Published in final edited form as:
Psychol Addict Behav. 2007 September ; 21(3): 373–386.

Substance Use Risk Across Three Generations: The Roles of Parent Discipline Practices and Inhibitory Control

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Abstract

This study used three generations and 21 years of prospective data to test models of intergenerational transmission of substance *use* and substance use risk. Thus, the study extends prior studies in the field that have focused predominantly on substance abuse. The association between the grandparental generation's (G1 mother and father) and the parental generation's (G2 father) alcohol use and illicit drug use was hypothesized to be mediated by G2's poor inhibitory control. Additionally, G1's poor discipline of G2 was hypothesized to be directly associated with the G2's substance use as well as partially mediate the association between G1's substance use and G2's inhibitory control. In turn, G2's substance use in late adolescence was expected to be associated with their offspring's (G3) poor inhibitory control at age 3 years. Findings partially supported the predictions and varied by substance. For alcohol use, only cross-generational associations in use were found. For illicit drugs, both poor inhibitory control and poor discipline played some mediational role in cross-generational use.

Keywords

substance use; intergenerational transmission; inhibitory control; parenting; temperament

Substance abuse disorders, particularly alcohol dependence and abuse, are among the most commonly occurring psychiatric disorders in the general population (Kessler et al., 1994) and are often co-morbid with other forms of psychopathology. Substance abuse also appears to be highly transmissible from one generation to the next. Additionally, there appear to be genetic influences on substance use in general (Kendler, Aggen, Tambs, & Reichborn-Kjennerud, 2006;Young, , Soo, Stallings, Corley, & Hewitt, 2006). From a prevention standpoint, it is desirable to identify not only cross-generational associations in risk but the mechanisms by which such associations occur. Predominant conceptual models regarding the development of substance use would suggest that multiple mechanisms are likely to operate. The life-span developmental approach emphasizes the interplay between characteristics of the individual and key social environments within contextual milieu (e.g. Hetherington & Baltes, 1988;Magnusson & Torestad, 1993;Patterson, Reid, & Dishion, 1992). In the case of substance use, both individual factors, such as temperamental risk factors (e.g., Giancola, Martin, Tarter, Pelham, & Moss, 1996;Iacono, Carlson, Taylor, Elkins, & McGue, 1999), and social interaction processes, in particular poor parental discipline (e.g., Bronte-Tinkew, Moore, &

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Support for the Three Generational Study was provided by Grant DA 051485 from the Division of Epidemiology, Services and Prevention Branch, National Institute on Drug Abuse (NIDA), and Cognitive, Social, and Affective Development, National Institute of Child Health and Human Development (NICHD), National Institutes of Health (NIH), U.S. Public Health Service (PHS). Additional support was provided by Grant MH 37940 from the Psychosocial Stress and Related Disorders, Division of Pediatric Translational and Treatment Development, National Institute of Mental Health (NIMH), U.S. PHS; and Grant HD 46364 from the Cognitive, Social and Affective Development, NICHD, and Division of Epidemiology, Services and Prevention Branch, NIDA, NIH, U.S. PHS.

Carrano, 2006;Dishion, Capaldi, & Yoerger, 1999;Walker-Barnes & Mason, 2004), have been implicated in the transmission across generations.

The current paper examines multiple hypothesized mechanisms of the intergenerational transmission of substance use (versus disorder). We posited that substance use in one generation is likely to have an effect on the next generation, both through its influence on temperamental risk (i.e., poor inhibitory control) and through its influence on parenting processes (i.e., poor discipline). Additionally, given that environmental effects, such as social interaction processes may shape the expression of temperamental characteristics, such as inhibitory control (e.g., Bates, Pettit, Dodge, & Ridge, 1998;Goldsmith, Buss, & Lemery, 1997) over time, we posited that the effects of poor parenting practices on the next generation's substance use may be at least partially mediated through effects on inhibitory control. Hypotheses were tested across three generations of the Oregon Youth Study (OYS) sample. This sample includes men (Generation 2, G2) who were selected to participate in the study at ages 9–10 years because they lived in neighborhoods with an elevated prevalence of delinquency, and it also includes the men's parents (Generation 1, G1) and the men's offspring (Generation 3, G3).

As described below, one of the primary aims of this study is to examine the intergenerational transmission of substance use. However, most of the research to date on the intergenerational transmission of the use of substances has focused on the transmission of substance abuse and dependence. Thus, our review of the past literature necessarily focuses on many of these studies. The terms *abuse* and *dependence* will be used to specify research on those clinical disorders, whereas the term "use" will be utilized to delineate the more general use of substances.

Inhibitory Control and the Transmission of Substance Use

As noted above, substance abuse appears to be highly transmissible. There is a threefold risk for alcohol abuse and a two-fold risk for substance abuse among relatives of alcoholics versus control participants with no familial history of alcoholism (Merikangas, 2002). Genetics almost certainly play a role in the transmission of substance abuse as well as the transmission of *use* (e.g., Young et al., 2006). A number of candidate genes have been identified that may be implicated in the transmission of alcoholism and the abuse of other substances (e.g., Comings, Muhleman, Wu, & MacMurray, 2000;Xu et al., 2004). However, in the absence of knowledge of an individual's genotype, it may be possible to identify temperamental traits that represent intermediate steps between genetic risk and the phenotypic expression of a behavior or disorder (Gottesman & Gould, 2003). In the case of substance use disorders, inhibitory control appears to be one such trait.

Inhibitory control refers to the ability to inhibit one's impulses and response tendencies and is a component of higher order mental functions known as the executive functions. Impairments in executive functioning, in general, and inhibitory control, in particular, as well as problems with self-regulation, impulsivity, and behavioral undercontrol (constructs that involve the lack of inhibitory control), have been documented in adults and adolescents with substance use problems (Finn, Sharkansky, Brandt, & Turcotte, 2000;Giancola et al., 1996;Martin, Lynch, Pollock, & Clark, 2000). Clearly, individuals with substance use problems have difficulty inhibiting their consumption of substances even in the face of negative consequences. Although such problems may be exacerbated by substance use, deficits in executive function and inhibitory control appear to precede substance use problems, particularly in cases of early onset substance use (Deckel & Hesselbrock, 1996;Nigg et al., 2004;Tarter et al., 2003).

Deficits in inhibitory control also appear to be a potential pathway in the intergenerational transmission of substance use and abuse. In a twin study, Slutske et al. (2002) demonstrated

that the genetic diathesis for alcohol dependence is at least partially mediated through the trait of behavioral undercontrol that accounted for about 40% of the genetic variation in the risk for alcohol dependence. Recent work has shown that sons of male alcoholics evidence difficulties with inhibitory control, in particular, and executive functioning, in general (e.g., Giancola et al., 1996;Iacono et al., 1999). Examining trajectories of substance use over time, Chassin, Flora, and King (2004) found that adolescent impulsivity predicted patterns of heavy alcohol and drug consumption from adolescence through young adulthood (ages 27–30 years) and that impulsivity partially mediated the effect of parental alcoholism on group membership.

Most of the research examining inhibitory control in the offspring of substance abusers has focused on older children (i.e., age 10 years and above). However, the precursors to later substance use and abuse may appear as early as the preschool years. In one of the few studies of preschool-aged sons of alcoholic fathers, Fitzgerald et al. (1993) demonstrated that these children showed greater impulsivity on a delay of gratification task requiring inhibition of a prepotent motor response than did the sons of nonalcoholic men. More recently, Eiden, Edwards, and Leonard (2004) examined effortful control (a construct including inhibitory control as well as attentional processes) in 2- and 3-year-old sons and daughters of alcoholic men. Sons of alcoholic men had significantly lower scores on effortful control, and poor effortful control was predicted by the father's alcoholism.

Parenting and the Intergenerational Transmission of Substance Use

When parents use or abuse substances, their discipline skills are likely to suffer. Parents' substance use and dependence have been linked to poorer monitoring of their children (Chassin, Pillow, Curran, Molina, & Barrera, 1993;Dishion et al., 1999); poorer control of their children's behaviors (Kandel, 1990); and poorer quality of interactions with their children in terms of lower engagement, positivity, and synchrony (Brook, Whiteman, Balka, & Cohen, 2001;Eiden, Chavez, & Leonard, 1999;Jacob, Haber, Leonard, & Rushe, 2000;Whipple, Fitzgerald, & Zucker, 1995). Additionally, parents' substance use and abuse predicts their use of ineffective discipline strategies, such as coercive control, and poor implementation of discipline strategies, such as failure to follow through on the use of consequences (Fals-Stewart, Kelley, Fincham, Golden, & Logsdon, 2004;Kandel, 1990;Tarter, Blackson, Martin, Loeber, & Moss, 1993).

