment research with adolescents are derived directly from those used in alcohol treatment

**TABLE 1** Indicators of Adolescent Alcohol Misuse Evaluated by Hays and Ellickson<sup>37</sup>

Frequency and quantity
Frequency in past year
Frequency in past 30 d
Quantity
High-risk drinking
Binge drinking
High or intoxicated
Alcohol with downers
Alcohol with uppers
Alcohol with marijuana
Drink before/during school
Drunk in public place
Drove after drinking
Negative consequences
Missed school or work
Felt sorry for
Felt sick
Physical fight
Trouble at school
Trouble concentrating
Was arrested
Passed out
Accident after drinking

research with adults. For example, many studies have measured adolescent alcohol misuse by using the adult-derived DSM-IV criteria.<sup>43</sup> However, there is considerable debate about the fundamental appropriateness of the DSM-IV criteria for estimating alcohol use problems among youths.<sup>44-47</sup> Limitations of the DSM-IV criteria include a lack of knowledge about the overall validity of the diagnostic criteria for adolescents, the fact that several DSM-IV symptoms are atypical for adolescents with substance use problems (eg, withdrawal and substance-related medical problems), the fact that some symptoms have low specificity in distinguishing adolescents with and without substance use problems (eg, tolerance to the effects of alcohol), and the fact that some symptoms tend to occur only in particular subgroups of teenagers (eg, hazardous use and legal problems appear primarily among older male adolescents with conduct disorders).<sup>46</sup> In addition, the DSM-IV criteria do not take into consideration the quantity or frequency of alcohol consumption, which introduces the possibility that a teenager could be heavily involved with alcohol but not qualify for a diagnosis of alcohol abuse or dependence.

Divergence in experts' opinions about what constitutes developmentally appropriate measurement of alcohol use problems has led to the use of different indicators of treatment responses across studies. The use of different indicators by different investigators makes comparison of treatment effects difficult. In fact, seemingly comparable studies purporting to use the same outcome measure often differ substantially from one another. For example, both Winters et al<sup>8</sup> and Gil et al<sup>48</sup> reported alcohol use frequency outcomes. Winters et al<sup>8</sup> assessed frequency by using a 7-point Likert scale ranging from never to  $\geq 40$  times and a recall period of 12 months. In contrast, Gil et al<sup>48</sup> assessed frequency by using the timeline followback method<sup>49,50</sup> and a recall period of 30 days. Such disparities reflect fundamental differences across studies in the measurement of adolescent alcohol treatment outcomes and highlight the need for greater specification of developmentally appropriate measures of adolescent alcohol use.

The clinical appropriateness of drinking measures also deserves comment. Stout<sup>51</sup> conducted in-depth analyses of Project MATCH data to determine empirically meaningful definitions of adult drinking behavior. Drinking episodes were defined as beginning with the consumption of  $\geq 1$  standard drink on 1 day and ending on a day of drinking followed by  $\geq 1$  day of abstinence. Not surprisingly, Stout<sup>51</sup> found that the majority of Project MATCH participants drank again after completing treatment for alcohol use problems. Even among those who achieved 60 successive days of abstinence, one half of the participants drank again within 60 to 120 days, and one half returned to heavy drinking within 3 to 7 months. Moreover, 1 day without drinking had little prognostic significance; periods of 2 to 13 successive days without drinking were associated with incremental increases in treatment gains, and a period of 14 successive days without drinking was the threshold for maximal treatment gains. On the basis of these findings, Stout<sup>51</sup> suggested that a more empirically and socially meaning-

ful definition of drinking episodes is as follows: a period of time beginning with the consumption of  $\geq 1$  standard drink on 1 day and ending on a day of drinking followed by  $\geq 14$  days of abstinence. Although the findings reported by Stout<sup>51</sup> may not be generalizable to adolescent alcohol treatment populations, given age-related differences in drinking patterns, they provide a starting point for future research on empirically meaningful definitions of adolescent drinking behavior.

