

# Adolescence effortful control as a mediator between family ecology and problematic substance use in early adulthood: A 16-year prospective study

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## Abstract

This study examined the mediated effect of early adolescence familial context on early adulthood problematic substance use through effortful control in late adolescence. The sample consisted of a community sample of 311 adolescents and their families comprising the control group within a randomized trial intervention. Parental monitoring and parent–child relationship quality (P-C RQ) were measured annually from ages 11 to 13. Effortful control was measured by self-reports and parent and teacher reports at ages 16 to 17. Self-reports of problematic tobacco, alcohol, and marijuana use were measured at ages 18 to 19, 21 to 22, 23 to 24, and 26 to 27. Structural equation modeling was employed to test hypothesized models. Only P-C RQ was found to be significantly associated with adolescent effortful control. As expected, higher levels of adolescent effortful control were associated with lower problematic substance use through early adulthood, controlling for previous substance use levels. Mediation analyses showed that effortful control significantly mediated the relationship between P-C RQ and problematic substance use. Higher relationship quality between youth and parents in early adolescence is associated with higher effortful control, which in turn relates to a lower level of problematic substance use in early adulthood.

The costs and consequences of drug dependence and abuse to the community and the lives of young adults are noteworthy (National Institute on Drug Abuse, 2015). For example, costs associated with alcohol abuse and dependence are directly related to lost work productivity, increased healthcare expenditure, and increased criminal justice expenses, including motor vehicle accidents (Centers for Disease Control and Prevention, 2016). The adverse health effects of tobacco dependence are also substantial. Almost \$170 billion per year is spent as direct medical care costs for adults who are nicotine dependent (Xu, Bishop, Kennedy, Simpson, & Pechacek, 2014). Smoking cigarettes causes close to 6 million deaths per year worldwide. Smoking will cause an additional approximately 8 million deaths annually by 2030 due to the aging population (World Health Organization, 2011). Marijuana is one of the most widely used drugs in the world. Marijuana abuse and dependence are suggested to increase the risk of various health and psychosocial problems, including psychosis, neurocognitive decline, sexually transmitted diseases, dropout from school, legal issues, and loss of educational

and occupational aspirations (Budney, Roffman, Stephens, & Walker, 2007; Di Forti et al., 2012; Meier et al., 2012; Rubino & Parolaro, 2016). Of interest, therefore, is an understanding of the ecology of protective factors that predict who is less likely to move an adolescent from drug use exploration to developing problematic behaviors in using substances in early adulthood. The family in general and parenting in particular are important for understanding risk and protection, as such information can be disseminated to the general public and because prevention programs can improve with respect to parenting targets (Spoth, Kavanagh, & Dishion, 2002).

Problematic substance use, such as abuse and dependence, is often understood as behavioral representations of an individual's inability to decide autonomously to control use (e.g., Baumeister, Vohs, & Tice, 2007; Koob & LeMoal, 1997). An individual difference factor that may be closely related to problematic substance use is *effortful control*. Effortful control reflects an individual's ability to regulate approach and avoidance of behavior in the face of immediate cues for reward or punishment, and involves the regulation of attentional processes, goal-directed attention persistence, and the inhibition of behavior (Miller & Byrnes, 2001; Rothbart, 2012; Rothbart & Posner, 1995). Individual differences in effortful control support complex emotional and behavioral regulation, which underlies appropriate and adaptive life decisions. For instance, a previous study revealed that individual differences in effortful control can account for movement

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from drug experimentation to dependence from adolescence to early adulthood, while controlling for peer influences (Piehler, Véronneau, & Dishion, 2012). Several other studies suggest that individuals with lower effortful control are more likely than those who report higher levels of effortful control to use both legal and illicit drugs (Novak & Clayton, 2001; Patock-Peckham, Cheong, Balhorn, & Nagoshi, 2001; Wills, DuHamel, & Vaccaro, 1995). Effortful control ability is regarded as an important facet of drug use disorders (Lyvers, 2000) in diagnostic evaluations such as the Diagnostic and Statistical Manual of Mental Disorders and International Classification of Diseases (Bell, Foxe, Ross, & Garavan, 2014). Hence, we may consider effortful control to be an important target of the prevention and treatment of problematic substance use.

Although effortful control is understood as being a facet of temperament with a genetic basis (e.g., Rothbart & Bates, 1998), the general consensus is that it can be refined and supported by environmental factors such as parenting one receives in childhood (Eisenberg et al., 2005; Karreman, van Tuijl, van Aken, & Dekovic, 2008; Rothbart & Bates, 2006). However, the connection between parenting and effortful control in adolescence is not well understood. It is generally suggested that effortful control rapidly develops in the early developmental stage ranging from 0 to 11 years (Davidson, Jackson, & Kalin, 2000; Eisenberg, 2012; Kochanska, Murray, Jacques, Koenig, & Vandegest, 1996) and it remains as a stable characteristic over the course of the life span. Thus, most studies that examined the environmental factors influencing development of effortful control so far have focused on childhood influences (Eisenberg, Spinrad, & Eggum, 2010).

Two factors, however, provide a rationale for the importance of examining the association between parenting and effortful control in adolescence. First, during adolescence many children still spend much time with their parents. Adolescents have numerous opportunities to learn skills to regulate their attention, emotions, and behavior to pursue their important personal goals through engaging in interactions and receiving support from their parents. Second, effortful control is under the direct influence of the executive attention network that includes the anterior cingulate cortex (ACC) and lateral prefrontal cortices (Posner, 2012; Rothbart & Rueda, 2005; Rothbart, Sheese, & Posner, 2007). The ACC and the lateral prefrontal cortices serve key roles in executive functions such as working memory, planning, and inhibition, and they are known to be the last brain areas to mature: they are likely to develop into one's late 20s (Johnson, Blum, & Giedd, 2009; Sowell, Thompson, Holmes, Jernigan, & Toga, 1999). Hence, adolescence is still a developmentally important stage for studying the influence of parenting on effortful control.

A parenting skill relevant from infancy through young adulthood is *parental monitoring*. It entails a collection of parenting skills that involves attention to, monitoring, and structuring a child's whereabouts and activities (Dishion & McMahon, 1998). Higher parental monitoring is associated with fewer problem behaviors (Fosco, Stormshak, Dishion,

& Winter, 2012; Lippold, Greenberg, Graham, & Feinberg, 2014; Patterson & Stouthamer-Loeber, 1984; Sampson & Laub, 1994), and substance use (Blustein et al., 2015; Branstetter, & Furman, 2013; Dishion & Loeber, 1985; Flannery, Vazsonyi, Torquati, & Fridrich, 1994; Fletcher, Darling, & Steinberg, 1995). Others have argued that the effect of parental monitoring on youths' behavioral problems can be mediated by youths' self-control ability (Kort-Butler, Tyler, & Melander, 2011). A number of previous studies found that parental supervision and monitoring have a significant association with youths' self-control (Hay & Forrest, 2006; Hope, Grasmick, & Pointon, 2003; Meldrum, 2008). Perhaps, if their parents track and structure their children's behavior through physical modification and rule setting, children may learn overall guidelines for their behaviors and in regulating emotions. It may be possible that parental monitoring can help prevent youths from abusing and becoming dependent on substances by promoting youths' effortful control ability.

