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Parent-Child Engagement in Decision Making and the Development of Adolescent Affective Decision Capacity and Binge Drinking

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Abstract

The goal of this study was to investigate how parents' engagement of their child in everyday decision-making influenced their adolescent's development on two neuropsychological functions, namely, affective decision-making and working memory, and its effect on adolescent binge-drinking behavior.

We conducted a longitudinal study of 192 Chinese adolescents. In 10th grade, the adolescents were tested for their affective decision-making ability using the Iowa Gambling Task (IGT) and working memory capacity using the Self-ordered Pointing Test (SOPT). Questionnaires were used to assess perceived parent-child engagement in decision-making, academic performance and drinking behavior. At one-year follow-up, the same neuropsychological tasks and questionnaires were repeated.

Results indicate that working memory and academic performance were uninfluenced by parent-child engagement in decision-making. However, compared to adolescents whose parents made solitary decisions for them, adolescents engaged in everyday decision-making showed significant improvement on affective decision capacity and significantly less binge-drinking one year later.

These findings suggest that parental engagement of children in everyday decision-making might foster the development of neurocognitive functioning relative to affective decision-making and reduce adolescent substance use behaviors.

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Introduction

A substantial body of literature demonstrates that various family characteristics, such as the quality of parent-child relationships, communication, and parental monitoring, are reliably associated with substance use behaviors among adolescents (Cohen, Richardson & LaBree, 1994; Shek, 1999). Recent studies also consistently show that early family environment influences subsequent brain and cognitive function during human development (Taylor, Eisenberger et al. 2006; Farah et al., 2008). In this study, we investigate the effect of one dimension of parenting, parent-child engagement in decision-making, on the development of specific neuropsychological functioning in adolescents, affective decision-making and working memory, as well as adolescent substance use behaviors, such as binge drinking.

Most animal and human studies on the effects of parenting behaviors on their offspring's brain functions and behaviors focus on the impact of early life experience in infancy or childhood (Fleming, O'Day & Kraemer, 1999; Mirescu, Peters & Gould, 2004). However, considerable evidence shows that the brain's structural maturation process continues through adolescence, especially in some prefrontal cortex (PFC) regions and systems associated with decision-making, emotion regulation and response inhibition (Giedd, 2004; Toga, Thompson, & Sowell, 2006). Therefore, parenting behaviors may still affect adolescents' brain function in ways that affect behavior during this developmental stage. Indeed, many studies have found a relationship between parenting influence and the development of adolescent substance use behaviors (Cohen, et al., 1994; Radziszewska, Richardson, Dent & Flay, 1996). Significant changes in the nature of family relations begin to occur during adolescence, and one of the primary developmental tasks for families of adolescents is renegotiating the balance between input from the child and parent with regard to family and personal decision-making and adolescent autonomy (Whittle, Yap et al. 2008). However, while numerous dimensions of parenting have been studied, including parental attachment, monitoring, knowledge in parenting, parent-child relationship, and family environment (Cohen, et al., 1994; Shek, 1999), to our knowledge, no study thus far has investigated the influence of parent-child engagement in decision making on the development of adolescent neuropsychological functions and its implications for substance use.

Previous studies demonstrate that some portions of the PFC including orbitofrontal, ventrolateral, and medial prefrontal regions are among the latest brain regions to mature and do not reach adult levels until one's early 20s or later (Giedd, 2004; Toga et al., 2006). Therefore, in the present study, we assessed two different neuropsychological functions, affective decision-making capacity and working memory, both of which are associated with different but interacting subregions of the PFC—the orbital/ventromedial sector of the prefrontal cortex (OFC/VMPC) and the dorsolateral sector of the prefrontal cortex (DLPC)—respectively (Fletcher, Frith & Rugg, 1997; Kringelbach, 2005). One widely used laboratory paradigm to assess affective decision-making is the Iowa Gambling Task (IGT) (Bechara, Damasio, Damasio & Anderson, 1994). Compared to other tasks, which assess brain functions related to explicit calculation of probabilities or expected value, the IGT requires participants to learn implicitly from their past experience (such as rewards and punishments encountered during the task) in order to infer the probable outcomes of the choices they are currently making (Bechara, 2004). Thus, the learning processes involved in the IGT are strongly influenced by affective and emotional systems (Wagar & Dixon, 2006), in which the OFC/VMPC plays a critical role (Li, Lu, D'Armenteau, Ng & Bechara, in press).