In summary, there is no doubt that developmental levels influence patterns of alcohol use. As noted by Chassin et al,<sup>15</sup> there is an overall age-related trajectory of early adolescent AOD use onset, late adolescent escalation in use, and adult decline in use; this general trajectory has led some researchers to consider substance abuse and dependence as developmental disorders.<sup>52,53</sup> Unfortunately, developmentally sensitive measurement strategies and techniques for assessing adolescent alcohol use behaviors are poorly specified. Experts in adolescent alcohol use problems disagree about what constitutes developmentally appropriate measurement of outcomes, especially in the case of quantity-frequency indicators, which are the most commonly used outcome variables in adolescent alcohol treatment studies. Other outcomes also have been reported (eg, negative consequences and high-risk drinking behaviors); however, the developmental appropriateness of these outcomes is currently unknown, and the use of different outcomes in different investigations makes comparisons of findings difficult. Finally, the empirical meaningfulness of conventional definitions of adult drinking episodes is questionable. Although the science of estimating adult drinking problems is much further evolved than the science of estimating adolescent drinking problems, even adult estimation methods remain imperfect.

#### **SUGGESTED VARIABLES AND METHODS FOR DEVELOPMENTALLY INFORMED RESEARCH ON THE EFFECTIVENESS OF CLINICAL TRIALS**

It is widely recognized that adolescents with alcohol use problems are a heterogeneous group, with individual differences in factors including the anticipated effects and consequences of substance use, the context and motivations of use, and the risk factors that contribute to or accompany AOD use.<sup>54</sup> These differences may help explain why certain substance-abusing adolescents may be more or less amenable and responsive to treatment and why many (perhaps most) teens who participate in AOD treatment experience relapse within 6 months after treatment completion. To date, very few studies have examined the different amenability of adolescents to various treatments. As knowledge develops about amenability to treatment factors in relation to substance abuse treatment, algorithms may be created to match teenagers with drinking problems to the specific treatment programs or program components with the greatest chance of success.

An intriguing putative factor regarding amenability to treatment is developmental level. As recognized by the National Institute on Alcohol Abuse and Alcoholism Undergraduate Drinking Initiative, the age/grade/developmental

stage of adolescents undergoing treatment for alcohol use problems may be an important predictor of responses to treatment. However, developmental level is rarely examined as a moderator variable in intervention studies, and developmental issues are rarely included in the design and evaluation of adolescent treatments.<sup>55</sup> Therefore, we do not know whether or when development-treatment interactions may occur when teenagers are being treated for alcohol use problems. The limited and separate frameworks in which developmental research and treatment research are conducted hamper the emergence of developmentally informed studies of the impact of adolescent alcohol abuse treatments. Advances in the fields of applied developmental science and developmental psychopathology have provided a rich array of concepts and terms for explaining adolescent phenomena<sup>56,57</sup>; however, adolescent alcohol abuse treatment research has been slow to incorporate developmental principles.<sup>58</sup>

When clinical trials of adolescent alcohol abuse treatment are longitudinal and include indices of developmental levels and variables that are developmentally relevant to adolescents, knowledge regarding the impact of developmental levels on treatment responses can progress.<sup>55</sup> To date, a wide variety of developmental processes and transitions have been proposed as potential moderators of adolescent alcohol treatment responses<sup>16</sup>; however, research concerning development-treatment interactions is scant. Only 3 studies to date have reported analyses of the impact of developmental level on adolescent alcohol treatment responses, and those reports were limited to tangential analyses concerning associations between age (which is related to but not isomorphic with developmental level) and drinking outcomes. Perhaps not surprisingly, those studies found no relationship between age and treatment responses.<sup>8,29,33</sup>

As argued above, adolescent alcohol treatment research needs to take a more direct approach to understanding how developmental issues may influence treatment responses among adolescents with alcohol use problems for the field to progress. To this end, Table 2 presents a list of the various developmental processes and transitions that have been proffered in the literature as putative influences on adolescent behavior including alcohol use. Although it is not exhaustive, the list is rather long and reflects both the burgeoning interest in and the great potential of examining developmental influences on treatment responses. Most of the developmental constructs included in the list have been shown to be associated positively with adolescent alcohol involvement, albeit modestly and in some cases equivocally. Moreover, none of these developmental constructs has been examined as a potential influence on responses to treatment for adolescent alcohol use problems. In the hope of stimulating research interest, a few of the more-promising developmental constructs are described briefly below.