*Parent-child relationship quality* is also highly relevant to the development of effortful control. Specifically, a warm and supportive parent-child relationship can contribute to the development of children's effortful control competencies by sustaining optimal arousal levels (e.g., emotionally positive parent-child relationships), providing a predictable and organized home environment, and by parents showing appropriate social skills to maintain good interpersonal relationships (Brody & Ge, 2001; Feldman & Klein, 2003). Eisenberg, Cumberland, and Spinrad (1998) argued that parents can facilitate their children's effortful control by demonstrating effective ways to handle their emotions and behaviors, and by developing healthy parent-child relationships. A number of previous studies suggest that higher supportive and warm parenting is associated with higher effortful control ability (Belsky, Pasco Fearon, & Bell, 2007; Gilliom, Shaw, Beck, Schonberg, & Lukon, 2002; Spinrad et al., 2007; Valiente, Lemery-Chalfant, Swanson, & Reiser, 2006). Furthermore, some studies found parents' emotional support and open communication with adolescents to predict lower likelihood of youth substance use (Wills & Clearly, 1996; Wills et al., 2001; Wills & Yaeger, 2003). Therefore, along with parental monitoring, having a good quality parent-child relationship appears to be an important factor in promoting adolescents' effortful control, which, in turn, may attenuate risks for future problematic substance use.

Although both parental monitoring and relationship quality may affect effortful control, no studies have examined whether these two parenting factors are differently associated with youths' effortful control ability. While both of them may be uniquely related to youths' effortful control, it is possible that one of the two parenting variables is more strongly associated with effortful control.

## The Present Study

To our knowledge, this is the first study to investigate effortful control as a mediator with parental monitoring, parent-

adolescent relationship quality, and problematic substance use based upon extensive (early adolescence to early adulthood) longitudinal data. Specifically, the present study followed a community sample of adolescents from ages 11 to 26–27 to test the following two hypotheses. First, we hypothesized that both parental monitoring and parent–adolescent relationship quality measured in early adolescence could predict effortful control in middle adolescence. It is expected that higher parental monitoring and parent–adolescent relationship quality would be associated with greater effortful control. However, the magnitude of these associations might differ. Second, it is hypothesized that the greater level of effortful control in adolescence would be associated with less problematic substance use behaviors in early adulthood.

## Method

### Participants

The present study is a secondary data analysis of a large randomized control trial ( $N = 999$ ) of the Family Check-Up intervention study (Dishion & Kavanagh, 2003). The original randomized longitudinal field trial (PAL 1) included a sample of 999 multiethnic young adolescents who attended three public middle schools in the northeast Portland, Oregon, metropolitan community and their families. The sample is divided into two cohorts of youth. Cohort 1 ( $n = 676$ ) was recruited and assessed in Grade 6 in the 1996–1997 academic year and Cohort 2 ( $n = 323$ ) in the 1998–1999 academic year. All families in three public middle schools were invited to complete a light assessment at the school only. Ninety percent of the students consented to complete the light assessment. As we primarily focus on examining a developmental process of problematic substance use, only participants from the control group ( $n = 498$ ) were drawn and used. Control group participants were observed longitudinally without receiving any interventions. A schoolwide behavioral risk screener (Teacher Risk Perception Questionnaire; Soberman, 1994) assessed students' self-management, behavior problems, and affiliation with problem peers. The screener enabled the division of the sample into three different risk groups: low-risk group, at-risk group, and high-risk group. Families were invited into an additional assessment if the student was deemed as at risk or high risk (assessment was more intense for these groups). As some baseline predictor variables of the present study were available only for the at-risk and high-risk groups, only participants and families from these two groups were used. As a result, 311 participants from the control group who belong to the at-risk and high-risk groups were part of the present study.

This subsample included 46.9% females and was ethnically diverse (36.3% Caucasian, 32.5% African American, 6.8% Hispanic, 1.6% Native American, 3.9% Asian, and 18.9% other). Parent reports collected when their adolescent was 16–17 years old revealed that 32.2% of the participants lived with both biological parents, 43.2% lived with their biological

mother, 9.7% lived with their biological father, and 14.9% lived in other family configurations. At the initial interview, the median range of gross annual household income was \$30,000 to \$39,999, with 29.7% of households earning less than \$20,000 per year and 9.9% earning more than \$90,000. All parents and youth consented to participate in the study, and all procedures of the study were reviewed and approved by the Institutional Review Board at the University of Oregon.

### Procedure

A detailed description of the Family Check-Up intervention is available from a number of previously published papers (e.g., Connell, Dishion, Yasui, & Kavanagh, 2007; Dishion & Kavanagh, 2003). From ages 11 to 13, yearly surveys primarily took place in the school context and through the mail. Parents and youth were followed and assessed regardless of what school the student was attending. At ages 16–17, participants were assessed at school or through other means (e.g., home visit and mail). After participants graduated from high school, they were primarily assessed through the mail. To minimize attrition, we asked participants at each wave of data collection to provide other people's contact information (e.g., friends or extended family members) who could help us find them if they had moved before the next wave of data collection. Participants received \$5 for sending their new contact information when they moved. As a result, longitudinal retention rates were overall high, with approximately 80% of youths being retained across the study span from ages 11 to 26–27. All respondents were assured of the confidentiality of their responses and compensated for their participation.

### Measures

*Parental monitoring (ages 11 to 13).* Parental monitoring was measured with the House Rules Questionnaire (HRQ; French & Weih, 1990) annually from ages 11 to 13. It consists of 21 items with a 5-point rating scale ranging from 1 (*almost always true*) to 5 (*almost always false*). Parents and youths responded to this measure. The HRQ assesses the extent to which parents control their child's household rules, responsibility, and unsupervised free times. Sample items include "be home after school by a certain time," "finish his/her chores before s/he is allowed to go out with friends," and "know(s) which friends my child hangs out with after school." Parent and youth reports were collected annually. The mean of 21 items was computed for each assessment separately for parent and youth reports. Higher scores indicate greater parental monitoring. This measure has been used in previous peer-reviewed studies (i.e., Kjellstrand & Eddy, 2011; Van Ryzin, Johnson, Leve, & Kim, 2011). Internal consistency for both parent and youth reports were acceptable (parent  $\alpha = 0.79$ – $0.84$  and youth  $\alpha = 0.84$ – $0.85$ ).

*Parent–child relationship quality (P-C RQ; ages 11 to 13).* P-C RQ was measured using two youth-report measures.