In this study, we used the Self-ordered Pointing Test (SOPT) (Peterson, Pihl, Higgins & Lee, 2002) to assess working memory capacity. This task requires in each trial that an individual memorize a maximum number of 12 items, either visually or phonologically

encoded, and then hold them “online” for further operations. Because there are six trials of the SOPT, the maximum capacity is not required in the first trial but the amount of information increases cumulatively over the course of each trial. This process resembles that of transient online storage, or active monitoring and retrieving of the increasing amount of information (Petrides, Alivisatos, Meyer & Evans, 1993) in the concept of working memory. This task has also been linked to neural activity within the DLPC (Petrides et al., 1993). Moreover, since working memory is highly related to general cognitive functions, such as reading, mathematics and reasoning (Jarrold & Towse, 2006), we also asked the participants to report their academic performance.

The current study investigated whether parent-child engagement in decision-making would account for changes in adolescents’ neuropsychological functions as well as substance use behaviors such as binge-drinking at a one-year follow-up. The measure of parent-child engagement in decision-making indicates adolescents’ perception of the degree to which their parents engaged them in everyday decision-making processes on issues such as spending money, leisure activities, or how late adolescents can stay out (Dornbusch, et al., 1985; Radziszewska, et al., 1996; Steinberg, 1987). In this study, we tested the hypothesis that adolescents who participated in the decision-making processes either by themselves or with their parents would show more improved affective decision-making capacity and less binge-drinking one year later compared to those whose parents made solitary decisions for them.

Methods

Sample

This study was supported by the Pacific Rim Transdisciplinary Tobacco and Alcohol Use Research Center (Johnson, 2006). All research protocols were approved by both Institutional Review Boards of the University of Southern California (USC) and Chengdu, China Center for Disease Control (CDC). To ensure maximum variability across the student sample, two academic high schools and two vocational high schools were selected for the study. One 10th grade class from each of the four schools was randomly selected, and a total of 223 students (ages 15–17) were invited to participate. The gender and school type were almost equally distributed. Of the student total, sixteen participants at Time 1 (June 2006) and fifteen in the one year follow-up (Time 2, June 2007) were excluded from the data analysis due to computer malfunctions or failure to complete the survey. The final sample size included 192 participants (86.1% of total participants). There were no statistically significant differences in age, gender and school type between participants in Time 1 and Time 2.

Measures and Procedures

Measures included two computer-assisted neuropsychological assessments and a questionnaire at both Time 1 and Time 2.

Time 1

Neuropsychological assessments

Iowa Gambling Task (IGT; Bechara, et al., 1994): In the IGT, four decks of cards labeled A’, B’, C’ and D’ are displayed at computer screen. The participant starts the task with a sum of make-believe money in his or her account. The subject is required to select one card at a time from one of the four decks. Turning each card can bring an immediate large monetary reward in Decks A’ and B’ and a small monetary reward in Decks C’ and D’. As the game progresses, there are also unpredictable losses among the cards. The schedule of gain and loss is pre-programmed. Decks A’ and B’ are disadvantageous because they yield high immediate gains but greater losses in the long run, and Decks C’ and D’ are advantageous in

that they yield lower immediate gains but smaller losses in the long run. An IGT net score is obtained by subtracting the total number of selections from the disadvantageous decks (A' + B') from the total number selections from the advantageous decks (C' + D').

Self-ordered pointing test (SOPT: Peterson et al., 2002): The SOPT has both verbal and non-verbal components with three trials of each. In the verbal component, subjects view pictures of concrete, nameable objects; whereas in the non-verbal component, subjects view abstract designs that are difficult to name or encode verbally. In each trial, 12 pages are presented sequentially, with each page depicting the same 12 pictures but in a different spatial arrangement on each page. Subjects are instructed to point to a different picture in each presentation. The total number of correct selections of different pictures represents the working memory score. In our study, the internal consistency across the 6 trials was 0.86.