As might be expected, parents who cannot effectively manage their children's behavior and who resort to harsh discipline practices are likely to have adolescents who use substances at higher rates (Bronte-Tinkew et al., 2006;Walker-Barnes & Mason, 2004). For instance, Bronte-Tinkew et al. demonstrated that fathers who were authoritarian (i.e., strict and not supportive) had children who engaged in substance use at earlier ages than their peers. Walker-Barnes and Mason found that higher levels of psychological control (reflecting the use of coercive parenting techniques) predicted higher levels of substance use by ninth graders.

Parenting as a Mediator in the Intergenerational Transmission of Substance Use

As noted above, over recent years a good deal of evidence has accumulated suggesting that lack of inhibitory control is a potential pathway through which risk for substance abuse is transmitted from one generation to the next. Parental substance abuse, as well as high rates of or illicit use, is likely to have direct effects on inhibitory control as parents who cannot inhibit their impulses (and thus their substance use) are likely to pass the characteristic on to their offspring. However, although some temperamental traits, including effortful control, appear to have genetic underpinnings, they are also influenced by environment (Goldsmith et al., 1997), and their expression may be modified over time by proximal social interaction processes, such as parenting (Bates et al., 1998). From a prevention perspective, it is important to uncover potential processes affecting the expression of temperamental traits over the course

of development. Given that these social interaction processes may be more easily observable, they could become targets of preventive interventions.

Poor parental discipline skills may be particularly detrimental to the development of inhibitory control in children. Children's behavioral control is regulated externally in infancy and gradually becomes internalized over the course of development (Kochanska, Murray, & Harlan, 2000;Olson, Bates, & Bayles, 1990). Parents are key facilitators in this process, helping the child to learn to regulate his or her own impulses and behavior. Thus, ideally, when disciplining a child, a parent not only would control the child's immediate behavior but also would teach the child why a given behavior might be unacceptable and provide the child with alternative behaviors. This is the basis for what is known as authoritative parenting, in which the parent promotes not only behavioral control but also autonomy on the part of the child (Baumrind, 1967). Given such parenting, the child should come to internalize not only the ability to control his or her behavior but also various appropriate behavioral alternatives.

Conversely, if parents either utilize ineffective discipline skills or utilize effective skills inconsistently, they are unlikely to be able to control the child's behavior. Consequently, the child may internalize those poor controls with resulting poor inhibitory control. Similarly, if parents utilize disciplinary practices that emphasize external control over the child behavior (e.g., corporal punishment, yelling, or punitive techniques that do not involve reasoning with the child), the child may also fail to internalize mechanisms for self-regulation (Repetti, Taylor, & Seeman, 2002). In support of these predictions, inconsistency in parental discipline (Lengua, Wolchik, Sandler, & West, 2000) and parental use of power assertive strategies (Zhou, Eisenberg, Wang, & Reiser, 2004) have been linked to difficulties with impulsivity or poor effortful control. Conversely, maternal nonpunitive behavior between the ages of 13 and 24 months predicts better child inhibitory control at age 8 years (Olson, Bates, Sandy, & Schilling, 2002).

In sum, substance use by parents may foster poor discipline practices that, in turn, are detrimental to the development of inhibitory control. Thus, one would expect that in addition to a direct path from parental substance use to inhibitory control reflecting shared genetic vulnerability, there would also be an indirect path between parental substance use and offspring inhibitory control through quality of parental discipline, thus representing at least partial mediation. In support of this, Eiden et al. (2004) demonstrated that paternal warmth mediated the association between paternal alcoholism and effortful control in sons, suggesting that substance dependence may indeed impact offspring's inhibitory control through its effect on parenting. Patock-Peckham and Morgan-Lopez (2006) found that permissive parenting on the part of the same gender parent negatively affected impulse control, which in turn predicted greater alcohol use and alcohol problems in college students. No one has yet, to our knowledge, examined the potential mediating effects of parent discipline practices on the association between parental substance *use* and offspring inhibitory control. If such a link could be shown, then mechanisms would be more clearly established, and discipline practices could be a potential point of intervention in interrupting the intergenerational transmission of substance use.

Overview of the Current Study

The hypothesized pathways in Figure 1 were tested using structural path modeling. For the conceptual model, substance use overall is shown, but in the model tests, alcohol and illicit drug use were examined in separate models. As depicted, we expected that the frequency of G1's substance use when their sons were ages 9 to 12 years would be negatively associated with G2's inhibitory control at ages 14 to 16 years. Additionally, we hypothesized that G1's substance use would be positively associated with poor discipline practices when their sons were ages 13 to14 years. Poor discipline practices were indexed by the parents' use of harsh

discipline, ineffective techniques, and poor implementation. In turn, we expected that G1's poor discipline practices would contribute to higher G2 substance use and G2 inhibitory control. Finally, the youth's inhibitory control was expected to be negatively associated with his substance use at ages 16 to 18 years.

We expected to see many of the same effects in the third generation. We posited that G2's adolescent substance use would be positively associated with his use of poor disciplinary practices when his children were age 21 months. In turn, G2's use of poor discipline was expected to be positively associated with G3's low inhibitory control as early as age 3 years. Finally, because inhibitory control is presumed to be a trait, and thus at least partially genetically transmitted, we hypothesized that G2's inhibitory control would be directly positively associated with the same trait in G3.

The current study expands upon previous research in a number of ways. First, prior studies in the area have focused on the intergenerational transmission of substance use disorders. This is understandable, given that substance use disorders demonstrate the greatest heritability, followed by substance dependence, and lastly by use in both adults and adolescents (Merikangas, 2002). However, recent twin studies have demonstrated that *substance use* does have a heritable component (Kendler et al., 2006;Young et al., 2006), and there are a number of reasons why the study of the transmission of substance use may be valuable. First, there are large numbers of users of illicit drugs and heavy users of alcohol without diagnoses of substance abuse or dependence problems (Substance Abuse and Mental Health Services Administration, 2005). This substance use alone has grave effects for individuals and society in terms of health, unemployment, and crime (Bray, Zarkin, Dennis, & French, 2000;Miller, 2003). Given the high costs of substance use in general, the markers of risk seem worthy of exploration.

Additionally, reliance on diagnoses to determine study groups may exclude individuals who do not meet full criteria for a diagnosis but who nonetheless evidence significant features of a disorder. For example, in a study of differing pathways of criminal offending over a period of 10 years, Wiesner and Capaldi (2003) found that 40% of men who were classified as chronic high offenders, and thus were engaging in a significant level of crime, did not receive a diagnosis of antisocial personality disorder. Thus, diagnoses may be less sensitive to patterns of symptoms, particularly when data are being used to examine long-term outcomes. In studies of the transmission of substance use, the focus only on individuals who have been diagnosed with substance use disorders may exclude people who, although not diagnosed, nonetheless show significant difficulties with substance use that are likely to be transmitted to the next generation. Finally, from a prevention perspective, it would be useful to explore the transmission of risk for substance use in general, because, if substance use and substance dependence shared some markers of risk, then efforts to prevent both types of problems could have some similar foci. Given the reasons listed above, this study focused on the transmission of the *use* of alcohol and that of marijuana and other illicit drugs versus dependence on any one category of substance.

This study also builds upon past studies by examining the effects of combined mother and father substance use both on their own discipline skills and on their sons' inhibitory control and adolescent substance use. Past studies have tended to focus on the substance use of only one parent, generally the father. Additionally, mechanisms of transmission of risk for different classes of substances, specifically alcohol and illicit drugs (i.e., marijuana and other drugs), are explored. (It would have been desirable to examine effects for marijuana and those for other illicit drugs separately, but rates of illicit drug usage were too small to allow for this; thus marijuana and other drugs were combined.) Past research into the transmission of substance use through the trait of inhibitory control has largely tended to focus on the transmission of alcohol dependence and abuse. Young et al. (2006) examined the transmission of use of

different classes of substances and found that there appeared to be one underlying genetic component for tobacco, alcohol, and marijuana use. However, as few other studies have explored the associations of inhibitory control and parenting in the transmission of use of different classes of substances, we did not make differential predictions for the different substances in this study.