The first, Positive Parent–Child Relations (Child and Family Center, 2001; Dishion, Ha, & Véronneau, 2012), consists of six items that are rated on a Likert scale ranging from 1 (*never true*) to 5 (*always true*). It assesses the extent to which parents and children show trust, comfort, and enjoyment in their relationships. It includes statements such as “I really enjoy being with my parents” and “My parents trust my judgment.” Mean scores were created for each of the annual assessments; Cronbach  $\alpha$ s ranged from 0.89 to 0.90. The second scale, Parent–Child Conflict (Child and Family Center, 2001; Dishion et al., 2012), included five items reflecting how frequently parents and child engaged in conflict behaviors, such as “parent and youth got angry at each other,” “had big argument about little thing,” and “argued at the dinner table.” Each item was scored on a scale ranging from 0 (*never*) to 7 (*more than seven times*). Items describing parent–child conflict were reversed to render the P-C RQ score. Mean scores were created for each annual assessment. Cronbach  $\alpha$ s ranged from 0.71 to 0.81.

*Effortful control (ages 16 to 17).* Effortful control was measured by youth, parent, and teacher reports at ages 16 to 17. For parent and youth reports, we used the effortful control scale from the Early Adolescent Temperament Questionnaire—Revised (EATQ-R; Ellis & Rothbart, 2001). The EATQ-R effortful control scale consists of 16 items that assess activation control, attention, and inhibitory control. Each item has a 5-point Likert scale ranging from 1 (*almost always untrue*) to 5 (*almost always true*). Higher scores indicate greater effortful control. The youth and parent reports of effortful control essentially include the same items, with the pronouns changed appropriately (e.g., “I” to “My child”). For the parent report, participants and caregivers could complete the effortful control scale. When multiple caregivers responded, their answers were averaged into one parent-report score. Cronbach  $\alpha$  for this scale was 0.80 for youth reports and 0.87 for parent reports. The teacher report of effortful control consisted of five items similar to those of the EATQ-R effortful control scale and included activation control, inhibitory control, and attention components (i.e., “thinks ahead of time about the consequences of actions,” “plans ahead before acting,” “pays attention to what he or she is doing,” “works toward goals,” and “sticks to what he or she is doing until it is finished, even with unpleasant tasks”). During the family assessment, youths were asked to identify two teachers who know them very well. One of these two teachers was randomly selected and completed the questionnaire. Teachers used the identical 5-point Likert scale to assess how frequently each participant engaged in these behaviors. The internal consistency of the teacher report was 0.94.

*Early adulthood problematic substance abuse (ages 18–19 to 26–27).* Problematic substance (tobacco, alcohol, and marijuana) use index scores were measured four times between ages 18–19 to 26–27 (i.e., at ages 18–19, 21–22, 23–24, and 26–27) except tobacco (it was not measured at ages 26–27). The items for problematic substance use behaviors

were based upon interview items from the Composite International Diagnostic Interview (Andrews & Peters, 1998). For problematic alcohol use, the questions were “Have you ever tried to stop using alcohol and found you could not?” (*Yes/No*); “Have you found that you cannot get as buzzed as used to?” (*Yes/No*); “Have you ever gone to school or work when you were drunk?” (*Yes/No*); “When you get buzzed, how much do you get buzzed?” (4-point scale: 0 = *did not get buzzed*, 1 = *a little bit*, 2 = *quite a bit*, and 3 = *very much*); and “How many times had five or more drinks in a row over the last 3 months?” (6-point scale: 0 = *never*, 3 = *3 to 5 times*, 5 = *more than 10 times*). The last two items were rescaled to the 0 to 1 range. To be specific, the fourth item was divided by three and the fifth item was divided by five. This rescaling does not affect correlations, the proportion of variance explained, or the significance of results (see Cohen, Cohen, West, & Aiken, 2003). For problematic marijuana use the items were “Have you ever tried to stop using marijuana and found you could not?” (*Yes/No*); “Have you found that you cannot get as high as used to?” (*Yes/No*); “Have you ever gone to school or work when you were high?” (*Yes/No*); “Have you ever had any problems related to school or work, such as not doing assignments or forgetting things, because of marijuana?” (*Yes/No*); and “When you get high, how much do you get high?” (4-point scale: 0 = *did not get high*, 1 = *a little bit*, 2 = *quite a bit*, and 3 = *very much*). Again, the last item was rescaled to 0 to 1 range by dividing it by 3. We computed the sum of problematic alcohol and marijuana use items, and the scores ranged from 0 to 5. For problematic tobacco use, we asked only one question (“Have you ever tried stop using tobacco and found you could not?”) because other problematic substance use items were more appropriate for alcohol or marijuana use. Piehler et al. (2012) used and validated these measures previously.

#### Covariates

*Self-control (ages 11 to 13 years).* As we did not measure effortful control at ages 11 to 13, we used self-control from ages 11 to 13 as a proxy covariate measure of effortful control. Children’s self-control was assessed by the self-reported Children’s Perceived Self-Control Scale (CPSCS; Humphrey, 1982). CPSCS consists of 11 items that assess children’s various cognitive and behavioral self-regulations skills. Cronbach  $\alpha$ s for the CPSCS from ages 11 to 13 were low. Systematic investigation showed that 3 items consistently contributed to low reliability; we thus dropped them to increase the internal validity. The three items were “If someone bothers me, I ignore them”; “I know when I am doing wrong without being told”; and “If work is too hard, I switch what I am doing.” After we reduced the items, the reliability was acceptable across ages 11 to 13 ranging from 0.74 to 0.79. Higher scores indicate higher self-control.

*Levels of tobacco, alcohol, and marijuana use (ages 16 to 17 years).* At ages 16 to 17, participants reported the level of

their tobacco, alcohol, and marijuana use over the past 3 months, respectively. This measure uses a Likert-type scale that ranges from 0 (*never*) to 7 (*2 or 3 times a day or more*). This measure has demonstrated good stability and predictive validity of later substance use (Van Ryzin, Fosco, & Dishion, 2012). It also has been used in a number of intervention studies (e.g., Stormshak et al., 2011; Van Ryzin, Stormshak, & Dishion, 2012).

