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Effects of a Combined Parent–Student Alcohol Prevention Program on Intermediate Factors and Adolescents’ Drinking Behavior: A Sequential Mediation Model

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Objective: Previous work revealed that the combined parent–student alcohol prevention program (PAS) effectively postponed alcohol initiation through its hypothesized intermediate factors: increase in strict parental rule setting and adolescents’ self-control (Koning, van den Eijnden, Verdurmen, Engels, & Vollebergh, 2011). This study examines whether the parental strictness precedes an increase in adolescents’ self-control by testing a sequential mediation model. **Methods:** A cluster randomized trial including 3,245 Dutch early adolescents (M age = 12.68, SD = 0.50) and their parents randomized over 4 conditions: (1) parent intervention, (2) student intervention, (3) combined intervention, and (4) control group. Outcome measure was amount of weekly drinking measured at age 12 to 15; baseline assessment (T0) and 3 follow-up assessments (T1–T3). **Results:** Main effects of the combined and parent intervention on weekly drinking at T3 were found. The effect of the combined intervention on weekly drinking (T3) was mediated via an increase in strict rule setting (T1) and adolescents’ subsequent self-control (T2). In addition, the indirect effect of the combined intervention via rule setting (T1) was significant. No reciprocal sequential mediation (self-control at T1 prior to rules at T2) was found. **Conclusions:** The current study is 1 of the few studies reporting sequential mediation effects of youth intervention outcomes. It underscores the need of involving parents in youth alcohol prevention programs, and the need to target both parents and adolescents, so that change in parents’ behavior enables change in their offspring.

What is the public health significance of this article?

This study suggests that the maximum delay in adolescent drinking behavior can best be achieved by (a) targeting both parents and adolescents; and (b) ideally, changing parenting behavior prior to changing adolescents’ self-control.

Keywords: alcohol prevention, sequential mediation, rules about alcohol, self-control

The analysis of mediational effects is imperative to understand how interventions achieve effectiveness and is therefore often applied in prevention research. The most common way to investigate mediation is the use of single mediational models. That is,

ideally, an intervention (X_0) affects the mediator at T1 (mediator at first follow-up; M_1), which leads to the outcome at T2 (Y_2) ($X_0 \rightarrow M_1 \rightarrow Y_2$). However, single mediational models assume that the mediators are influenced by the intervention itself and not by each other. Whereas, particularly in multicomponent interventions, it is likely that change in one mediator causes change in another mediator, which subsequently leads to positive intervention outcomes, the so-called sequential mediation (Taylor, MacKinnon, & Tein, 2008). In these types of models, two or more mediators intervene in a series between an independent and a dependent variable (e.g., $X_0 \rightarrow M_1 \rightarrow M_2 \rightarrow Y_3$). Given that complex relationships exist between youth psychosocial interventions and outcomes (MacKinnon, 2008; Spoth, Greenberg, & Turrissi, 2008), testing sequential mediation relations might be a better test of the theoretical assumptions of models underlying youth prevention programs. In addition, in multicomponent interventions, the order in which the interventions are carried out may imply that potential mediators will be affected at different time points. Very often,

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intervention research focuses on a single mediation model, while theories and intervention design suggest a sequential mediation chain.

Despite large benefits, sequential mediation analysis has been used only in a handful of studies until now. Surprisingly, two of these studies made use of cross-sectional designs (Lachman & Agrigoroaei, 2012; Neuman, Leibowitz, & Schwarz, 2000) although it is known that one of the most important tests of mediation relations is the investigation of temporal relations between intervention, mediator and outcomes (Kraemer, Wilson, Fairburn, & Agras, 2002; MacKinnon, 2008; Maric, Wiers, & Prins, 2012). Another two studies examined sequential mediation in longitudinal nonintervention studies with children and adolescents (Pedersen, Vitaro, Barker, & Borge, 2007; Tein, Sandler, & Zautra, 2000). Both studies demonstrate the presence of sequential mediation in relation to a range of adolescent and parental behavior strategies, respectively. With regard to youth intervention programs, one recent study tested sequential mediation relations. Deković, Asscher, Manders, Prins, and van der Laan (2012) tested the hypothesis that the effect of an intervention targeting adolescent externalizing problems would be mediated by two variables in turn: parental sense of competence and positive changes in parenting. The results supported a sequential pattern of change: increases in parental sense of competence predicted increases in positive discipline, which in turn predicted decreases in adolescent externalizing problems. Though empirical studies are scarce, existing studies demonstrate the utilization of sequential mediation analysis.