Regarding puberty, AOD use has been found to be more prevalent in early-maturing boys and girls, whereas on-time or late maturation has been found to be unrelated to substance use.<sup>59</sup> For example, Dick et al<sup>60</sup>

**TABLE 2** Developmental Processes and Transitions That May Affect Responses to Treatment for Adolescent Alcohol Use Problems

Developmental Domain	Developmental Construct
Biological	Menarche, pubertal status, pubertal timing
	Hormonal changes
	Physical appearance and size
	Maturation of prefrontal cortex/limbic system
Psychological	Individuation
	Identity formation
	Problem-solving
	Self-regulation
	Executive mental functions
	Autonomy
	Ego development
	Negative affect
	Positive affect
	Cognitive capacity
	Moral reasoning
Social	Perspective taking
	Intimacy and heterosexual involvement
	Peer influences
	Parent-child influences and parental control
	Sibling influences
	Interpersonal negotiation and social problem-solving
	Gender roles
	Media and information sources
Transitions	Role transitions (role selection and role socialization)
	Elementary school to middle school
	Middle school to high school
	Getting a driver's license
	Getting a job outside the home
	Loss of virginity

found that early menarche was associated with earlier initiation and greater frequency of adolescent drinking. However, Susman and Rogol<sup>59</sup> pointed out that, in regard to complex behaviors such as substance use, the variance accounted for by pubertal status or pubertal timing, although statistically significant, is small. They noted that puberty is an integrated biological and social construct related to biological changes such as secondary sexual characteristics, the adolescent growth spurt, and hormonal shifts, as well as psychosocial changes such as family conflict, depression, and aggressiveness. Furthermore, contexts (eg, family, peers, and neighborhood) seem to moderate the linkages among pubertal status, psychological processes, and behaviors, which demonstrate reciprocal interactions and bidirectionality in their relationships with one another.

The maturation of the prefrontal cortex/limbic system and its manifestation in psychological changes, including self-regulation, executive mental functions, and cognitive capacity, represent another developmental process that may influence responses to treatment for alcohol use problems. As observed by Keating,<sup>61</sup> a major cognitive shift that occurs during adolescence is the attainment of a more fully conscious, self-directed, self-regulating mind. This shift seems to be directly related to changes in the prefrontal cortex, specifically its roles as

an integrator of cognitive functions and a regulator of emotion, attention, and behavior. Keating<sup>61</sup> also indicated that individual differences in the integration of cognition, emotion, and behavior may influence the development of psychopathological conditions, presumably including substance use problems. Support for this contention is found in neuropsychological and functional MRI studies of adolescent substance abusers, which found that heavy alcohol use, and especially heavy alcohol use combined with heavy marijuana use, is associated with neurocognitive and brain response deficits.<sup>62-66</sup> Currently, it is not clear whether these deficits are antecedents or consequences of adolescent AOD use, and it is not known how such deficits may affect responses to treatment.

Changes in social functioning are another hallmark of adolescent development that may influence responses to treatment for alcohol use problems. As Brown<sup>67</sup> described, the adolescent peer context grows increasingly influential, complex, and multilayered as adolescents mature. These changes in the peer system are intertwined with normative processes of individual development, with the peer system growing with the individual. Regarding adolescent AOD use, a robust and well-replicated research finding is a strong association between peer use and adolescent substance use.<sup>15</sup> In addition, peer use seems to be an important predictor of adolescent substance abusers' posttreatment relapse; Brown et al<sup>10</sup> found that 90% of adolescent relapses occurred in the presence of other people and were related to direct and indirect social pressure to use. The mechanisms of association between adolescent and peer substance use remain questionable, with plausible explanations including peer selection, peer influence, or a false-consensus effect.<sup>15</sup> On a more general level, Brown<sup>67</sup> nicely captured the inherent complexity of studying the adolescent peer context by noting that its essential components include (1) characteristics of the individual, (2) characteristics of the relationship partners (eg, ages, attitudes, and behaviors of friends), (3) characteristics of the relationships (eg, intimacy, support, trust, conflict, and stability), and (4) relationship dynamics (eg, power dynamics and conflict resolution styles).