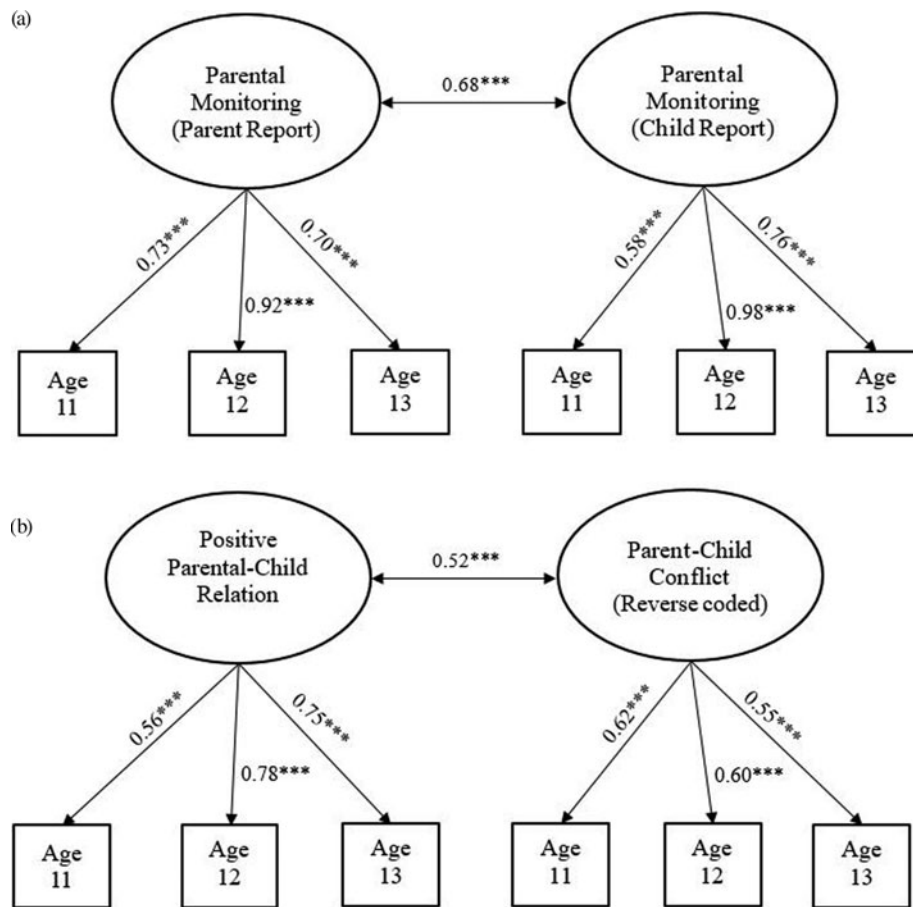
### Strategy for analyses

First, we calculated descriptive statistics and multivariate outlier analyses using Cook's distance and leverage statistics to identify influential data (Cook, 1977; Neter, Wasserman, & Kutner, 1989). Second, we employed structural equation modeling to test the two study hypotheses using Mplus software (Version 7; Muthén & Muthén, 1998–2012). As there were too many parameters to include all three outcomes (i.e., problematic tobacco, alcohol, and marijuana use) in the same model, we used three models examining one outcome measure at a time. Each of these models tested how parental monitoring and P-C RQ differently predicted effortful

control (Hypothesis 1), and whether greater level of effortful control was associated with less problematic substance use while controlling for family ecology factors (Hypothesis 2).

We constructed the parental monitoring latent variable by using factor scores of parent and child reports of parental monitoring latent variables that were measured across ages 11 to 13. P-C RQ latent variable was also constructed by using factor scores of two different child-report latent variables (i.e., Positive Parent–Child Relations and Parent–Child Conflict) that we measured across ages 11 to 13. Prior to exporting these factor scores, we conducted confirmatory factor analyses to examine model fit and factor loadings. Figure 1 presents more detailed results on these confirmatory factor analyses. To determine model fit, we used the comparative fit index (CFI; critical value  $\geq 0.90$ ; Bentler, 1990), standardized root mean square residual (SRMR; critical value  $\leq 0.10$ ; Kline, 1998), and the root mean square error of approximation (RMSEA; critical value  $\leq 0.08$ ; Steiger, 1990).

For the problematic alcohol and marijuana use models, we used the maximum likelihood estimation with robust standard errors estimator, as indicators of problematic alcohol and marijuana use latent variables were nonnormally distributed.



**Figure 1.** (a) Confirmatory factor analysis of parent- and child-report parental monitoring latent variables. Root mean square error of approximation = 0.05, comparative fit index = 0.99, standardized root mean square residual = 0.04. \*\*\* $p < .001$ . (b) Confirmatory factor analysis of parent–child positive relation and parent–child conflict latent variables. Root mean square error of approximation  $< 0.001$ , comparative fit index = 1.00, standardized root mean square residual = 0.02. \*\*\* $p < .001$ .

The weighted least squares means and variances (Muthén, du Toit, & Spisic, 1997) estimator was used for the problematic tobacco use model, as the indicators of this latent variable were all binary variables. Finally, we tested mediated effects using the Rmediation program (Tofghi & MacKinnon, 2011), which examines asymmetric confidence limits of mediated effects. This method has shown good statistical power and excellent control of Type I error rates (MacKinnon, Lockwood, & Williams, 2004). The Rmediation software calculates the 95% upper and lower confidence intervals for the mediated effect. If zero is not included in the confidence interval, the mediated effect is assumed as significant. Missing data was handled by full information maximum likelihood based on the missing at random assumption. To increase the estimation precision of missing data, we included teacher's risk perception, antisocial behavior, and substance use level at the baseline as auxiliary variables.

## Results

### *Preliminary analyses*

Table 1 summarizes analyses of descriptive statistics and missing data. Skewness (cutoff < 2) and kurtosis (cutoff < 7) of all variables fell within the acceptable range (see West, Finch, & Curran, 1995, for a review) except for some substance use variables. There was a large amount of missing data on parental monitoring variables at ages 11, 12, and 13. We conducted attrition analyses using baseline demographic variables (i.e., gender, ethnicity, grade point average, whether biological father and mother living together, teacher ratings of participants' risk, and substance use) to examine whether there was any systematic bias in the missing data. We found that none of these baseline variables was related to missingness (i.e., participants with and without monitoring data). Multivariate outlier analyses identified no influential cases.

### *Findings of structural equation model*

The model fit of all three final models were acceptable: problematic tobacco use model,  $\chi^2(65) = 81.85$ ,  $p = .08$ , RMSEA = 0.03, and CFI = 0.96; problematic alcohol use model,  $\chi^2(78) = 100.47$ ,  $p < .05$ , RMSEA = 0.03, CFI = 0.98, and SRMR = 0.05; and problematic marijuana use model,  $\chi^2(78) = 134.16$ ,  $p < .001$ , RMSEA = 0.05, CFI = 0.95, and SRMR = 0.05.

*Problematic tobacco use model.* After controlling for self-control in early adolescence, P-C RQ significantly predicted effortful control at ages 16–17 ( $p < .01$ ). However, the effect of parental monitoring in early adolescence on effortful control was not significant ( $p > .05$ ). As expected, individuals with higher effortful control in middle adolescence were less likely to report problematic tobacco use in early adulthood ( $p < .001$ ) over and above the effect of tobacco use in middle adolescence and family-related predictors in early

adolescence (Figure 2). Effortful control significantly mediated between P-C RQ and problematic tobacco use, 95% confidence interval (CI) [−0.867, −0.121], but not with parental monitoring, 95% CI [−0.608, 0.283].

*Problematic alcohol use model.* Consistent with the problematic tobacco use model (Figure 3), P-C RQ significantly predicted effortful control ( $p < .001$ ), but there was no significant association between parental monitoring and effortful control ( $p > .05$ ). Greater effortful control was associated with less problematic alcohol use in early adulthood ( $p < .05$ ). Effortful control significantly mediated between P-C RQ and problematic alcohol use, 95% CI [−0.368, −0.002], but not parental monitoring, 95% CI [−0.199, 0.067].