Previously, a brief universal Dutch alcohol prevention program (PAS) effectively influenced drinking behavior among early adolescents when their parents as well as adolescents were targeted. In the parents program, a presentation was held at a parents' meeting at the beginning of year 1, 2, and 3 in high school. Parents received background information about alcohol use among youth and were encouraged to set strict rules. About 6 months later, the students received an e-learning program in class that consisted of four lessons in year 1 and one hardcopy booster lesson in year 2. This combined parent–student intervention effectively curbed the onset and amount of weekly drinking up to 54 months after baseline in comparison with a control condition (Koning, van den Eijnden, Verdurmen et al., 2011; Koning, van den Eijnden, Verdurmen, Engels, & Vollebergh, 2013; Koning, Vollebergh et al., 2009). The separate parent and student intervention did not effectively change adolescents' drinking. Moreover, a previous report testing multiple mediators assessed at one time point demonstrated that an increase in both strict parental rule setting and adolescents' self-control accounted for the effectiveness of the combined parent–student intervention (Koning, van den Eijnden, Engels, Verdurmen, & Vollebergh, 2011), but did not allow any conclusions with respect to sequential effects. That is an omission, as we have reasons to believe that the combined parent–student intervention changed parenting behavior first and thereafter adolescents' self-control and that this, in turn, led to delayed onset of drinking. First, the combined intervention had a separate parent component that was carried out first, followed by the separate student component. Based on previous research on the relevance of strict alcohol-specific rules (Abar, Abar, & Turrisi, 2009; van der Vorst, Engels, Meeus, & Deković, 2006; Yu, 2003), parents' restrictiveness was targeted in the parent intervention. In the stu-

dent intervention, adolescents' attitudes and self-restraining skills were targeted about 6 months later (theory of planned behavior: Ajzen & Fishbein, 1980; social–cognitive theory: Bandura, 1996). Thus, parental behavior was targeted first and presumably changed prior to adolescents' behavior. Second, previous mediational analyses (Koning, van den Eijnden, Engels et al., 2011) showed that the separate parent intervention did effectively increase parental strictness, yet the separate student intervention did not significantly change adolescents' self-control. This underscores the assumption that the increase in parental strictness was needed to induce change in adolescents' self-control. This assumption is supported by a number of theories stating that parents are important contributors to the development of self-control in their offspring (e.g., self-determination theory; Gottfredson & Hirschi, 1990; Koning, van den Eijnden, & Vollebergh, 2014; Ryan & Deci, 2000). Based on theory and previous results, a next logical step would be to investigate the effects of the PAS intervention within a sequential mediation framework.

Current Study

This study employs a mediational analysis to investigate the chain of reactions between intervention, potential mediating variables, and outcomes. Based on theory and previous research (e.g., Ajzen & Fishbein, 1980; Bandura, 1996; Koning, van den Eijnden, Engels et al., 2011), we expect a chain of reactions in which *only* the combined parent–student intervention leads to increases in the use of parental rules, changes in the use of rules will lead to increases in adolescent self-control behavior and this will, in turn, lead to positive program outcomes (delayed onset of drinking). We tested a three-path mediational model using a bias-corrected bootstrapping method as recommended by Taylor et al. (2008). The research questions are investigated in a cluster randomized trial including 3,245 adolescents and their parents who participated from age 12 to 16.

Method

Design and Procedure

From a list of Dutch high schools, 80 schools randomly were selected and invited to participate in the study if the following inclusion criteria were met: (a) at least 100 first-year students, (b) <25% students from migrant populations, and (c) not offering special education. Nineteen secondary schools were randomly assigned by an independent statistician to one of the four conditions: (1) parent intervention, (2) student intervention, (3) combined student–parent intervention, and (4) control condition (business as usual). Randomization was carried out centrally, using a blocked randomization scheme (block size 5) stratified by level of education, with the schools as units of randomization. Within each participating school, all first-year students in different educational levels (vocational to preuniversity) participated in the intervention.

Baseline data (T0) were collected at the beginning of the first year in high school, before any intervention was carried out, and again 10 (T1), 22 (T2), and 34 (T3) months later. Annual measurements were chosen for reasons relating to the intervention implementation and school facilities. That is, the interventions were carried out annually in years 1 to 3, with a few months in

between the parents and students intervention. Moreover, as high school teachers already experience a high workload burden for implementation of their regular school curriculum, we did not want to overburden them. Adolescent data was collected by means of digital questionnaires administered in the classroom by trained research assistants. Prior to data collection, passive informed parental consent was obtained. The trial protocol (NTR649) was approved by the Medical Ethical Committee.

Participants

Nineteen schools, including 3,490 adolescents were selected to participate in the study. Because of initial nonresponse ($n = 122$) and exclusion of adolescents who responded inconsistently on the quantity-frequency items (indicated 1 or higher drinks and zero on the number of days or vice versa) measuring weekly drinking ($n = 123$), 3,245 adolescents were eligible for analyses.