Finally, one of the greatest strengths of the current study is its wealth of longitudinal data. Cross-sectional and short-term longitudinal studies often examine characteristics such as inhibitory control in offspring during late adolescence or early adulthood when any deficits might be attributable to damage from established patterns of drug use (Nigg et al., 2004). In the current study, inhibitory control was measured at ages 14 to 16 years in the G2 youths, a time period when differences in risk variables may be well established, but before these differences could be viewed as the effects of prolonged substance use (Nigg et al.).

Method

Participants

Analyses were conducted using prospective data from three generations of the OYS and the Three Generational Study (3GS) a ongoing study of the children of the OYS G2 men. The sample of G1 and G2 participants was originally recruited for the OYS, a 20-year long study of the development of antisocial behavior and substance use. All fourth-grade boys attending schools in higher juvenile crime areas of a medium-sized metropolitan region in the Pacific Northwest were eligible for the study, as were their parents. A sample of 206 boys was recruited to participate in OYS (a 74% recruitment rate). The 3GS study is an ongoing study of the children of the OYS G2 men. Children are assessed at ages 21 months and 3, 5, 7, 10, and 12 years. The 3GS focuses on the biological offspring of the G2 men. Because of financial and practical considerations, only the first two children of the G2 man and any given biological mother are eligible to participate.[1] For the study reported here, data from the 21-month (3GS Year 1) and 3-year assessments (3GS Year 2) were used.

By 2006, 130 of the original 206 OYS men had fathered 261 biological children. Of these, 180 G3 children fathered by 104 G2 men had participated in either the 3GS Year 1 or Year 2 assessments. Reasons for missing data for the 81 children who did not participate in either assessment included the father having lost contact with the child (36%), the child still being too young for the assessment at the time of the study reported here (35%), the child being too old for the assessment at the inception of 3GS (16%), refusal to participate in the study (9%), the child's ineligibility to participate because they were a third child (2%), and the death of the child (2%). Of the 180 G3 children who had participated in 3GS, 2 were missing data on G1 at OYS Time 1 and were therefore removed from the analysis. This resulted in a final sample for analysis of 178 G3 cases, representing 103 G2 men. At the 3GS Year 1 assessment, the G3 children had a mean age of 21 months (*SD* = 3.4 months) and at the 3GS Year 2 assessment, a mean of 39 months (*SD* = 3.5 months). Forty-six of the children (44.7%) had no siblings in the analyses, whereas 40 (38.8%) had one sibling, 16 (15.5%) had two siblings, and one (1%) had three siblings in the analyses. At the time that the children completed the 3GS Year 2, the G2 fathers were an average age of 27 years (*SD* = 2.5 years; range = 21 to 31 years), and the mothers' average age was 25 years (*SD* = 3.7 years; range = 17 to 41 years).

For G1, only the biological parents of the G2 men were included in the study. This resulted in a sample of 141 biological parents (95 mothers, 46 fathers), representing the 103 families of the G2 men. The G1 mothers in the study had a mean age of 33 years (*SD* = 4; range = 24 to

[1]At the inception of the study, all of the biological offspring of a G2 father were assessed. This was later changed because of practical and financial considerations. Thus, in some cases, children had more than one sibling in the study.

50) and the G1 fathers a mean age of 37 years (*SD* = 7; range = 27 to 57) at the start of the OYS. The sample reflected the ethnic and socioeconomic composition of the region at the time; 90% of G1 and G2 OYS participants were Euro-American and the majority was lower- and working-class families (Hollingshead, 1975). Eighty percent of the G3 offspring were Euro-American.

Procedures

G1 and G2 samples—Multimethod, multiagent assessments of the G2 youth and their parents were conducted yearly starting at Grade 4 (at approximately ages 9 to 10 years). Assessments included structured interviews and questionnaires for both the young men and their parents. Interviewers also completed ratings of the participants' behaviors. To assess school adjustment, achievement test scores and school records were collected, and teachers completed questionnaires.

G3 sample—The 3GS Year 1 (age 21 months) and 3GS Year 2 (age 3 years) assessments included structured laboratory tasks with the parents and children (not used in the current study) as well as parent-completed questionnaires and interviews over the course of several visits for each assessment age. The first visit was conducted with the mother; a second, separate assessment was conducted with the father within 2 weeks.

Measures

Constructs—The current study used multiple indicators from multiple agents to build theoretical constructs measuring outcomes and variables of interest as described by Patterson and Bank (1986). In building constructs, the two criteria specified by Patterson and Bank were used: (a) items included in the scale had to show acceptable internal consistency (i.e., an alpha of .60 or higher and an item-total correlation of .20, $p < .05$) and (b) a scale had to converge with other indicators designed to assess the same construct (i.e., the factor loading for a one-factor solution had to be .30 or higher). To form the constructs described below, scales were created from instruments containing relevant items. Scales that met the above reliability criteria were standardized and then aggregated by computing the mean to form a construct score. Some scales with alphas below .60 were used if their component items appeared to have face validity and to maintain similarity in constructs across years or generations.

The data presented in the current study were taken from Years 1 through 9 of the OYS and Years 1 and 2 of the 3GS. Selections of the assessment years included in the current study were made on the basis of theoretical considerations regarding developmental process. In addition, reliability was a consideration. For example, as substance use shows episodic patterns in general, data from two assessment time points were used to measure substance use.

G1 substance use during G2's late childhood—Substance use for G1 was assessed via 12 self-report questionnaire items at OYS Year 1 (G2 ages 9 to 10 years) and 13 each of self- and spouse-report items in OYS Year 3 (G2 ages 11 to 12 years). Questions included reports on frequency of alcohol, marijuana, and drug use, and alcohol use volume (e.g., "When drinking, how often do you have three or four drinks?"). For the majority of questions, parents were asked how often they used the different substances "in general." They were also asked about alcohol volume when they drank. At OYS Year 3, an item measuring consequences of alcohol use (e.g., "Do you become argumentative when drinking?") was added. In OYS Year 1, only self-report scales were available. Scales were first formed by substance (alcohol, marijuana, and other drugs). Alcohol use was examined separately, whereas marijuana and other illicit drug use were combined for analysis. Alcohol use in Year 1 was calculated as the mean of the frequency and volume indicators for mother ($r = .53$, $p < .01$), and father ($r = .66$,

$p < .01$). Marijuana use was measured by one item, and other drug use was represented by a scale of seven items (mother alpha = .64, father alpha = .80).

In OYS Year 3, much the same process was used, with the exception that spouse reports on the other's substance use were available. Thus, the mean of self- and spouse reports was taken to form mother and father scales for each substance type (correlations between reporters ranged from .53 to .82). Alcohol was measured as the mean of three indicators within reporter (frequency, volume, and consequences), and alphas ranged from .69 for mother self-report to . 79 for father self-report. Spouse and self-report of alcohol use were significantly correlated for mother ($r = .78$) and father ($r = .82$) at the .05 significance level. Marijuana use was measured using one self- and spouse-report item, and other drug use was once again measured using a seven-item scale (alpha's ranged from .67 to .85).

The mother and father alcohol scores were first combined within time (OYS Year 1 $r = .53$, $p < .01$ and OYS Year 3 $r = .65$, $p < .01$). The mean of the two time points ($r = .67$, $p < .01$) was taken to represent G1 alcohol use. Marijuana was taken as the mean of mother and father scores within OYS Year 1 ($r = .44$, $p < .01$) and OYS Year 3 ($r = .62$, $p < .01$). Similarly, the mean of mother and father other drug use was taken within OYS Year 1 ($r = .60$, $p < .01$) and OYS Year 3 ($r = .73$, $p < .01$). The mean of OYS Year 1 and OYS Year 3 marijuana use was then computed ($r = .71$), as was done for the other drug use scales ($r = .56$, $p < .01$). Finally, the marijuana use and other drug use composites were combined ($r = .51$, $p < .01$) to represent G1 illicit substance use.[2]

G1 discipline of G2 in early adolescence—Items from the OYS Year 5 (G2 ages 13 to 14 years) parent interview formed two subscales for both the G1 mother's and father's discipline of their G2 son. Poor Discipline Implementation was formed using five items (e.g., "How often does your son get away with things that you feel should have been punished?"; mother alpha = .67, father alpha = .60). Five items assessed the Poor Results of Discipline (e.g., "How often are you confident you can change your child's behavior?"; mother alpha = .84, father alpha = .81). A third scale including four items from the Conflict Tactics Scale (Straus, 1979) was completed by G2 and served as the indicator of G1's harsh discipline of G2 (e.g., "When having an argument, how often in the past year did your parent push or shove you?"; mother alpha = .77, father alpha = .68). For each G1 parent, a Poor Discipline Scale was created consisting of the Poor Discipline Implementation, Poor Discipline Results, and Harsh Discipline Scales. Though the standardized alphas for the scales were a bit low (.44 for mothers and .57 for fathers), the component scales and items were deemed to be face valid. The G1 mother and father poor discipline constructs were significantly correlated ($r = .54$, $p < .05$); thus, they were averaged to form the G1 poor discipline construct.