*Problematic marijuana use model.* In line with the findings of two previous models, only P-C RQ was significantly associated with effortful control ( $p < .001$ ). Higher effortful control also predicted less problematic marijuana use in early adulthood ( $p < .001$ ) while controlling for all covariates (Figure 4). Effortful control again significantly mediated between P-C RQ and problematic marijuana use, 95% CI [−0.809, −0.110], but not parental monitoring, 95% CI [−0.445, 0.155]. Table 2 presents detailed information regarding the mediated effects.

### *Findings of post hoc analyses*

The measure of parental monitoring (HRQ) includes both measures of active parental effort to monitor child and parental knowledge (see Stattin & Kerr, 2000, for a review). As the primary interest of the present study was measuring active parental effort of monitoring, we conducted a post hoc analysis excluding two HRQ items (i.e., “know(s) which friends my child hangs out with after school” and “know(s) or have met most of child's neighborhood friends”) that measure parental monitoring knowledge. The results remained unchanged by including the revised parenting monitoring measure in the mediation models. To be specific, the association between parental monitoring and effortful control (standardized  $B = 0.03$ ,  $SE = 0.12$ ,  $p = .81$ ) remained nonsignificant.

We conducted another post hoc analysis to investigate the effect of the large amount of missing data in parental monitoring measures. We found some items from another child-report questionnaire in the study to represent the concept of parental monitoring. These items include “In the last week, I went places without telling parent”; “In the last week, parent let me go anywhere I pleased”; and “In the last week, I was at friend's house and no parents were around.” We collected these items from ages 11 to 13 and used the 7-point Likert scale. These items had no missing data at baseline (age 11) and a low proportion of missing data at ages 12 and 13. We reversed coded these items and created a new parental monitoring latent variable by using these items from ages 11 to 13, and reran the hypothesized model by switching the parental monitoring latent variable. Findings were consistent with those from our original model. To be specific, we found no

**Table 1.** Descriptive statistics for all study variables

Variables	<i>M</i>	<i>SD</i>	Skewness	Kurtosis	Missing
Parental monitoring (youth)					
Age 11	3.84	0.63	−0.69	0.52	41.8%
Age 12	3.66	0.66	−0.55	−0.24	43.7%
Age 13	3.45	0.67	−0.34	−0.23	68.5%
Parental monitoring (parent)					
Age 11	4.34	0.43	−1.58	4.94	42.1%
Age 12	4.25	0.45	−1.29	1.92	45.3%
Age 13	4.01	0.55	−1.52	3.64	68.8%
Positive parent–child relations					
Age 11	3.60	0.99	−0.47	0.57	0%
Age 12	3.41	0.97	−0.23	−0.67	12.2%
Age 13	3.26	1.04	−0.23	−0.88	16.4%
Parent–child conflict					
Age 11	1.02	1.11	1.70	3.04	0%
Age 12	1.01	0.99	1.53	2.59	12.2%
Age 13	0.99	1.00	1.56	2.45	16.1%
Self-control					
Age 11	2.98	0.73	0.02	0.17	0%
Age 12	2.98	0.67	0.17	0.40	12.2%
Age 13	2.98	0.69	−0.25	0.38	15.8%
Effortful control					
Youth age 16–17	3.30	0.46	0.10	−0.07	21.5%
Parent age 16–17	3.23	0.54	−0.38	0.17	32.8%
Teacher age 16–17	3.59	0.75	−0.01	−0.48	37.0%
Tobacco use level age 16–17	0.90	2.19	2.28	3.49	21.5%
Problematic tobacco use					
Age 18–19	0.11	0.31	2.57	4.64	24.3%
Age 21–22	0.21	0.41	1.42	0.01	19.6%
Age 23–24	0.21	0.41	1.47	0.15	15.4%
Alcohol use level age 16–17	0.79	1.37	1.92	2.74	21.5%
Problematic alcohol use					
Age 18–19	0.90	0.96	0.83	−0.27	23.2%
Age 21–22	1.34	1.12	0.78	−0.17	18.3%
Age 23–24	1.43	1.12	0.68	0.03	13.5%
Problematic alcohol use age 26–27	1.35	1.07	0.65	0.21	20.9%
Marijuana use level age 16–17	0.72	1.69	2.50	5.22	21.5%
Problematic marijuana use					
Age 18–19	1.01	1.46	1.34	0.64	22.5%
Age 21–22	1.25	1.35	1.01	−0.00	19.9%
Age 23–24	1.21	1.33	1.06	0.25	14.8%
Age 26–27	1.20	1.16	1.01	0.34	23.2%

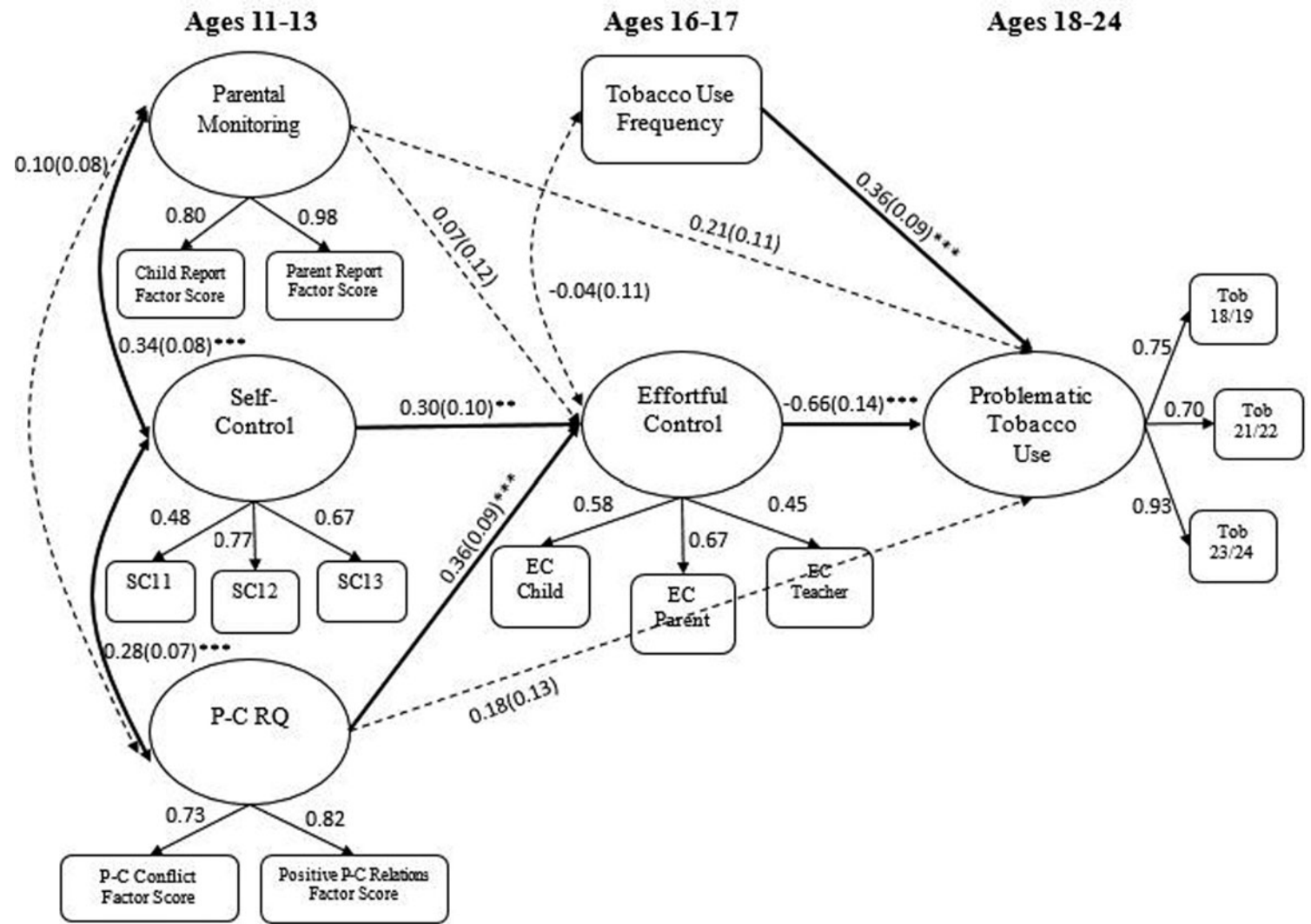
significant association between the new parental monitoring variable and effortful control (standardized  $B = -0.06$ ,  $SE = 0.14$ ,  $p = .64$ ). The association between P-C RQ and effortful control also remained significant ( $B = 0.31$ ,  $SE = 0.12$ ,  $p < .05$ ). Hence, it is less likely that there was a systematic bias in the result due to missingness of parental monitoring variables.