Changes in social functioning that may affect treatment responses also include changes in relationships with parents. Across the adolescent years, interactions with parents increasingly are based on conversation, negotiation, and joint decision-making, rather than on parents' unilateral control of behavior.<sup>20</sup> These shifts are accompanied by decreases in subjective rankings of child-parent closeness and objective measures of child-parent interdependence. A large body of empirical literature has documented strong associations between adolescent substance use and parenting variables such as parenting style, family climate, parent-adolescent relationships, and parents' specific socialization regarding the use of substances.<sup>15</sup> Currently, it is not known how developmental changes in relationships with parents may affect responses to treatment, directly or indirectly.

Major developmental transitions unique to adolescence may affect responses to treatment for alcohol use

problems as well. For example, it is interesting to speculate about the linkage between alcohol use and the developmental transitions to middle school and to high school (including the complex set of changes in academic and social contexts that accompany these transitions), given that the typical onset of alcohol use is between seventh grade and 10th grade.<sup>15</sup> Eccles<sup>68</sup> noted that understanding the impact of schools and school transitions on adolescent development requires a conceptual framework that considers simultaneously schools as contexts in which development takes place and the changing developmental needs of students as they move through the school system. Research to date has not examined how school transitions affect responses to alcohol treatment, although it is remarkable that the modal age of adolescents in treatment for AOD use problems (16 years) corresponds to the age at which most adolescents begin high school. The transition to working outside the home seems to be another adolescent change that affects AOD use.<sup>69</sup> Several studies have demonstrated that the number of work hours during adolescence is associated positively with substance use, particularly the use of alcohol and cigarettes, especially when involvement in employment comes to predominate over involvement in school-related and other activities. As is the case with school transitions, research has not examined how the transition to work may affect adolescents' responses to treatment for AOD problems.

As the preceding paragraphs illustrate, it must be recognized that many of the developmental constructs listed in Table 2 are interrelated and this interrelation reflects the complex, multivariate, causal connections that characterize relationships between developmental level and adolescent risk behaviors such as alcohol misuse. For example, hormonal changes produce increased physical size and significant pubertal development, which are accompanied by an acceleration of negative affect, which can lead to increases in parent-adolescent conflicts, which may exacerbate adolescent alcohol use problems and ultimately decrease responses to treatment.<sup>38</sup> A second example is individuation, which involves developmental transitions in social and intimate relationships, self-image, problem-solving, and self-regulation, all of which may contribute interdependently to alcohol use involvement and responses to alcohol treatment among teenagers.<sup>14</sup> Exactly how these groups of developmental variables interact with one another and which of these variables are more or less important in influencing adolescent alcohol treatment outcomes are not known.

It should be acknowledged that advocating for developmentally informed research is much simpler than actually conducting developmentally informed research. Although a full account of how to incorporate concepts and methods from developmental psychology and developmental psychopathology into adolescent alcohol treatment research is beyond the scope of this article, interested readers are referred to the reports by Cicchetti and Rogosch<sup>56</sup> and Lerner and Steinberg.<sup>57</sup> It is worthwhile to consider briefly how state-of-the-science approaches in applied developmental science might be incorporated into randomized, clinical trials with adolescents.



The developmental systems orientation described by Lerner<sup>70</sup> has become a fundamental perspective guiding theory and research in applied developmental science.<sup>71</sup> The developmental systems orientation has 3 key assumptions. First, it recognizes that individuals are embedded in multiple interrelated contexts (eg, family, school, peers, community, and culture). These contexts are interdependent, and involvement in these contexts shapes adolescent experience and behavior. Second, there are reciprocal interactions and bidirectionality in relationships between the individual and the contexts of which he or she is a part. Adolescents both influence and are influenced by people and events across different contexts. Third, adolescents are active contributors to their development, bringing a variety of personal characteristics, understandings, desires, and needs to bear on their interactions with the environment. From the developmental systems perspective, adolescent developmental trajectories, including those involving AOD use, are viewed as being determined by changing relationships between developing adolescents and their changing and interdependent contexts.