G2 inhibitory control in midadolescence—Inhibitory control was measured using parent and teacher report on the Child Behavior Checklist (CBCL; Achenbach & Edelbrock, 1983) at OYS Year 6 (ages 14 to 15 years) and OYS Year 7 (ages 15 to16 years). Nine items from the CBCL were used: Can't sit still; cries a lot; impulsive or acts without thinking; bites fingernails; nervous movements or twitching; picks nose, skin, or other body parts; repeats certain acts over and over; sudden changes in mood; and temper tantrums. Separate mother, father, and teacher scales were formed for OYS Years 6 and 7. The scales showed good

[2]Although it would be interesting to examine transmission separately for G1 mothers and G1 fathers, the sample size of each (95 and 46, respectively) was too small, thus significantly reducing power in models examining individual effects of each parent. To ensure there were no unique effects by parent, submodels were tested using latent variables (as indicated by separate G1 mother and G1 father scores) as predictors. After the path from the latent mother and father effects to various outcomes were entered, additional paths from specific mother and father indicators were tested for significance. In no case were the pathways from specific mother and father indicators significant in the presence of the path from the latent parent factor. Thus, to conserve power and more completely measure G1 effects, mother and father indicators were combined as detailed in the measures descriptions.

reliability within reporters (for mothers, standardized alphas = .71 and .73 in OYS Years 6 and 7, respectively; for fathers alphas = .71 and .69; for teachers, alphas = .70 and .71). Scales were averaged across reporting agents within OYS Year 6 (alpha = .76) and OYS Year 7 (alpha = .69). The inhibitory control scales at OYS Years 6 and 7 were strongly correlated ($r = .68$, $p < .05$), thus scores were averaged to form the G2 inhibitory control construct. Higher scores represent better inhibitory control.

G2 substance use in late adolescence—G2's substance use was measured using self- and parent reports from OYS Year 8 (G2 ages 16 to17 years) and OYS Year 9 (G2 ages 17 to 18 years). In a structured interview, the G2 youths were asked to report on their use of alcohol, marijuana, and other drugs in the past year. Alcohol and marijuana use were each formed from subscales measuring frequency, volume (e.g., "When using marijuana, how much do you usually use?"), and patterns of use (e.g., "Have you ever passed out from drinking?"). Other drug use was measured by frequency of use, as well as number of different substances tried in the previous year. As was done with the G1 substance use construct, scales were first computed separately for each substance. The two indicators comprising the other drug use measure were correlated .79 and .63 in OYS Years 8 and 9, respectively, whereas scale alphas for alcohol and marijuana use ranged from .91 to .92 across the 2 years.

The G1 parents reported via questionnaire about the frequency of the G2 youth's use of each class of substances (alcohol, marijuana, and other drug use), as well as whether the parent had ever seen the youth use each type of substance (for other drugs, parents were asked how many different types of drugs the youth had used). Within each substance type in each year, the mother and father reports were well correlated (r's ranged from .49 to .88); thus, the mean of parent reports was taken to form scales for each substance class. Youth and parent reports of alcohol were moderately correlated ($r = .52$, $p < .01$ at OYS Year 8; $r = .43$, $p < .01$ at OYS Year 9). The dual agent indicators for alcohol from OYS Years 8 and 9 were strongly correlated ($r = 76$, $p < .01$) and were therefore combined to form the measure for G2 alcohol use. Marijuana use consisted of self- and parent reports, ($r = .55$, $p < .01$ at OYS Year 8 and $r = .49$, $p < .01$ at OYS Year 9), as did other drug use ($r = .42$ and $r = .31$ for parent and self-report at OYS Years 8 and 9, respectively; both $p < .01$). The indicators by substance from each time point were significantly correlated (marijuana use $r = .74$, $p < .01$ and other drug use $r = .68$, $p < .01$) and therefore combined across time within substance, and then the mean of the cross time marijuana and other drug use ($r = .71$, $p < .01$) indicators was taken.

G2 poor discipline of G3 at age 21 months—In 3GS Year 1 (G3 age 21 months), the G2 father's poor discipline was measured using three self- and spouse-report subscales from the Discipline Questionnaire (Capaldi, 1995). The items in the scales measuring G2's poor discipline of G3 strongly paralleled those used to measure G1's poor discipline of G2. Poor Discipline Implementation was formed from seven items (e.g., "How often does child get away with things for which he should have been punished?), with the G2 father's self-report (alpha = .60) and a spouse report (alpha = .62) significantly correlated at .29. The Poor Discipline Results Scales were comprised of five items (e.g., "How often do you have to discipline your child repeatedly for the same thing?"); the G2 father self-report (alpha = .62) was correlated with the mother report (alpha = .54; $r = .35$, $p < .05$). The harsh discipline scale was formed using the mean of six items (e.g., "How often is your discipline harsh or mean?"), with a G2 father self-report alpha of .68 and a mother report alpha of .71; these two reports were correlated at $r = .25$. The multiagent poor implementation, poor results, and harsh discipline indicators were averaged to form the G2 father's poor discipline of G3 construct (alpha = .68).

G3 inhibitory control at age 3 years—The G3's inhibitory control was measured using parent report on the CBCL for ages 1.5 to 3 years (Achenbach, 1991,1992). Eleven items made up the Inhibitory Control Scale. These closely paralleled the items used to measure G2's

inhibitory control and included: Can't concentrate; can't sit still; can't stand waiting; cries a lot; gets into everything; picks nose, skin, and body parts; plays with own sex parts too much; quickly shifts from one activity to another; screams a lot; sudden changes in mood or feelings; temper tantrums or hot temper. The scale showed good internal consistency for both mothers (alpha = .80) and fathers (alpha = .76), and the two reports were moderately correlated (r = .40, $p < .05$). Thus, mother and father reports were averaged to produce the final G3 inhibitory control construct. Higher scores represent better inhibitory control.

Data Analytic Strategies and Preparation

Observed variable path modeling was conducted using MPlus 4.1 (Muthén & Muthén, 1998–2006). Several rules of thumb have been proposed with regards to appropriate sample size for SEM modeling, among them the guidance that sample size should be 10 times the number of free model parameters (see Bentler, 1995;Hu, Bentler, & Kano, 1992). The sample size for this study was 178; thus, using the above mentioned rule of thumb, any model tested should include no more than 17 free parameters. This made it difficult to use latent variable modeling. Preliminary analyses using latent variable modeling indicated that there were too many free parameters for a sample of 178. Similarly, when the latent models were attempted via bootstrapping, the standard errors became extremely unstable. Thus, the decision was made to use observed variable path modeling in all of the analyses. The complex sample option was used to adjust the standard errors to account for nonindependence of cases, as G3 siblings were nested within G2 fathers. Variables were examined for normality and outliers; those variables exhibiting significant skewness (all variables except G1 alcohol use, G2 alcohol use, and G3's inhibitory control) were transformed. Adequacy of model fit was assessed through examination of fit indices. Hypotheses regarding mediation were tested by examining significance tests of specific indirect pathways.

Missing Data

The use of constructs incorporating data from multiple time points lowered the likelihood of missing data; thus, there was little missing data for the constructs across the time points. The largest amount of missing data (11.8%) occurred for G2's discipline of G3 (3GS Year 1), primarily because some of the children were too old for 3GS Year 1 at the start of the study. G3's inhibitory control (3GS Year 2) represented the second largest amount of missing data, primarily due to some children still being too young to complete Year 2. Because the actual cases with missing data differed across 3GS Years 1 and 2, the lowest bivariate N within the model was that for G2 discipline and G3 inhibitory control; 136 cases had data at both 3GS assessment waves. To retain the maximum number of cases, full information maximum likelihood (FIML) estimation was used, which has been shown to provide unbiased estimates when data are missing at random (Arbuckle, 1996).

Results

As a first step, because G3 contained boys and girls, a one-way ANOVA was used to test for gender differences in the means of observed variables. There were no significant mean differences by gender for any of the six observed variables.