## Discussion

The primary aim of this study was to examine how family ecology in early adolescence is associated with problematic substance use in early adulthood through effortful control in late adolescence. The present findings mostly support our hypotheses. Effortful control was found to be a significant mediator between P-C RQ and problematic substance

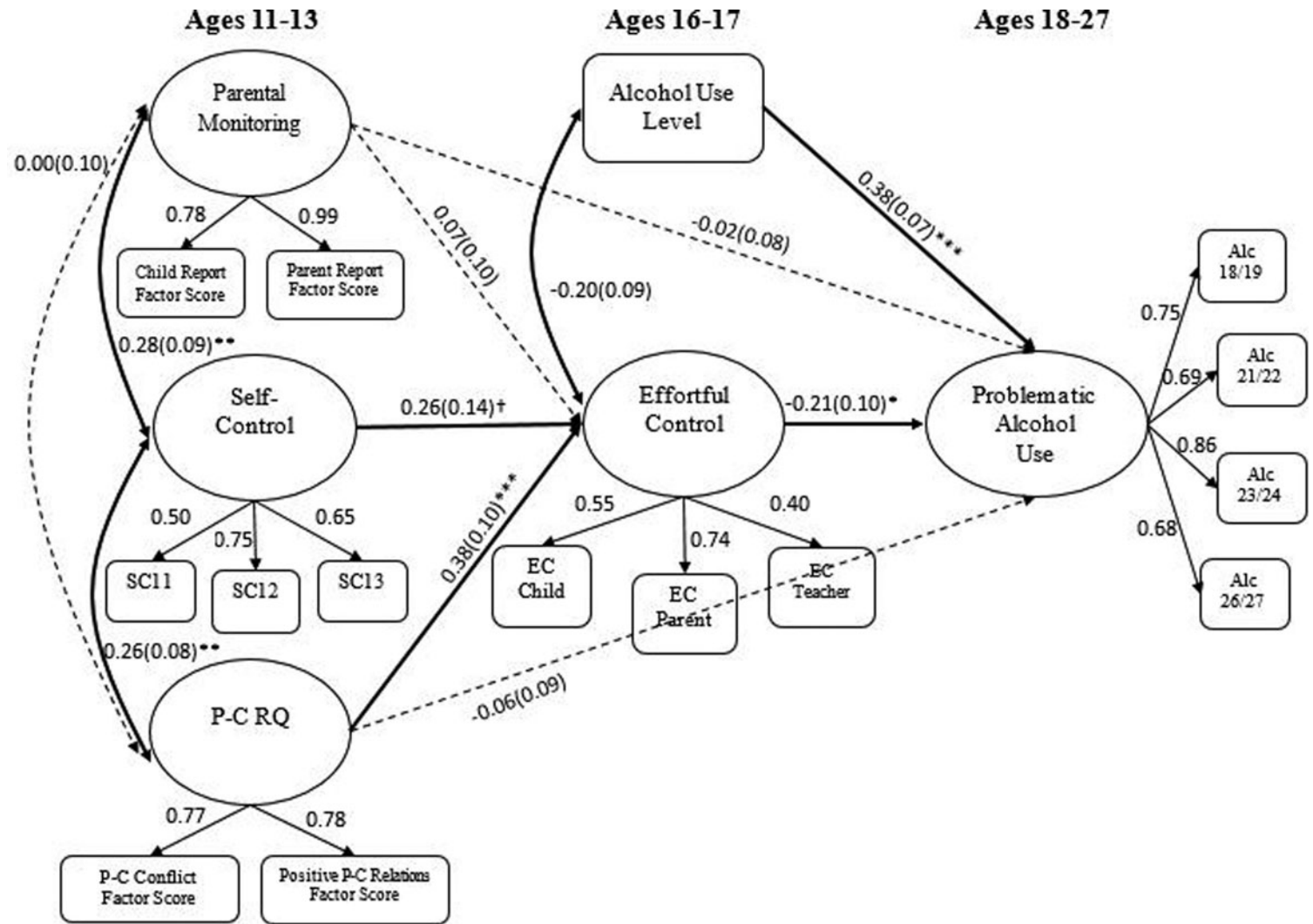
use. Contrary to our expectations, although self-control in early adolescence was moderately correlated with parent monitoring, parental monitoring was not a significant predictor of later effortful control.