Questionnaires

Perceived parent-child engagement in decision-making (Radziszewska et al., 1996; Dornbusch et al., 1985; Steinberg, 1987): Adolescents answered the following item: "In general, when it comes to spending money, doing fun activities, and deciding how late you can stay out, which of these statements most closely describes how you and your parents make decisions?" There were four response options: (1) My parents generally make these decisions (parents solitary decision makers); (2) My parents ask for my opinion but they generally make the decisions (joint process but parents decide); (3) I ask for my parents' opinion, but I generally make the decisions (joint process but adolescent decides); (4) I generally make the decisions (adolescent decides).

Perceived Parental Monitoring (Cohen, Richardson & LaBree, 1994): Adolescents answered the following 3 items: "How important is it to your parents to know where you are at all times?", "Are you allowed to go out with friends that your parents don't know?", "How often do your parents check whether you've done your homework?" The responses were made on a 4-point scale. Scale scores were the sum of these items. Higher scores reflect adolescents reporting that their parents supervised them more. The internal consistency of the scale in the current study was 0.68.

Perceived Family Support (Canty-Mitchell & Zimet, 2000): Adolescents answered the following 3 items: "I get the emotional help and support I need from my family", "I can talk about my problems with my family", "My family is willing to help me make decisions." The responses were made on a 4-point scale from "Strongly disagree" to "Strongly agree". Scale scores were the sum of these items. Higher scores reflect adolescents reporting that they perceived more support from their family. The internal consistency of the scale in the current study was 0.78.

Binge-drinkers: Binge-drinkers were defined as those who had had 4 or more drinks of alcohol in a row on at least one occasion in the past 30 days (Kolbe, Kann & Collins, 1993). The National Institute of Alcohol Abuse and Alcoholism (NIAAA) defines binge drinking as a pattern of drinking that brings a person's blood alcohol concentration (BAC) to a certain level or above. Therefore, although 5 or more drinks for males and 4 or more drinks for females is typically taken as the definition of past month binge drinking in western populations, we opted to define past month binge drinking as 4 or more drinks for both males and females in this study because of the generally lower body mass of Chinese youth.

School academic performance was assessed by the following question: "What is your usual academic performance at your current school or the last school where you received grades?" The five response options ranged from: 'Mostly A's, or 90 or more points, or Superior' to

‘Mostly F’s, or Below 60 points, or Failing’. A higher score represented a higher academic performance.

Time 2

The same neuropsychological tasks and questions regarding past month binge drinking and school academic performance at baseline were used at one year follow-up.

Data Analysis

Data were analyzed with the Statistical Package for the Social Sciences for Windows, Version, 16.0 (SPSS Inc., Chicago, IL). Among groups with different parent-child engagement in decision-making, Chi-square tests were used to test for differences in frequency distributions by gender and school type, and one-way ANOVA tests were used to test for differences in means of age, perceived parental monitoring and perceived family support. To analyze the IGT performance profile, we subdivided the 100 card selections into five blocks of 20 cards each in the IGT at Time 1 and Time 2, respectively. For each block, we counted the number of selections from Decks A' and B' (disadvantageous) and the number of selections from Decks C' and D' (advantageous), and then derived a net score for that block $((C'+D')-(A'+B'))$. We then conducted between-within ANOVA tests with ‘Parent-adolescent decision making process group’ as a between-subject factor and ‘Block’ as a within-subject factor. Paired-t tests were used to test the development of neuropsychological functions, academic performance and binge-drinking behaviors across the groups. To reveal the contributions of parent-child engagement in decision-making to year-one neuropsychological functions, academic performance, or binge drinkers, we tested a set of linear or logistical regression equations, respectively, with baseline values of the dependent measure, demographic characteristics entered in the model.

Results

Demographic characteristics

Table 1 shows that no significant differences in age, gender or school type were found among groups with differences in perceived parent-child engagement in decision-making ($P>0.05$).