Schulenberg<sup>72</sup> provided a good review of research approaches examining how adolescent developmental context variables may operate to set the stage for risk behaviors such as alcohol use. He noted that developmental contexts are multilevel, that is, adolescents are embedded in several primary contexts (eg, the family), which in turn are embedded in larger-scale, social, cultural, technological, political, and economic contexts, and these multiple contexts interact with each another. These developmental contexts also interact with individual characteristics (eg, self-regulation), and the interactions (as well as the developmental contexts and the individual characteristics themselves) demonstrate both continuities and discontinuities as a person matures. Moreover, contexts and individuals are thought to interact in a dynamic manner, such that predictors (eg, proportion of peers engaged in alcohol use) and outcomes (eg, an adolescent's own alcohol use) influence one another reciprocally over time. Exogenous characteristics (assumed causes) are often consequences of endogenous characteristics (assumed effects), and what may be considered superficially as cause-effect connections instead represent the ongoing interplay of the variables under consideration. As a result, causal direction is sometimes flipped. Schulenberg<sup>72</sup> also noted that specific developmental context factors can lead to a variety of outcomes (multifinality) and different developmental context factors can lead to the same set of outcomes (equifinality). Finally, he pointed out that risk behaviors such as alcohol use tend to build on themselves, with earlier risk behaviors portending and contributing to subsequent risk behaviors.

Schulenberg<sup>72</sup> noted that multilevel modeling analyses are required to account for such complexity and activeness in development. Outcomes need to be considered in terms of trajectories across multiple waves (ie,  $\geq 3$  waves of data) in growth mixture modeling analyses, which permit consideration of how multiple behaviors interact over time and individual similarities and differ-

ences in intraindividual changes. Although longitudinal research is essential for understanding how individual characteristics, contextual characteristics, and risk behaviors interact, Schulenberg<sup>72</sup> pointed out that this type of developmental research is necessarily correlational or quasiexperimental, because it is unethical, infeasible, or scientifically undesirable to conduct true experiments in which individuals are assigned to specific developmental contexts or individual risk factors. Although longitudinal research using growth mixture modeling analyses is not without its limitations (eg, preexisting difference and selection effects, third variable influences, and nonrandom attrition across waves of data collection), it is the best available approach to understanding how changes in context are related to changing person-context interactions and individual risk behavior trajectories and outcomes.

The foregoing paragraphs reflect the conceptual and practical complexities inherent in current research in applied developmental science. Many alcohol treatment researchers, including those specializing in adolescent treatments, are unaccustomed to thinking in such terms. Randomized, clinical trials of treatments for alcohol use problems are true experiments and, despite typically collecting  $\geq 3$  waves of data (ie, pretreatment, posttreatment, and follow-up data), do not routinely examine how individual characteristics, contextual characteristics, and alcohol outcomes develop and interact over time. Although they are somewhat daunting, research methods such as that described by Schulenberg<sup>72</sup> are key to understanding how developmental issues may influence treatment responses among adolescents with alcohol use problems. At present, integration and creativity in attempts to incorporate applied developmental science methods in studies of the effectiveness of treatments for adolescent alcohol use problems are sorely needed.

#### **EXISTING DEVELOPMENTAL MODELS OF ADOLESCENT ADDICTION**

Several developmental models of the causes of adolescent alcohol use problems have been proposed. Although they do not address directly how developmental levels may affect treatment responses, these models might provide insights regarding how developmental processes and transitions might influence alcohol treatment outcomes. For example, Schulenberg et al<sup>41</sup> proposed that excessive substance use during adolescence should be viewed as a sign of inadequate coping with developmental tasks. From the perspective of those researchers, inadequate coping is a manifestation of personality, and personality and environment interact in determining adolescent AOD use.

A different perspective was offered by Hampson et al,<sup>73</sup> who hypothesized that alcohol-related risk taking can be explained by a combination of risk perceptions, personality and values, and age. Research on this model suggests that personality variables and values are distal predictors of alcohol-related risk behavior and are associated with alcohol-related risk through the proximal predictor of risk perceptions. Another model of interest

is the developmental psychosocial model described by Baer and Bray,<sup>14</sup> which views developmental processes, including individuation, identity formation, mastery, intimacy, and autonomy, as key elements in the shifting patterns of influences on drinking behavior across the adolescent years.