The final sample ($N = 3,245$) was characterized by an average age of 12.6 ($SD = 0.49$) at baseline, consisting of 51% boys and 43% in lower education (prevocational and lower general secondary education). At baseline, the intervention conditions differed significantly from the control condition with respect to number of males and adolescents in lower secondary education (Table 1; see Koning, van den Eijnden, Verdurmen et al., 2011). At follow-up, no significant differences between the control and intervention conditions on demographic variables were found.

Loss to Follow-Up

A total of 3,054 students (94.1%) at T1, 2,812 students (86.7%) at T2, and 2,777 students (85.6%) at T3 stayed in the program and completed the follow-up assessment after 10, 22, and 34 months, respectively (see Figure 1).

Attrition analyses on demographic variables and alcohol use indicated that participating adolescents at follow-up were more likely to be younger (T1: $t(3243) = 3.34, p < .001$; T2: $t(3243) = 6.27, p < .001$; T3: $t(3243) = 5.24, p < .001$), more often in higher education (T1: $\chi^2(1) = 7.9, p = .01$; T2: $\chi^2(1) = 50.9, p < .001$; T3: $\chi^2(1) = 32.7, p < .001$), and drank less alcohol (T1: $t(2932) = 3.59, p < .001$; T2: $t(2932) = 4.01, p < .001$; T3: $t(2932) = 4.25, p < .001$) compared with nonparticipating adolescents at baseline. No differences between nonresponding and responding adolescents at follow-up were found with respect to gender.

Interventions

Parent intervention. This intervention targets parental rules for their children's alcohol use and consisted of three elements:

1. In the regular parents' meeting, a short presentation (20 min) was given containing information about the adverse effects of alcohol use at a young age and the negative effects of permissive parental attitudes toward children's alcohol use. The presentation was given by an expert on alcohol use.
2. After the plenary meeting, the parents of the students of the same class joined the teacher of that class in a class meeting to discuss rules and reach consensus on a set of shared rules. To this end, the teacher presented a list of plausible rules, and the subsequent discussion was directed at reaching agreement. Teachers were trained by prevention professionals.
3. An information leaflet with a summary of the presentation and a report of the outcome of the class meeting was sent to parents' home addresses for two reasons: first, as a reminder of the information given in the presentation and the rules agreed upon in the class meeting, and second, parents who did not attend the parents' meeting were provided with the same information.

Student intervention. The student intervention targets the students' abilities to develop a healthy attitude toward alcohol use and to train their refusal skills. Trained teachers conducted the intervention (four lessons) in all first-year classes in March/April 2007. Each lesson was comprised of

1. an introduction movie followed by a few questions,
2. questions to assess knowledge,
3. questions/exercises to reflect upon their own attitude/behavior, and
4. a closing assignment integrating the previously obtained information.

One year later, a booster lesson (using a hard copy) was carried out in class, which involved a repetition of the digital alcohol program.

Combined intervention. Schools in this condition carried out both the parent and student intervention.

Control condition. Schools in the control condition received no intervention, but were allowed to continue their business-as-usual practices. For a more detailed description of the interven-

Table 1
Characteristics of the Students at Baseline

Variable	Conditions			
	Parent intervention $n = 735$	Student intervention $n = 874$	Combined intervention $n = 753$	Control condition $n = 883$
Male n (%)	335 (45.6)	422 (48.3)	446 (59.2)	455 (51.5) ^a
Age, years: M (SD)	12.6 (0.47)	12.7 (0.50)	12.7 (0.52)	12.7 (0.53) ^a
Low level of education ^b n (%)	218 (29.7)	363 (41.6)	259 (34.4)	525 (59.5) ^a

^a Significantly different from the active interventions at $p < .05$. ^b Lower secondary vocational education.