Descriptive and Correlational Analyses

To assess the prevalence of substance use within the sample, the percentages of G1 mothers and fathers who had ever used alcohol or marijuana and other drugs and the percentage of G2 youth who had used alcohol or marijuana and other drugs in the past year were calculated and averaged across the assessment periods, as shown in Table 1. Additionally, to explore the prevalence of usage that might be considered to be more patterned, the percentages of both the G1 parents and the G2 youths who had had five to six drinks half the time they drank (for G1)

or in the past 2 weeks (for G2) and the percentages of parents and youth who used marijuana or other drugs more than one time a month ever (for G1) or in the past year (for G2) were calculated. The percentages demonstrated that the rates of both G1 and G2 participants who ever used alcohol or marijuana were fairly substantial, whereas the rates of other drug use were lower. In terms of heavier alcohol use, 13% of the G1 fathers reported drinking five to six drinks at least half of the times that they drank. More than monthly marijuana use was about equal in the G1 and G2 samples, whereas the G2 sample showed higher rates of monthly other drug use. Notably, whereas G1 father use and problematic use were slightly higher across substances, the differences between his use and that of the G1 mothers were not statistically significant, χ^2s = 0.01 to 1.80, *p*s = .18 to .96.

Correlational analyses for alcohol use—The correlation matrix for the observed variables, along with means and standard deviations, are shown in Table 2. As predicted, G1's alcohol use was positively associated with that of G2 in adolescence. Contrary to predictions, however, there were no significant associations between G1's alcohol use and either G1's parenting or G2's inhibitory control. However, as hypothesized, there was a negative association between G1's poor parenting and G2's inhibitory control, and G2's inhibitory control was, in turn, negatively associated with the youth's alcohol use in adolescence. There was also a significant positive association between G1's poor parenting and G2's adolescent alcohol use. Finally, there was an unexpected positive association between G1's alcohol use and G2's poor discipline of G3.

In terms of associations between G2 and G3, consistent with hypotheses and replicating the findings for G1 and G2, there was a moderate positive association between G2's late adolescent alcohol use and G2's poor discipline of G3. Also, as hypothesized, G2's poor discipline of G3 showed a negative association with G3 inhibitory control. G2's inhibitory control in midadolescence was also moderately negatively associated with his poor parenting of G3 up to 13 years later. Unexpectedly, and contrary to hypotheses, neither G2's alcohol use nor his inhibitory control in midadolescence were related to his offspring's inhibitory control at the age of 3 years. There were several correlations that were below the cutoff point of .30 for moderate correlations (and this was the case for the correlational analyses for illicit drug use below). However, given that alcohol use (and the other use of illicit substances) is multiply determined, this is not surprising.

Correlational analyses for illicit drug use—As predicted, G1's illicit drug use was negatively associated with G2's inhibitory control in midadolescence. In turn, G2's inhibitory control in midadolescence and illicit drug use in late adolescence were negatively associated. A key question was whether G1's illicit drug use would be associated with poorer parenting of G2. As hypothesized, G1's illicit drug use was positively associated with G1's poor discipline. Further, G1 poor discipline was associated with lower inhibitory control in G2, as well as moderately predictive of higher levels of G2 substance use in late adolescence. In terms of direct associations between G1's behaviors and the same behaviors in G2, there was a positive association between G1's illicit drug use and that of G2 in late adolescence, as well as a slightly more substantial association between G1's poor discipline of G2 and G2's poor discipline of G3 up to 13 years later.

Turning to associations between G2 and G3 variables, consistent with hypotheses and replicating the findings for alcohol use, G2's late adolescent substance use was positively associated with G2's poor discipline of G3. Contrary to hypotheses but similar to the alcohol findings, there was no significant association between G2's illicit drug use and G3's inhibitory control.

Multivariate Model

Alcohol use—Figure 2 shows the full three generational model with nonsignificant paths removed exhibiting acceptable fit, $\chi^2 = 4.05$ (7 *df*), $p = 0.77$, Comparative Fit Index = 1.000, Root-Mean-Square Error Association = .000. All displayed pathways were significant at the $p < .05$ level. It should be noted that in no case did the removal of nonsignificant paths substantially affect the magnitude or significance of the significant paths. Consistent with results from the correlational analyses, there was a significant direct path between G1's alcohol use and that of G2. Additionally, G1's poor parenting had a direct effect on G2's adolescent alcohol use. As predicted, however, the path between G1's poor discipline and G2's alcohol use was also partially mediated through G2's inhibitory control with poorer parenting associated with poorer inhibitory control and greater alcohol use. Finally, G1's alcohol use continued to predict poorer parenting of G3 by G2.

In the portion of the model reflecting the associations between G2 and G3, as in the G1 to G2 portion of the model, there was no direct association between G2's alcohol use and their poor parenting of G3. Also, similar to the patterns of associations between G1 and G2, there was no direct path between G2's alcohol use and G3's inhibitory control. There were also no direct effects of G2's inhibitory control on that of G3. Given that substance use may be one expression of poor inhibitory control and that there was a significant negative association between G2's midadolescent inhibitory control and his poor discipline of his children, once G2's inhibitory control was accounted for in the model, there may no longer have been enough power to detect any additional variance explained by G2's substance use. In fact, G2's inhibitory control was negatively associated with G2's poor parenting of G3 and that in turn was negatively associated with G3's inhibitory control. This indirect path between G2's inhibitory control and that of G3 was significant (standardized beta = .08, $p < .01$ [$Z = 2.67$]). Together with the results of the G1 to G2 model, this suggests that one important influence on the development of inhibitory control may be parenting.

Illicit drug use—Figure 3 shows the full three generational model exhibiting acceptable fit with nonsignificant paths removed, $\chi^2 = 7.78$ (7 *df*), $p = 0.46$, Comparative Fit Index = 1.000, Root-Mean-Square Error Association = .000. As was the case with the alcohol model, the removal of nonsignificant paths did not substantially alter the magnitude of the significant paths. We predicted that the pathway between G1's illicit drug use and that of G2 would be partially mediated by G2's inhibitory control. There was an indirect effect of G1's illicit drug use on G2's use through inhibitory control (standardized beta = .07, $p = .08$ [$Z = 1.75$]). Another aim of this study was to delineate mechanisms through which G1's substance use might impact G2's inhibitory control. As hypothesized, there was significant indirect path from G1's illicit drug use to G2's inhibitory control through G1's poor discipline of G2, thus showing partial mediation of the path by poor discipline (standardized beta = −.08, $p < .05$ [$Z = -2.07$]). G1's illicit drug use predicted poorer G1 discipline of G2, which in turn negatively impacted G2's inhibitory control. G2's inhibitory control was then negatively associated with his later substance use.

It is also worth noting that there was a significant positive association between G1's poor discipline and G2's illicit drug use in the bivariate correlations. However, this association was no longer significant in the multivariate model including G2's inhibitory control. Thus, the path between G1's parenting and G2's illicit drug use was completely mediated by G2's inhibitory control (standardized beta = .10, $p < .05$ [$Z = 2.31$]). Similarly, the path between G1's poor discipline of G2 and G2's poor discipline of G3 proved to be mediated by G2's inhibitory control in midadolescence (standardized beta = .11, $p < .01$ [$Z = 2.66$]).

Turning to the associations between G2 and G3, we found that, unlike findings for the G1 to G2 portion of the model, there was no longer a significant path between G2's illicit drug use

and G2's poor discipline of G3. As was the case with the alcohol use, G2's inhibitory control had a significant effect on that of G3 through its negative association with G2's poor discipline, which in turn was negatively associated with G3's inhibitory control (standardized beta = .08, $p < .01$ [$Z = 2.60$]). As noted in the results of the correlational analyses, there was no direct association between inhibitory control in G2 and the same trait in G3.

Discussion

Research into the transmission of substance dependence and abuse suggests that multiple mechanisms are likely to be involved in the process. Two pathways that have been implicated in the transmission of substance dependence and abuse are inhibitory control and poor parenting (e.g., Giancola et al., 1996;Iacono et al., 1999). The aim of the current study was to build upon past research in several ways. First, the possibility that inhibitory control mediated the association between parental substance *use* (vs. dependence) and offspring's later use was explored. Second, the roles of poor parental discipline both in mediating the association between G1 substance use and that of G2 and also in mediating the association between G1's substance use and G2's inhibitory control were investigated. We posited that G1's substance use would negatively affect G1's parenting, which would then have direct effects on G2's substance use as well as indirect effects as it negatively influenced G2's inhibitory control. Additionally, although much of the prior research has focused on the transmission of alcohol dependence and abuse from one generation to the next, the current study examined transmission of alcohol use and illicit drug use separately. Finally, the model examined these questions prospectively across three generations.