Figure 1 shows perceived parental monitoring and perceived family support across groups. One-way ANOVA tests revealed significant group differences in both variables ($F_{(3, 188)}=7.40$; $P<0.001$ for perceived parental monitoring; $F_{(3, 188)}=4.03$; $P<0.05$ for perceived family support). Post hoc Tukey tests indicated that adolescents whose parents made solitary decisions for them reported significantly higher perceived parental monitoring compared to adolescents who either made decisions solely or collaboratively with parents ($P<0.05$). They also reported significantly lower perceived family support compared to adolescents who participated in decisions (either jointly with parents or solely) ($P<0.05$).

Correlations between neuropsychological variables and academic performance

Table 2 reports partial correlations among IGT net scores, working memory, and academic performance at Time 1 and Time 2, after controlling for gender, age and school type. Time 1 IGT net scores was significantly correlated with Time 2 IGT net scores and academic performance ($r=0.36$, $P<0.001$; $r=0.18$, $P<0.05$; respectively). Time 1 working memory was significantly correlated with Time 2 working memory ($r=0.54$, $P<0.001$) and school academic performance at both Time 1 and Time 2 ($r=0.32$, $P<0.001$; $r=0.27$, $P<0.001$; respectively). Time 1 academic performance was significantly correlated with Time 2 academic performance ($r=0.63$, $P<0.001$). At Time 2, IGT net scores, working memory and academic performance were significantly correlated with one another ($P<0.05$).

Behavioral performance on the IGT

Figure 2 presents the IGT net scores as a function of group and block (left plot: Time 1; right plot: Time 2). At Time 1, a 4 (group)×5 (IGT block) ANOVA test revealed only a significant block effect after the Greenhouse-Geisser adjustment ($F_{(2, 8, 528.1)} = 10.00$; $P < 0.0001$). The group and interaction effects between group and block were not significant ($F_{(3, 188)} = 0.82$; $P = 0.48$; $F_{(8.67, 528.1)} = 1.32$; $P = 0.20$, respectively). At Time 2, a 4 (group)×5 (IGT block) ANOVA test revealed a significant block effect and interaction effect between group and block after the Greenhouse-Geisser adjustment ($F_{(2, 8, 528.1)} = 30.8$; $P < 0.0001$; $F_{(8.67, 528.1)} = 1.87$; $P < 0.05$, respectively). In addition, there was a significant group effect ($F_{(3, 188)} = 5.12$; $P < 0.05$). Post hoc tests confirmed that adolescents whose parents made solitary decisions performed worse than other groups ($P < 0.05$). There was no difference in the IGT net scores among the three groups of adolescents who participated in their own decisions. These results indicate that there was no significant difference between groups on the IGT performance at Time 1. However, adolescents whose parents made solitary decisions for them performed worse on the IGT compared to other groups at Time 2.

Neuropsychological functions and academic performance at Time 1 and Time 2

Table 3 reports results of affective decision-making, working memory and academic performance across groups from Time 1 to Time 2. These results indicate that from Time 1 to Time 2 any level of adolescent input in decision-making (from parents making decisions but seeking adolescents' opinion, to the adolescents independently making their own decision) was associated with significantly increased affective decision-making scores ($P < 0.05$). Strikingly in contrast, adolescents with parents making solitary decisions did not show improvement on affective decision-making. Only adolescents who made decisions by themselves demonstrated significantly increased working memory scores from Time 1 to Time 2 ($P < 0.05$). Moreover, academic performance of all groups did not differ significantly from Time 1 to Time 2 ($P > 0.05$).

Variables predicting neuropsychological functions and academic performance at Time 2

The results of linear regression analysis for variables predicting IGT net scores, working memory and academic performance at Time 2 are summarized in Table 4. Model 1 shows that affective decision-making capacity at Time 1 significantly predicted affective decision-making capacity at Time 2 ($Beta = 0.35$, $P < 0.001$). Moreover, compared to the group of adolescents whose parents made solitary decisions for them, all other groups showed significant or marginally significant improvement on the development of affective decision-making capacity from Time 1 to Time 2 (all $P < 0.1$).

Model 2 shows that compared to vocational high school students, academic high school students had significant improvement on the development of working memory from Time 1 to Time 2 ($Beta = -4.58$, $P < 0.001$). Moreover, working memory at Time 1 significantly predicted working memory at Time 2 ($Beta = 0.52$, $P < 0.001$). In Model 3, as expected, school academic performance at Time 1 significantly predicted school academic performance at Time 2 ($Beta = 0.67$, $P < 0.001$). Surprisingly, affective decision-making instead of working memory significantly predicted school academic performance at Time 2 ($Beta = 0.14$, $P < 0.05$). Adolescents with different parent-child engagement in decision-making did not have significant differences in the development of working memory or school academic performance.