The developmental social information processing model described by Brown and colleagues<sup>74,75</sup> posits that cognitive and emotional states influence youth drinking behavior within a social context. This model incorporates distal factors (eg, biological risk and cultural experiences) and core proximal circumstances (eg, alcohol availability and motivational state) in predicting adolescent drinking problems.<sup>25</sup> A final model is the multivariate developmental model of adolescent alcohol use problems described by Windle,<sup>76</sup> which emphasizes social influences (ie, parents, siblings, and peers) as proximal predictors of adolescent alcohol involvement. These proximal influences work in concert with more-distal influences (eg, biogenetic dispositional factors and temperamental characteristics) to determine alcohol behaviors. Windle<sup>76</sup> also incorporated aspects of the affect regulation model of alcohol use, which focuses on stress, negative affect, and mood regulation as determinants of alcohol involvement.

Finally, Graber<sup>35</sup> described 3 contrasting types of models of how developmental transitions and challenges may result in psychopathological conditions. Although the emphasis is on internalizing problems, these models also may apply to drinking problems. Models of cumulative and simultaneous events posit that, when individuals experience major life events or transitions (eg, school change or pubertal changes), either in close sequence (cumulatively) or simultaneously, they are more likely to demonstrate negative behavioral outcomes resulting from the confluence of events. In contrast, accentuation models posit that developmental transitions accentuate existing problems; it is the interaction of previous problems with the transitions that predicts who will experience a worsening of problems during adolescence. Finally, heightened sensitivity models posit that biological systems may be more sensitive to environmental or contextual influences during times of rapid changes; differential sensitivity models take this a step further by suggesting that there may be preexisting characteristics that increase sensitivity to developmental transitions and challenges.

Several developmental models of the causes of adolescent alcohol use problems have been described in the literature. Ranging from models emphasizing coping deficits, risk perceptions, or socialization processes to comprehensive multivariate models including both proximal and distal predictors from a variety of domains, they offer suggestions regarding how developmental processes might influence alcohol treatment outcomes. In addition, contrasting models originally designed to explain the impact of developmental transitions on adolescent internalizing disorders may be equally relevant to adolescent substance use problems. However, none of the models described above has ever been incorporated

into a study examining the effectiveness of treatments for adolescent alcohol use problems.

## CONCLUSIONS

We currently know that treatment can be effective for teenagers with alcohol use problems. However, relapse rates remain high, with most treated adolescents returning to AOD use within 6 months after the completion of treatment. Attention to developmental variables may help improve the effectiveness of adolescent alcohol treatment. Research studies conducted with community samples have found that developmental variables affect the patterns of AOD involvement, the prevalence of various problems arising from use, the means by which teenagers make and maintain behavioral changes, patterns of risk for alcohol use problems, and interactions between patterns of risk and teenage alcohol use. Moreover, several developmental models of the causes of adolescent alcohol use problems have been proposed. Unfortunately, none of these developmental variables or models has ever been incorporated into a study examining the effectiveness of treatments for adolescent alcohol use problems.

Clinical research with AOD-abusing teenagers has been constrained by a reliance on models and methods borrowed from the adult substance abuse treatment literature. Research that incorporates developmental science perspectives holds vast promise for improving the developmental congruence (and hence the success) of treatments for adolescent drinking problems. Unfortunately, such research is scant, in part because developmentally sensitive measurement strategies and techniques for assessing adolescent alcohol use behaviors remain poorly specified, in part because clinical researchers are unfamiliar with developmental science perspectives, and in part because of the conceptual and practical complexity inherent in developmental research. Regardless of its sources, this paucity of developmentally informed research on the effectiveness of clinical trials has kept the field ignorant regarding whether and when development-treatment interactions may occur in adolescent alcohol treatment.

This article provides a review of the developmental issues, processes, models, and methods that should be considered in attempts to understand the impact of developmental variations on responses to treatment for adolescent alcohol use problems. My intent was to inspire clinical researchers to begin to take a more-direct approach to understanding how attention to developmental issues may inform treatment and influence treatment responses among adolescents with alcohol use problems. Only when clinical trials of adolescent alcohol treatments are longitudinal and include indices of developmental levels and developmentally relevant variables can knowledge about the impact of developmental levels on treatment responses progress.

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**Developmentally Informed Research on the Effectiveness of Clinical Trials: A Primer for Assessing How Developmental Issues May Influence Treatment Responses Among Adolescents With Alcohol Use Problems**

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