Study findings indicated that both G1's alcohol and G1's illicit drug use when the G2 youths were in late childhood were positively associated with G2's use of the same substances in late adolescence. Consistent with research showing that a number of other factors, including antisocial behavior, deviant peer involvement, and parenting affect substance use, the magnitude of the correlation was moderate. However, the findings clearly indicate an association between parental use and that of the next generation. These findings are consistent with other studies indicating that substance *use* is heritable (Kendler et al., 2006;Young et al., 2006), although substance dependence appears to be more highly heritable than substance use, which is to be expected given that it is a more severe form of substance use. Additionally, although most other studies have examined the transmission of alcohol use, this study demonstrated that both alcohol and illicit drug use are transmitted across the generations.

Given this intergenerational transmission of use, it is useful from the standpoint of prevention to know whether those traits that appear to be intermediary in the transmission of substance *dependence* are also implicated in the transmission of *use* and also to determine the role of environmental influences such as parenting. Both inhibitory control and parenting appear to have differential roles in the transmission of alcohol use and that of illicit drugs.

Alcohol use

Although G1's alcohol use had a direct effect on G2's use in adolescence, none of the hypothesized effects of parental alcohol use on parenting or inhibitory control were found. We expected that parental alcohol use would be associated with poor parental discipline and poor inhibitory control in G2, but no such linkages were found. This is not inconsistent with past research. In a sample of adolescent twins, Young et al. (2006) found that although tobacco and marijuana use had strong genetic influences, genetics effects were less influential for alcohol use. Instead, environmental influences were more important. In this study, two environmental influences— that is, G1's alcohol use (which would provide a social context in which G2 could witness and learn norms around use) and G1's parenting practices—showed direct positive influences on G2's later alcohol use in adolescence. By contrast, G1's alcohol use did not

appear to affect the trait of inhibitory control, which is presumably more genetically determined. Young et al. found that genetic influences were much stronger in the transmission of alcohol *problem use*. This would help to explain why prior research examining the offspring of parents diagnosed with substance use disorders has found a link between parental substance dependence and inhibitory control although we failed to find such a link here. More severe forms of alcohol use appear to be more highly transmissible.

Although G1's alcohol use did not affect inhibitory control directly, G2's inhibitory control was linked to the youth's alcohol use, with poorer inhibitory control predicting greater usage. This is consistent with past literature suggesting that inhibitory control is implicated in the development of alcohol use and dependence problems in both adults and youths (Finn et al., 2000;Giancola et al., 1996;Martin et al., 2000). Additionally, poor parenting by G1 was associated with greater alcohol use by G2 in adolescence. Finally, as hypothesized and consistent with Patock-Peckham and Morgan-Lopez's (2006) study of college students, poor discipline was indirectly associated with G2's alcohol use through its negative effect on G2's inhibitory control.

The results from the third generation parallel those in the first and second generations. Again, G2's alcohol use was associated neither with his parenting nor with his offspring's inhibitory control. Also consistent with the G1 to G2 model, G2's poor discipline of G3 was negatively associated with G3's inhibitory control. However, in the bivariate correlations, there was an association between G2's alcohol use and his poor discipline of G3, although this association was no longer significant in the multivariate model. It is not clear why this was the case for the G2 to G3 model but not so for the G1 to G2 model. It is possible that alcohol use impinges more on parenting when children are very young.

Illicit drug use

Although inhibitory control does not appear to mediate the association between alcohol use in one generation and the next, it was a marginally significant mediator in the transmission of illicit drug use as represented by the use of marijuana and other drugs. Higher levels of parental illicit drug use predicted problems with inhibitory control and, subsequently, higher levels of substance use in their adolescent sons. Additionally, in bivariate correlations, G1's illicit drug use was negatively associated with their sons' inhibitory control, suggesting some impact of substance use on this temperamental trait. However, inhibitory control did not reach conventional levels of significance as a mediator in the association between G1's use of either alcohol or illicit drugs and that of G2. To the extent that adolescent inhibitory control marks heritable temperamental risk for substance use, these findings suggest that substance use overall may be less heritable than substance dependence and abuse.

Contrary to hypotheses, the G2 fathers' illicit drug use in late adolescence was not related to their children's inhibitory control at age 3 years in either the bivariate or the multivariate analyses. It is possible that inhibitory control in the preschool years is qualitatively different than adolescent inhibitory control; executive functioning, in general, continues to develop across the first 10 years of a child's life (Welsh, Pennington, & Grossier, 1991). Additionally, behaviors that in early adolescence would be clear indicators of difficulty (e.g., cannot sit still) are more normative for 3-year-olds. Thus, as the child ages, problems with inhibitory control may become more apparent and perhaps more stable. Further, although the trait of inhibitory control has been found to be fairly stable across the preschool years and even into early childhood (e.g., Kochanska, Murray, & Coy, 1997;Kochanska et al., 2000), data have not yet accumulated on stability from preschool to adolescence. Hence, although there is an association between parental illicit drug use and offspring inhibitory control in adolescence, the same association may not be apparent at younger ages.

Another aim of this study was to examine the role of poor parenting in transmission of substance use from one generation to the next. Poor parenting has been linked separately to both parental substance use and inhibitory control. As predicted, parental illicit drug use was associated with poor parenting. Additionally, we hypothesized that poor parenting would at least partially mediate the association between parental illicit drug use and offspring inhibitory control, and this proved to be the case. There was a significant indirect path between G1 illicit drug use and G2's inhibitory control in adolescence through G1's poor discipline.

There was also evidence of a direct association between poor parental discipline strategies and later adolescent substance use in the significant bivariate correlation between these two variables. In the multivariate analyses, the association between poor parental discipline and later adolescent illicit drug use was mediated by inhibitory control. Thus, inhibitory control appears to be affected by parental behaviors and mediates the effects of these behaviors on late adolescent illicit drug use.

In the second and third generations, the associations between G2 illicit drug use and subsequent parenting were less clear than in the first and second generations. It should be borne in mind that parenting by G2 was measured up to 12 years after their late adolescent illicit drug use. As hypothesized and consistent with findings in G1 and G2, bivariate correlations showed a modest positive association between G2's illicit drug use in late adolescence and poor discipline of G3. This association, however, became nonsignificant in the multivariate model. This may be due to the fact that G2's inhibitory control in midadolescence showed a strong association with his parenting of his child up to 13 years later. Given that substance use may be one expression of poor inhibitory control (e.g., Giancola & Tarter, 1999), in the model tested here, G2's inhibitory control might have accounted for much of the variance in his parenting that would have otherwise been explained by illicit drug use. Other studies examining associations between parental substance use and discipline skills have not accounted for parental inhibitory control (e.g., Fals-Stewart et al., 2004;Kandel, 1990;Tarter et al., 1993). Nor did we account for G1's inhibitory control in the tests of associations between G1 and G2 characteristics. Thus, it appears that, in the case of illicit drug use, a parent's poor inhibitory control may account for both their later substance use and their later poor discipline.

This association between inhibitory control in midadolescence and later parental discipline in both the alcohol use and the illicit drug use models highlights an unexpected but nonetheless important finding from this study: Inhibitory control appears to be a risk factor not only for the intergenerational transmission of illicit drug use but also for the transmission of poor discipline practices. In both models, inhibitory control fully mediated the association between G1's poor discipline of G2 and G2's poor discipline of G3. The finding that inhibitory control influences parenting is not inconsistent with the literature. Inhibitory control appears to underlie a number of disorders of regulation (Giancola & Tarter, 1999), and poor parenting may be reflective of difficulties in regulation. The choice and then correct implementation of effective discipline techniques requires that a parent remain calm in the face of irritating or even downright maddening child behavior (e.g., Patterson & Forgatch, 1987;Webster-Stratton, 1997), inhibiting both tendencies to become angry at child misbehavior or to respond with harsh discipline. Thus, parents with poor inhibitory control are unlikely to be able to consistently utilize effective discipline strategies. As seen in both the G1 to G2 and G2 to G3 analyses, poor discipline then impinges negatively on offspring's inhibitory control. Therefore, it is not surprising that inhibitory control mediates the association between poor parenting practices in one generation and the next.