The total amounts of variance (R square) in the linear regression models for variables predicting the IGT net scores, working memory and academic performance at Time 2 were 27%, 49% and 47%, respectively. Parenting variables accounted for a significant proportion of the variance (3%) only in the first model, which predicted the IGT net scores at Time 2.

Parental Decision-making Styles and Binge drinking Behaviors

Table 5 describes the proportion of adolescents reporting past month binge drinking by parent-child decision engagement status at Times 1 and 2. Among adolescents whose parents made solitary decisions for them, the proportion of binge drinkers increased from 6.9% at Time 1 to 27.6% at Time 2 one year later ($t_{28}=2.27$; $P<0.05$). In contrast, among adolescents who participated in or made their own decisions, the proportion of binge drinkers remained the same or tended to decline from Time 1 to Time 2.

The results of logistic regression analysis for variables predicting binge-drinking at Time 2 are summarized in Table 6. It shows that compared to females, males were 4.5 times more likely to engage in binge-drinking behavior at Time 2 ($P<0.05$). Relative to the non-binge drinkers, binge drinkers at Time 1 were about 22 times more likely to be binge drinkers at Time 2 ($P<0.0001$). Moreover, after controlling for age, gender, school type and binge-drinking at Time 1, compared to adolescents whose parents made solitary decisions for them, adolescents with some degree of participation in decision-making resulted in 75% to 97% fewer binge drinkers at Time 2 (all $P<0.05$).

Discussion

Results from this study confirmed our hypothesis that over the course of a year adolescents who had the opportunity to participate in decision-making processes in their daily life showed significant improvement in their affective decision-making capacity and less binge-drinking behavior compared to adolescents whose parents made decisions for them. One previous study found that parental nurturance was associated with better memory ability during childhood (Farah, et al., 2008), and our study extends this finding by suggesting that family experience has a critical impact on the development of neuropsychological functions even during adolescence.

Interestingly, one recent study found that utilizing a dopamine agonist methylphenidate (MPH) challenge, undergraduate students with low early life parental care performed differently in a monetary reward card-sorting task, leading the authors to suggest that low parental care might be associated with decreased prefrontal dopamine levels (Engert, Joobert, Meaney, Hellhammer & Pruessner, 2009). Another study showed that during a conflict resolution interaction with their parents, adolescents with larger amygdale volume maintained aggressive affective behaviors for a longer duration, and decreased left OFC volume in males was associated with greater reciprocity of dysphoric behaviors during parent-adolescent interactions (Whittle et al., 2008). These studies together with ours suggest that variations in parenting practices in an adolescent's daily life might be associated with dynamic changes in the neural systems of their offspring. However, because of the cross-sectional nature of these previous studies authors were unable to determine whether differences in the neural transmission system or the regional brain volume resulted from, or represented early predictors of parental practice. Our longitudinal study established a causal relationship between parent decision-making styles and the development of adolescent affective decision-making capacity. However, in order to investigate the underlying neural mechanisms, future functional imaging studies are warranted.

In the present study, we found that parent-child engagement in decision-making predicted IGT performance but not SOPT scores one year later. Given the behavioral nature of this study, we can only speculate on the underlying neural mechanisms. Extensive clinical research as well as functional imaging studies delineate the OFC/VMPC as one of the key neural structures important for normal IGT performance, especially when working memory capacities are intact (Bechara, 2004; Li, et al., in press). On the other hand, the DLPC region is one of the key structures important for normal working memory task performance, such as