Effortful control often has been regarded as a dimension of temperament that develops until childhood (Davidson et al., 2000; Eisenberg, 2012; Kochanska et al., 1996). Hence, most of previous studies that investigate the influence of parental factors on effortful control focus on childhood. However, the findings of the present study support the claim that examining the relationship between parenting practices and effortful control in adolescence can be important. During adolescence youths still spend a significant amount of time with parents and learn to regulate their emotions and behaviors. In addition, over this time, brain areas particularly relevant to function of effortful control, such as the ACC and the

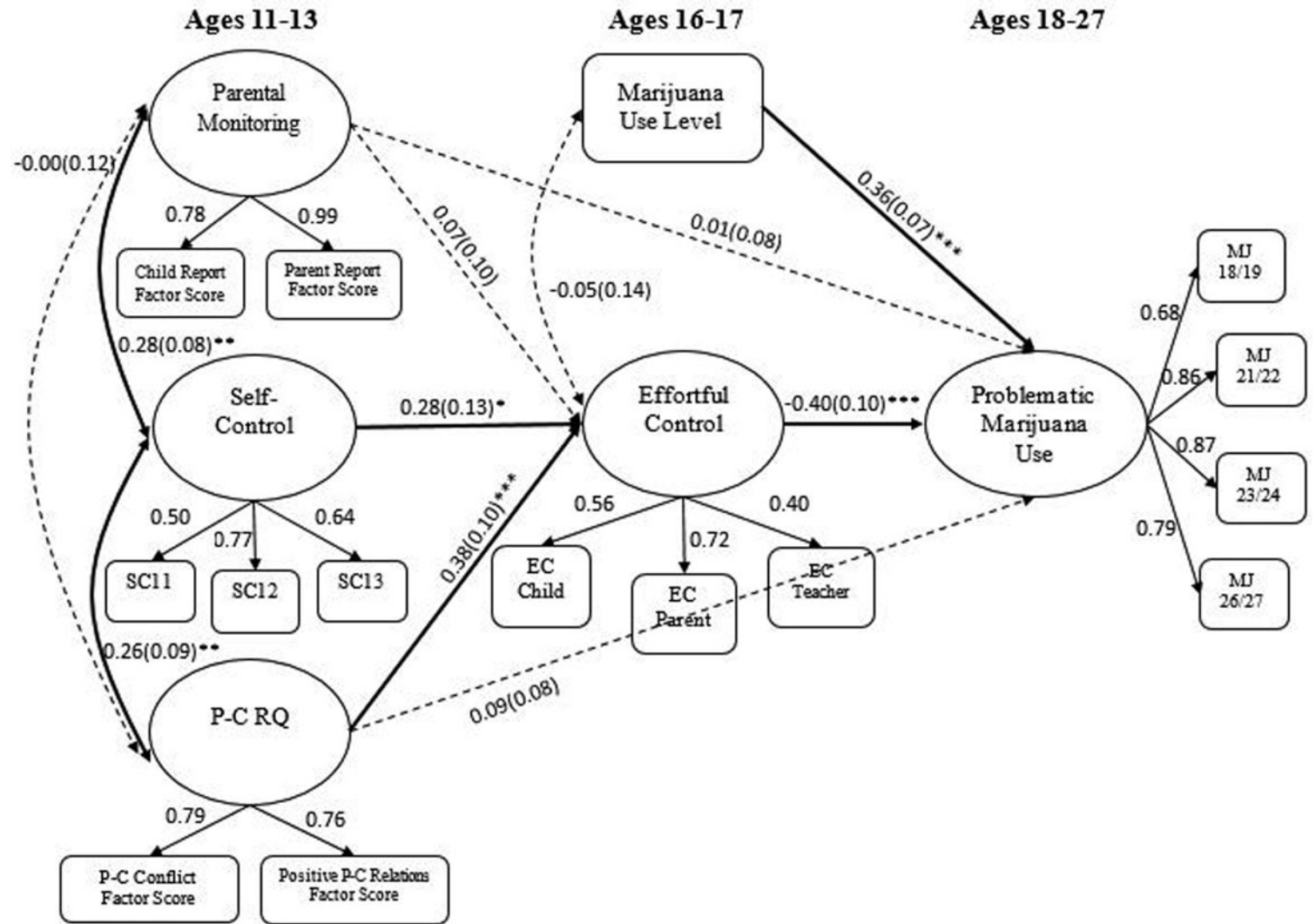


**Figure 2.** Summary of problematic tobacco use as an outcome model. P-C RQ, parent–child relationship quality. Path estimates are standardized regression coefficients. The values in parentheses are standard errors. Dotted lines are nonsignificant paths. \*\* $p < .01$ , \*\*\* $p < .001$ .





**Figure 3.** Summary of problematic alcohol use as an outcome model. P-C RQ, parent–child relationship quality. Path estimates are standardized regression coefficients. The values in parentheses are standard errors. Dotted lines are nonsignificant paths. \* $p < .05$ , \*\* $p < .01$ .



**Figure 4.** Summary of problematic marijuana use as an outcome model. P-C RQ, parent–child relationship quality. Path estimates are standardized regression coefficients. The values in parentheses are standard errors. Dotted lines are nonsignificant paths. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

**Table 2.** Mediated effects of effortful control as mediator and 95% asymmetric confidence interval (CI)

Predictor	Outcome	<i>a</i> Path $\beta$ (SE)	<i>b</i> Path $\beta$ (SE)	<i>ab</i> Correl.	Point Estimate	95% Asymm. CI	
						Lower	Upper
Parental monitoring	Problematic tobacco use	0.06 (0.11)	-1.87 (0.56)	-0.13	-0.120	-0.608	0.283
P-C RQ		0.24 (0.08)	-1.87 (0.56)	0.14	-0.443	-0.867	-0.121
Parental monitoring	Problematic alcohol use	0.06 (0.09)	-0.60 (0.30)	-0.17	-0.041	-0.199	0.067
P-C RQ		0.26 (0.08)	-0.60 (0.30)	0.01	-0.156	-0.368	-0.002
Parental monitoring	Problematic marijuana use	0.07 (0.09)	-1.53 (0.44)	-0.13	-0.112	-0.445	0.155
P-C RQ		0.27 (0.09)	-1.53 (0.44)	0.07	-0.410	-0.809	-0.110

Note: P-C RQ, Parent-child relationship quality.

prefrontal cortex, continuously develop (Johnson et al., 2009; Sowell et al., 1999). Recent developmental neuroimaging studies found that observed positive and negative mother and adolescent interactions significantly predicted structural changes of youths in their prefrontal (e.g., ACC and orbitofrontal cortices) and limbic-striatal regions (e.g., amygdala, hippocampus, and nucleus accumbens), which are known to serve important roles in emotion and behavioral regulations and reward processing (Whittle et al., 2014, 2016). Thus, the findings of the present study support the argument that positive family ecology might be associated with further development and/or refinement of effortful control in adolescence.