This finding has important implications for preventive intervention efforts to break the cycle of intergenerational transmission of poor parenting. A number of studies, including one with the current sample, have now established that poor parenting in one generation is a risk factor

for poor parenting in the next generation (Capaldi, Pears, Patterson, & Owen, 2003;Conger, Neppi, Kim, & Scaramella, 2003;Thornberry, Freeman-Gallant, Lizotte, Krohn, & Smith, 2003). One common intervention for offspring who experienced poor parenting practices (particularly extremes such as abusive parenting) is to teach them effective discipline strategies in the hopes that they will then utilize these strategies with their own offspring (Skowron & Reineman, 2005). Given the long-reaching effects of poor inhibitory control on later parenting, this study suggests a two-pronged approach in preventing the transmission of poor parenting: Teaching both appropriate discipline practices and strategies for enhancing inhibitory control. Additionally, this study suggests that earlier intervention for poor inhibitory control could potentially prevent more problems.

It could be argued that inhibitory control in the model tested in the current study is simply a proxy for antisocial behavior. A previous study with this sample found that antisocial behavior partially mediated the association between G1's poor parenting of G2 and G2's poor parenting of G3 (Capaldi et al., 2003). Deficits in inhibitory control, as well as other executive functions, are associated with antisocial and aggressive behavior (Morgan & Lilienfeld, 2000). However, such deficits appear to precede aggressive and deviant behavior (e.g., Giancola & Parker, 2001). Thus, inhibitory control may serve as an early marker in children of risk for a range of later difficulties, including substance use, antisocial behavior, and poor parenting.

A final contribution of the current study is the finding that the mechanisms of transmission for alcohol use may differ from those for illicit drug use. Alcohol use in one generation appears to be directly related to that in the next. Although parenting and inhibitory control play roles in the next generation's use, they do not appear to be influenced by the parent's alcohol use. In contrast, illicit drug use in the first generation influences that in the next through a number of mechanisms including poor parental discipline and, less strongly, poor offspring inhibitory control. This may be reflective of the potentially greater seriousness of marijuana and other drug use. Although alcohol use can certainly be problematic, it is still a legal and fairly normative behavior. In contrast, marijuana and other drugs are illegal and thus any use may reflect greater severity in substance use, which is likely to impinge negatively on parenting practices as well as perhaps to exert genetic influences through effects on temperamental traits.

Limitations and Directions for Future Research

Although the current study featured multimethod, multiagent prospective data over a 20-year period, there were also a number of limitations. First, only male offspring were included in the portion of the model that focused on G1 to G2 intergenerational transmission. This study is not unlike many previous studies in this respect. However, research has shown that substance dependence, particularly alcohol dependence, appears to be equally heritable in men and women (Slutske et al., 2002). Additionally, studies have linked difficulties with inhibitory control to substance use and dependence in women (Giancola, Mezzich, & Tarter, 1998; Slutske et al.). Because the original G1 to G2 study (OYS) was focused on male offspring, the focus of the G2 to G3 study (3GS) is necessarily primarily on the fathers. For the G2 mothers, no data on G1 parenting of her or her adolescent inhibitory control and substance use were available. Thus, mothers were not included in the analyses of transmission from G2 to G3. This may account for the drop in magnitude of some of the paths; for example, in the model of illicit drug use, the path coefficient for the association between G1 parenting (which included both G1 mothers and fathers) to G2 inhibitory control was −.40, whereas the path from G2's parenting (including only fathers) to G3's inhibitory control was −.28. It would be extremely difficult, if not impossible, to have prospective data on both the mothers and fathers across three generations. However, future studies might examine the effects of both mother and father substance use on younger children's inhibitory control. In a related vein, the relatively small sample size also made it difficult to examine the contributions of the effects of G1 mother and

G1 father substance use and discipline practices separately. This was partially because there were fewer G1 father participants than G1 mothers. However, as noted above, preliminary analyses revealed that separate parent variables did not explain any additional variance than did the combined parental variables. That said, it would be desirable to test the separate effects of mother and father substance use in a larger sample. Additionally, the small size of the sample at G3 precluded latent variable modeling, as well as testing for possible gender differences (or lack thereof) in the effects of G2's substance use on G3's preschool characteristics (although there were no gender differences on the major constructs for G3).

Finally, although the measures for the major constructs across the generations were very similar, they covered different developmental periods. For example, G2's inhibitory control was measured in midadolescence whereas G3's was measured at age 3 years. This precluded conducting a straight replication of findings from G1 to G2 in the G2 to G3 analyses. As noted above, it may also be an explanation for why some associations found in the G1 to G2 analyses were not present in those for G2 to G3. Further, the potential differences between inhibitory control measured in adolescence and inhibitory control at age 3 years may also explain the lack of a direct association between G2's inhibitory control and that of G3. As the G3 sample ages, it will be possible to test whether the associations found in the G1 to G2 analyses are directly replicable and whether there is a stronger association between G2's midadolescent inhibitory control and G3's inhibitory control measured at the same developmental stage.

Overall, this study is one of only a small handful of prospective three generational studies to examine the transmission of substance use (e.g., Fuller et al., 2003;Thornberry, Marvin, & Freeman-Gallant, 2006). Consistent with previous evidence from studies of parents with substance use dependence and their offspring, inhibitory control appears to be influential in the transmission of substance use from one generation to the next, at least in the case of illicit drug use. Additionally, inhibitory control appears to mediate the association between parental use of poor discipline practices and their offspring's use of the same poor practices years later. Thus, this study adds to growing evidence that inhibitory control may be implicated in and an early risk factor for a number of difficulties, including substance use, antisocial, aggressive behavior, and poor parenting. This suggests that one major avenue for the prevention of transmission of a number of behavior problems across generations should be strengthening the ability to inhibit inappropriate or poorly chosen responses in children and in young parents.

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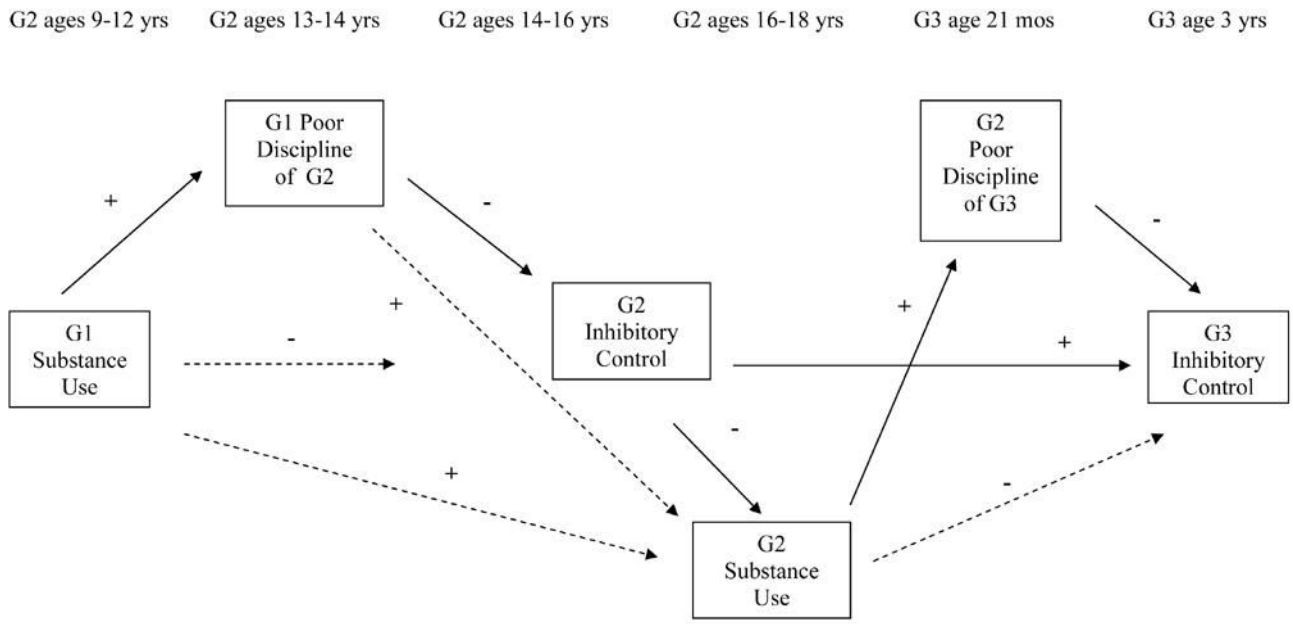

Figure 1. Hypothesized Model of the Intergenerational Transmission of Substance Use

Note. Dotted lines represent hypothesized partially mediated pathways. Direct effects are also hypothesized. G1 = grandparental generation; G2 = parental generation; G3 = Generation 3.