the SOPT (Petrides et al., 1993). Studies indicate that the OFC/VMPC is involved in executive functions (EFs) that are influenced by affect, such as best-guess estimation, and tasks involving monetary gains and losses (Elliott, Rees & Dolan, 1999; Kringelbach, 2005). The DLPC, in contrast, appears to be relevant to aspects of EFs that are less influenced by affect, such as response inhibition, manipulating information on-line, considering options, and updating performance outcomes (Fletcher, Frith & Rugg, 1997; Goel & Dolan, 2000). Previous studies also demonstrate that during development, the functional maturation process of the OFC/VMPC can be distinguished from the maturation of other prefrontal regions such as the DLPC (Hooper et al., 2004; Overman et al., 2004). Indeed, researchers have proposed that, whereas adolescents of age 16 or older may possess the same level of logical competencies as adults, these adolescents still show age variance in their actual decision-making ability due to different age-related social and emotional factors (Steinberg, 2005). One of these social and emotional factors is peer influence. In the presence of peers, adolescents are more likely to engage in risky behaviors than when acting alone (Gardner & Steinberg, 2005). The results from our study also suggest that parental decision-making styles might be another social and emotional factor with lasting impact on adolescent neuropsychological functions, especially those relating to emotion regulation and affective decision-making.

Importantly, we also found that parent-child engagement in decision-making significantly predicted the development of binge-drinking behaviors. These results are consistent with previous findings that differences in child rearing styles have a profound effect on a host of outcomes such as psychological competence, adaptive functioning, adjustment, and alcohol and tobacco use among adolescents (Gerra, et al., 2009; Shek, 1999). Buri (1991) and Baumrind (1971) have proposed three distinct prototypical patterns of parenting styles: permissive, authoritarian, and authoritative (Baumrind, 1971; Buri, 1991). In our study, parents who made solitary decisions without asking for their adolescent's opinion might be similar to authoritarian parents. Authoritarian parents tend to be less warm than other parents and value unquestioned obedience from their children. They allow children very little input into how things are run in the household or their lives (Buri, 1991). Previous studies indicate that authoritarian styles have been associated with various negative outcomes. For example, studies on the parenting patterns of mothers and fathers of drug-dependent individuals report that their fathers tend to be rejecting and lacking in emotional warmth and their mothers tend to be dominant and authoritarian (Gerra et al., 2009). The harsh and demanding parenting practices were also associated with higher levels of parent-adolescent conflict as well as low self-esteem, hopelessness, and mental illness (Shek, 1999). Interestingly, in our study, adolescents whose parents made solitary decisions for them also reported the highest levels of parental monitoring and lowest levels of family support. Indeed, perceived high paternal control and low paternal care form a pattern characteristic of "affectionless control" which has been previously reported in individuals with substance use disorders (Torresani, Favaretto & Zimmermann, 2000).

Working memory was significantly correlated with school performance both at baseline and year one. However, after entering all the neuropsychological variables, our linear regression model showed that IGT net scores, and not working memory, significantly predicted academic performance one year later. Although some cross-sectional studies indicate that working memory is highly correlated with fluid intelligence and other high-level cognitive skills such as reading, mathematics and reasoning (Jarrold & Towse, 2006), other longitudinal studies suggest that strengths such as self-discipline (Duckworth & Seligman, 2005) and emotional intelligence (EI) (Gil-Olarte Marquez, Palomera Martin & Brackett, 2006), instead of general intelligence such as IQ, are better predictors of the development of adolescent academic performance. Certainly, self-discipline and EI share some common

neural underpinnings with affective decision-making (Bar-On, Tranel, Denburg & Bechara, 2003).

Several limitations of this study exist. First, parent-child engagement in decision-making was measured using adolescent self-reports that may not reflect the actual behavior and attitudes of parents. However, research suggests that adolescents' perceptions of their parents behaviors are more effective predictors of adolescent development than the actual behavior of the parents (Gray & Steinberg, 1999). Second, in our study, the sample sizes of adolescent binge drinkers are relatively small compared to many samples of western adolescents reported in the literature. Although the prevalence of substance use in our sample was very similar to that of other large-scale population studies of students in China (Johnson, 2006; Xing, Ji & Zhang, 2006), future studies are needed to establish generalization to other cultural/environmental settings. Third, since this longitudinal study was limited to two waves, it is possible that there might be a bidirectional relationship between parental decision-making styles and affective decision-making. In this study, we found that parent-child engagement in decision making predicted the development of adolescent decision-making capacity one year later. It is also possible that adolescent decision-making capacity might have influenced the way their parents made decisions. Future studies should test this hypothesis. Other limitations related to the fact that there were 13.9% of attrition rate in this study. However, since there is no reason to believe that those who dropped out of the study were systematically different from those who remained in the study, there is only a small potential for attrition bias. Finally, although the internal consistency for perceived parental monitoring is relatively low in this study (0.68), a commonly-accepted rule of thumb is that an internal consistency of 0.6–0.7 indicates acceptable reliability.