Consistent with previous studies in childhood (e.g., Belsky et al., 2007; Gilliom et al., 2002; Spinrad et al., 2007; Valiente et al., 2008), P-C RQ in early adolescence was associated with higher effortful control in middle adolescence. Several factors can be related to the link between P-C RQ and effortful control. First, supportive and warm relationships between parents and children may prevent youths from experiencing overarousal of negative affect that can undermine their attention flexibility and other cognitive skills, such as planning and problem solving (Eisenberg et al., 2005; Hoffman, 2000; Raver, 1996). Greater relationship quality is likely to increase youth positive emotion, which is suggested to broaden overall cognitive capacity (e.g., attention and problem solving) and increase mental flexibility (Fredrickson, 1998, 2013). Hence, maintaining good relationships between parent and child may have a positive influence in refining youths' effortful control ability. Second, youths may be more likely to pay attention to and follow their parents' requests for modifying and controlling behaviors and emotions when they have supportive rather than coercive relationships (Dix, 1991; Grusec & Goodnow, 1994). This can be crucial for youths to learn effective ways to handle their emotions and behaviors with the help of the scaffolding their parents provide (Eisenberg et al., 1998, 2005). Third, positive family ecology may be biologically important in developing children's regulation abilities and higher cognitive functions. Although it is a beginning stage of research, recent neurobiological prospective studies have found importance of positive parent-child relationships in brain development. For instance, using longitudinal neuroimaging, Luby et al. (2012)

found that higher observed maternal support predicted larger hippocampal development, which is crucial in memory and modulation of stress, among their children. More recently, Towe-Goodman et al. (2014) also found that fathers' sensitive and supportive parenting of 24-month-olds significantly predicted their children's executive functioning ability a year later.

Although we originally hypothesized that parental monitoring in early adolescence would also predict effortful control in middle adolescence, we found no significant association between the two. We can speculate some theoretical explanations.

First, perhaps the mechanism of parental monitoring on prevention of youth substance use may be different. During adolescence, youth begin to develop their autonomy and identity and therefore often rebel against parents' suggestions, expectations, or rules (Hashmi, 2013). Tracking and structuring youth behavior by direct physical modification and setting up rules may be less effective in developing the youths' ability to regulate emotion and behavior. However, this could be effective in preventing deviant peer association. For instance, in previous research, we found that lower parent monitoring in early adolescence was particularly relevant to clustering with substance-using peers, which in turn predicted increased substance use through late adolescence (Van Ryzin & Dishion, 2014).

Second, another possibility is due to the decreased need for parental monitoring on the refinement of effortful control in adolescence. There is a natural decrease in parental monitoring from childhood to adolescence (Hayes, Hudson, & Matthews, 2003; Matjasko et al., 2013). Perhaps, as the need for parental monitoring decreases from childhood to adolescence, the magnitude of parental monitoring's influence on refining adolescents' effortful control capacity may become smaller. Unfortunately, the present study cannot unequivocally test this question as we measured the parental monitoring variable only in early adolescence. Additional research testing this possibility should be conducted before a firm conclusion can be drawn.

Third, this null finding might also be attributed by a somewhat ambiguous conceptualization of parental monitoring. Parental monitoring is usually defined as a collection of parenting skills that involve attention, limit setting, and monitoring a child's whereabouts and behaviors (e.g., Dishion & McMahon, 1998). However, this conceptualization could

potentially entail a harsh, punitive, and coercive type of parenting to control and monitor youth. We found a small and statistically nonsignificant correlation between parental monitoring and P-C RQ in the present study. This finding suggests that parental monitoring does not necessarily involve positive and supportive interactions between parents and youths. Furthermore, a number of previous studies suggest that permissive and authoritarian parenting styles are associated with lower levels of adolescent self-regulatory ability compared to authoritative parenting style (Brody & Flor, 1998; Brody & Ge, 2001; Patock-Peckham et al., 2001). Thus, it is possible that parents using overly strict standards to monitor adolescents and using punitive measures in controlling youths' behavior and emotion may cancel out the positive effect of parental monitoring on further developing effortful control. More nuanced conceptualization and investigations of parental monitoring are required in future studies.

As we hypothesized, individuals with higher effortful control in middle adolescence were less likely to engage in problematic substance use behaviors. This finding is consistent with those of previous studies (Creemers et al., 2010; Novak & Clayton, 2001; Patock-Peckham et al., 2001; Piehler et al., 2012; Wills et al., 1995). Even controlling for frequency of middle adolescence substance use, effortful control remained a significant predictor of problematic substance use behaviors in the model.

Why would individuals with high effortful control be less likely to report problematic substance use? A number of potential underlying mechanisms can be speculated. First, effortful control involves the ability to regulate attention (selective and sustained) to focus on important personal goals, the ability to inhibit a dominant response, and the ability to activate a subdominant response that is more appropriate, such as planning and detecting errors (Eisenberg, 2015; Rothbart & Bates, 2006). For example, youth with high effortful control may be able to more effectively maintain their ongoing goal pursuits (e.g., academic goals) by successfully inhibiting themselves from responding to cues for substance use (e.g., peers' invitations to use) and by switching their attention and activating behaviors back to pursuing their important goals. Second, individuals with higher levels of effortful control may be more successful in regulating negative emotions. For example, a recent longitudinal study on adolescents found that higher effortful control was associated with lower depressive symptoms (Wang, Chassin, Eisenberg, & Spinrad, 2015). The failure to regulate negative emotions may increase the risk of using maladaptive coping strategies such as substance use (see Cheetham, Allen, Yücel, & Lubman, 2010, for a review). Third, individuals with high effortful control may be less likely to affiliate with deviant, substance-using

peers. Previous studies found that individuals with higher effortful control are less likely to engage in substance use behaviors through affiliating with substance-using peers (Creemers et al., 2010; Wills & Cleary, 1999). Perhaps, individuals with high effortful control are less vulnerable to progressing toward problematic substance use through the social learning process.

### *Strength and limitations*

The present study has several strengths that add to the literature. First, while most studies were cross-sectional, this model provides a developmental model of how family ecology and problematic substance use behaviors are associated through effortful control from early adolescence to young adulthood. Second, we compared the role of both parental monitoring and P-C RQ on effortful control. Third, effortful control was measured by three different reports including youth, parents, and teacher. Thus, this measure captures youths' effortful control in a less biased way.

Nonetheless, there are also limitations to the present study. First, although the current study established temporal precedence among study variables and included important covariates, these findings are not *causal*. Second, effortful control was not measured from ages 11 to 13. However, we used self-control as a proxy variable of effortful control at these ages. Third, the present sample is based upon youth who are at risk for developing problem behaviors. Thus, the findings of the present study are not generalizable to other typically developing youths. However, given that youths who are at risk are often more likely to benefit from preventive family interventions (e.g., Dishion et al., 2015), studies that focus on at-risk youth are important. Fourth, some measures (e.g., P-C RQ and problematic substance use) were assessed only by youth reports. Future studies that employ direct observation of parent-child interactions and biological markers of substance use will decrease the potential bias of self-report.

### *Conclusion*

To our knowledge, this is the first study to longitudinally investigate the relations between family ecology and problematic substance use mediated by effortful control from early adolescence to early adulthood. Findings show the relative importance of P-C RQ over parental monitoring in predicting effortful control during adolescence. As we expected, individuals with higher effortful control were less likely to report problematic substance use. Interventions that target promoting higher P-C RQ and youth effortful control skills may be important in preventing early adulthood substance use problems.

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