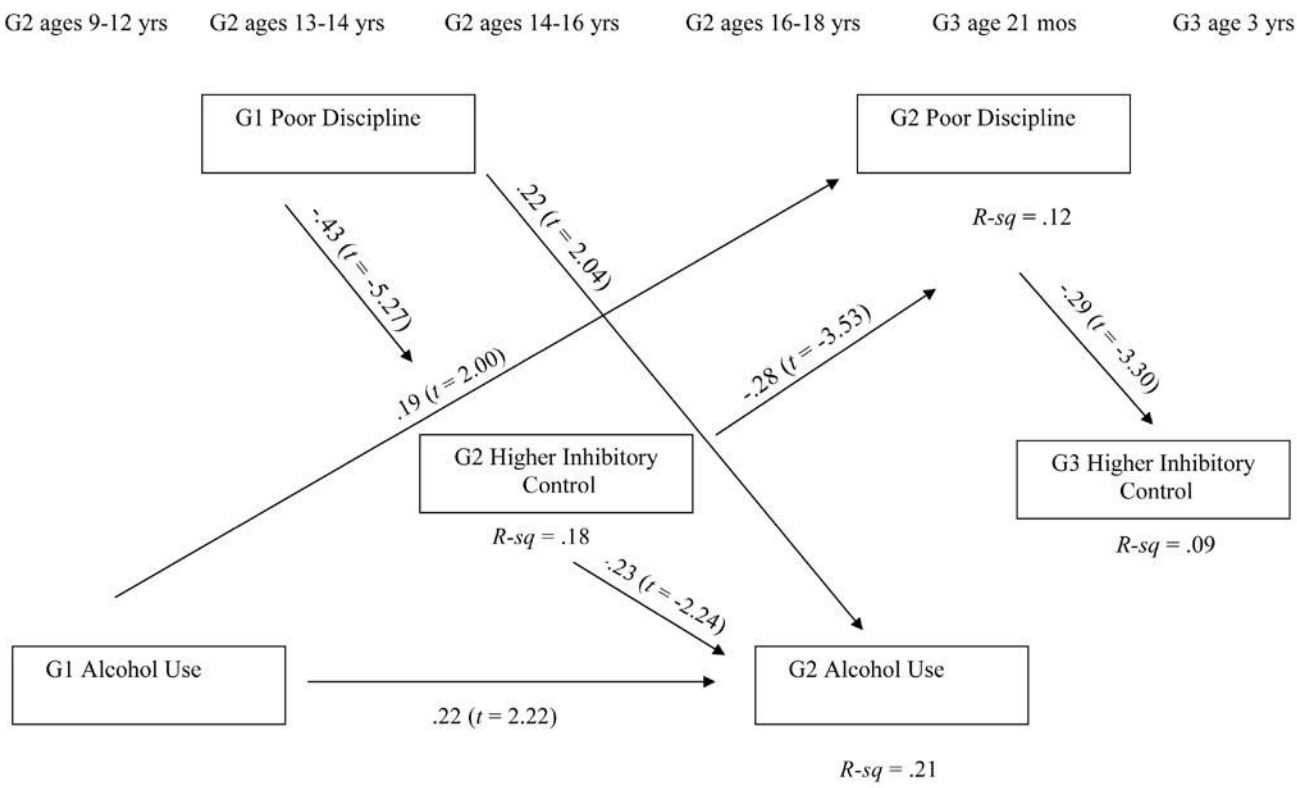

Figure 2. Risk for Alcohol Use Across Three Generations

Note. G1 = grandparental generation; G2 = parental generation; G3 = Generation 3.

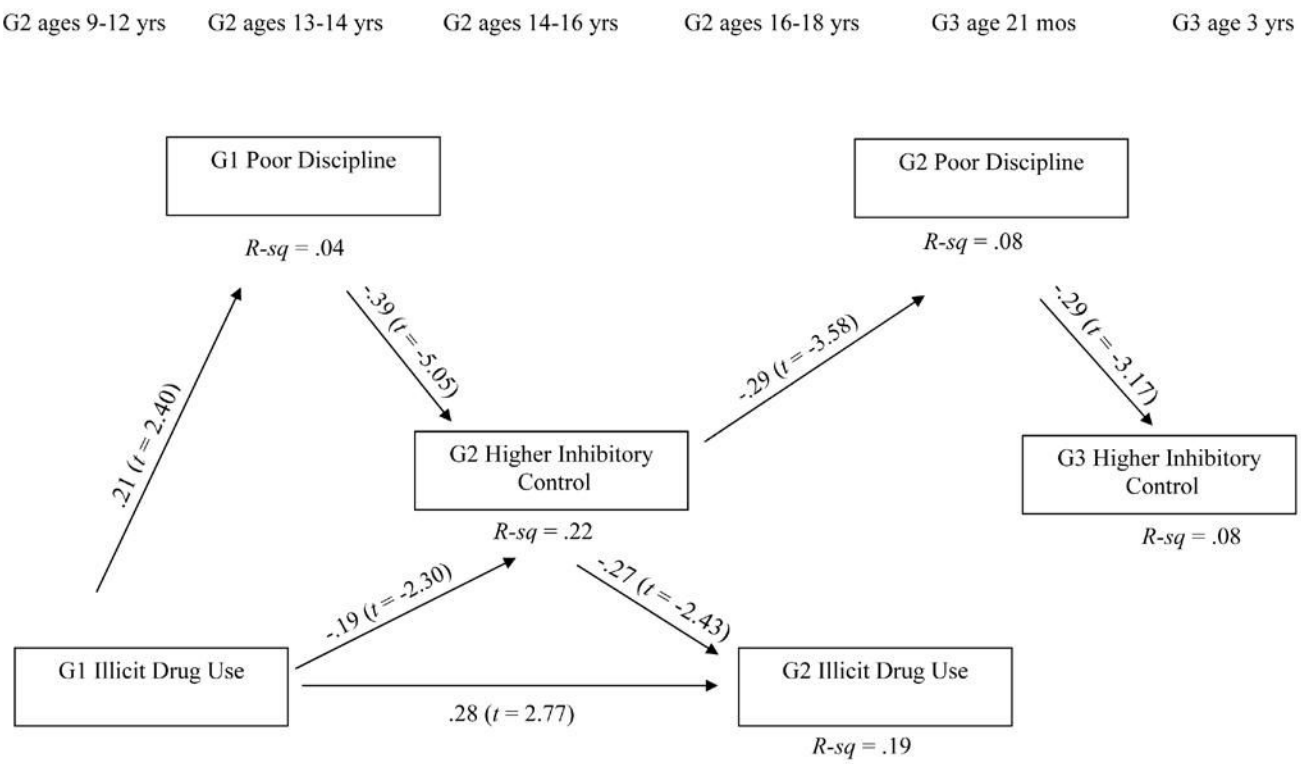

Figure 3. Risk for Illicit drug use Across Three Generations

Note. G1 = grandparental generation; G2 = parental generation; G3 = Generation 3.

Table 1

Prevalence of Alcohol, Marijuana and Other Drug Use in G1 and G2

	Used alcohol [a] (%)	Had 5–6 alcoholic drinks at a time[b] (%)	Used marijuana [a] (%)	Used marijuana once a month or more often [c] (%)	Used other illicit drugs [a] (%)	Used other illicit drugs once a month or more often [c] (%)
G1 Father	90	13	54	13	22	0
G1 Mother	84	6	61	13	20	0
G2 Youth	82	29	38	15	18	8

[a] For G1, ever used; for G2 in the last year.

[b] For G1, half the time that they drink; for G2 in the past 2 weeks.

[c] For G1, “in general”; for G2 in the past year.

Table 2

Correlations between the Variables in the Models

	1	2	3	4	5	6	7	8
1. G1 Alcohol Use								
2. G1 Illicit Drug Use	.41**							
3. G1 Poor Discipline	.08	.20*						
4. G2 Inhibitory Control	−.12	−.27**	−.45**					
5. G2 Alcohol Use	.27**	.21**	.35**	−.36**				
6. G2 Illicit Drug Use	.20**	.35**	.17*	−.36**	.66**			
7. G2 Poor Discipline	.18*	−.01	.22**	−.31**	.21**	.22**		
8. G3 Inhibitory Control	−.14	.08	−.09	.06	−.03	−.12	−.28**	
Mean	0.01	−0.70	1.63	−0.32	0.14	−0.75	0.35	0.02
Standard Deviation	0.83	0.22	0.28	0.18	0.94	0.25	0.14	0.89
3GS *N*	178	178	167	173	177	177	159	157

* $p < .05$.

** $p < .01$.