In summary, the longitudinal study reported here indicates that discouraging adolescents from engaging in their decision-making process may retard the development of affective decision making capacity and increase the risk for substance use. Conversely, involving adolescents in decisions that affect them might foster the development of skills in self-regulation and decision-making, and reduce risk for substance use in the long-term.

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Figure 1. Perceived parental monitoring and perceived family support by groups with different parent-child engagement in decision-making. * $P < 0.05$.

Figure 2.

The IGT net scores $((C'+D')-(A'+B'))$ by group across five blocks of 20 cards expressed as mean+S.E. at Time 1 (left panel) and Time 2 (right panel). Positive net scores reflect advantageous (non-impaired performance) while negative net scores reflect disadvantageous (impaired) performance.

Table 1

Demographic Characteristics

Decision-maker(s)	School Type		Gender		Age	
	academic % (n)	vocational % (n)	Male % (n)	Female % (n)	Mean (SD)	
Parents solitary decision makers	10.6 (11)	20.2 (18)	15.3 (15)	14.9 (14)	16.24 (0.75)	$F_{(3,188)}=0.76$
Joint process but parents decide	36.9 (38)	30.3 (27)	36.7 (36)	30.9 (29)	16.13 (0.59)	$\chi^2_{(3)}=2.66$ $P=0.45$
Joint process but adolescent decides	35.0 (36)	38.2 (34)	37.8 (37)	35.1 (33)	16.20 (0.51)	$P=0.52$
Adolescent decides	17.5 (18)	11.2 (10)	10.2 (10)	19.1 (18)	16.35 (0.54)	
Total	100 (103)	100 (89)	100 (98)	100 (94)	16.21 (0.59)	

Table 2

Partial correlations controlling for age, gender and school type

	1	2	3	4	5	6
Time 1 Variables						
1. IGT Net Scores	-	0.04	0.05	0.36***	0.11	0.18*
2. Working Memory		-	0.32***	0.14	0.54***	0.27***
3. Academic Performance			-	0.07	0.13	0.63***
Time 2 Variables						
4. IGT Net Scores				-	0.20*	0.16*
5. Working Memory					-	0.21**
6. Academic Performance						-

Note:

* $P < 0.05$;

** $P < 0.01$;

*** $P < 0.001$

Table 3

Neuropsychological functions and academic performance at Time 1 and Time 2

Decision-maker(s)	IGT Net Scores		Difference between Time 1 and Time 2		Working Memory		Difference between Time 1 and Time 2		Academic Performance		Difference between Time 1 and Time 2	
	Time 1 Mean(SD)	Time 2 Mean(SD)			Time 1 Mean(SD)	Time 2 Mean(SD)			Time 1 Mean(SD)	Time 2 Mean(SD)		
Parents solitary decision makers	0.5(19.7)	-2.8 (28.5)	$t_{28}=0.93; P =0.36$		60.1 (6.8)	60.5 (6.6)	$t_{28}=-0.20; P =0.84$		3.2(1.1)	3.1 (1.1)	$t_{28}=1.70; P =0.1$	
Joint process but parents decide	0.8(21.2)	14.0(28.8)	$t_{64}=3.81; P <0.001$		62.5 (6.0)	63.0 (6.3)	$t_{64}=0.73; P =0.47$		3.4 (1.1)	3.5 (1.0)	$t_{64}=0.00; P =1.0$	
Joint process but adolescent decides	5.7 (24.6)	14.2 (34.6)	$t_{69}=2.10; P <0.05$		61.7 (7.1)	62.1 (7.14)	$t_{69}=0.65; P =0.52$		3.6 (1.0)	3.5 (0.9)	$t_{69}=0.44; P =0.66$	
Adolescent decides	4.6(20.4)	15.4 (32.2)	$t_{27}=2.05; P <0.05$		60.0 (6.8)	63.1 (4.80)	$t_{27}=2.51; P <0.05$		3.5 (1.2)	3.3 (1.0)	$t_{27}=1.70; P =0.10$	

Table 4

Summary of linear regression analysis for predicting IGT Net Scores at Time 2 (Model 1), working memory at Time 2 (Model 2) and school academic performance at Time 2 (Model 3)

	Model 1 (DV=IGT Net Scores at Time 2)				Model 2 (DV=Working Memory at Time 2)				Model 3 (DV=Academic Performance at Time 2)			
	B	S.E.	Beta	95% CI for B	Lower	Upper	B	S.E.	Beta	95% CI for B	Lower	Upper
Age	-3.16	3.98	-0.06	-11.01	4.69	0.51	0.51	0.68	0.05	-0.84	1.86	0.01
Gender (Reference=Female)	5.37	4.56	0.09	-3.61	14.35	0.9	0.78	0.07	0.07	-0.66	2.45	-0.1
School type (Reference=Academic)	-7.99	5.5	-0.13	-18.86	2.87	-4.44	0.95	-4.58***	0.14	-6.03	-2.41	0.11
Time 1 Variables												
IGT Net Scores	0.53	0.11	0.35***	0.31	0.75	0.03	0.02	0.09	0	-0.02	0.06	0.14*
Working memory	0.48	0.37	0.11	-0.25	1.21	0.51	0.07	0.52***	0.01	0.38	0.63	0.04
Academic Performance	-0.19	2.51	-0.01	-5.13	4.76	-0.45	0.44	-0.07	0.06	-1.31	0.42	0.67***
The person make decisions (Reference= Parents solitary decision makers)												
Joint process but parents decide	14.52	7.16	0.22*	0.37	28.66	0.63	1.23	0.04	0.18	-1.81	3.06	0.08
Joint process but adolescent decides	12.82	6.98	0.20#	-0.98	26.62	0.32	1.2	0.02	0.13	-2.06	2.69	0.07
Adolescent decides	19.16	8.44	0.21*	2.53	35.83	1.05	1.47	0.05	0.03	-1.86	3.95	0.01

Note: B=regression unstandardized beta weights; S.E.=Standard Error; CI=confidence interval; DV=Dependent Variable;

P<0.1;

* P<0.05;

*** P<0.001;

In bold are the P-value statistically significant at the 1%, 5% or marginally significantly at 10% level

Table 5

The distributions of binge-drinkers at both Time 1 and Time 2

Decision-maker(s)	Binge Drinkers			Difference between Time 1 and Time 2
	N	Time 1	Time 2	
		n (%=n/N))	n (%=n/N))	
Parents solitary decision makers	29	2 (6.9)	8 (27.6)	$t_{28}=2.27; P <0.05$
Joint process but parents decide	65	7 (10.8)	6 (9.2)	$t_{64}=0.81; P=0.42$
Joint process but adolescent decides	70	7 (10.0)	6 (8.6)	$t_{69}=0.45; P =0.66$
Adolescent decides	28	3 (10.7)	1 (3.6)	$t_{27}=1.44; P =0.16$

Table 6

Summary of logistic regression analysis for predicting binge drinkers at Time 2

	B	S.E.	OR	95% CI for B	
				Lower	Upper
Age	0.62	0.47	1.85	0.74	4.65
Gender (Reference=Female)	1.51	0.69	4.51 *	1.17	17.43
School type (Reference=Academic)	0.62	0.61	1.86	0.56	6.21
Binge drinkers at Time 1	3.61	0.77	22.05 ***	8.19	166.78
The person make decisions (Reference=Parents solitary decision makers)					
Joint process but parents decide	-2.36	0.85	0.09 *	0.01	0.49
Joint process but adolescent decides	-1.92	0.73	0.15 *	0.04	0.61
Adolescent decides	-3.64	1.38	0.03 *	0.02	0.4

Note: B=regression unstandardized beta weights; S.E.=Standard Error; OR=Odds Ratio; CI=confidence interval;

* P<0.05;

*** P<0.001;

In bold are the ORs statistically significant at the 1% or 5% level