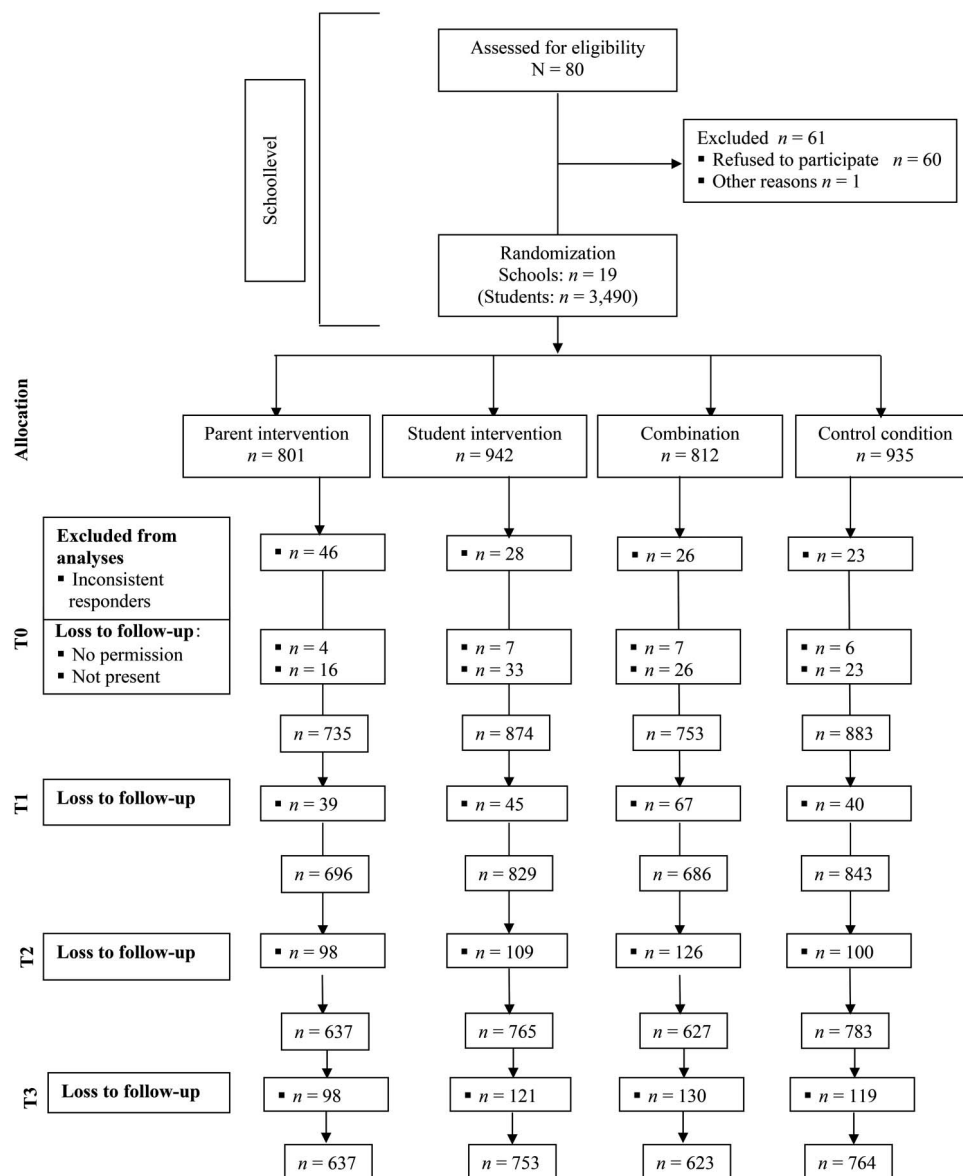


Figure 1. Flow chart of the participants through the trial.

tions, see earlier reports (Koning, van den Eijnden, Verdurmen et al., 2011; Koning et al., 2009).

Measures

Outcome measure. The outcome of interest was the amount of drinking in a typical week (average number of glasses consumed each week). To compute the average amount of drinking per week, the quantity frequency measure was used (Engels & Knibbe, 2000). Frequency was measured by asking the number of days the adolescent usually drank on weekdays (Monday to Thursday) and weekend days (Friday to Sunday). Quantity was measured by asking how many glasses of alcohol the adolescent usually drinks on a weekday and weekend day (Engels, Knibbe, & Drop, 1999). Quantity frequency was com-

puted by calculating the products of the number of days and the number of glasses, then summing the two products for week-days and weekend days.

Mediators. The mechanisms that were changed by the intervention and mediated the effect on the amount of weekly drinking are rules about alcohol and self-control reported by the adolescent. The use of self-reports for the assessment of adolescent drinking behavior have been found to be fairly reliable (Koning, Harakeh, Engels, & Vollebergh, 2010).

Rules about alcohol use reflect parental degree of rule-setting behavior experienced by the adolescents (van der Vorst, Engels, Meeus, Deković, & van Leeuwe, 2005). Items included "I am allowed to have one glass of alcohol when one of my parents is at home," "I am allowed to drink several glasses of alcohol when one

of my parents isn't home," and "I am allowed to drink alcohol at a party with my friends." The mean of 10 items rated on a 5-point scale from 1 (*never*) to 5 (*always*) reversely scored was used, that is, higher scores indicating more rule-setting behavior ($\alpha = .90$).

Self-control reflects the ability to control responses, interrupt undesired behavioral tendencies, and refrain from acting on them. The measure is the shorter version (13 items) of the original measure developed and tested by Tangney, Baumeister, and Boone (2004). The mean of 13 items rated on a 5-point scale, ranging from 1 (*not at all like me*) to 5 (*very much like me*) was used. Example items are "I have trouble saying no" and "I do certain things that are bad for me, if they are fun." If needed, items were reversely scored so that higher scores indicated higher self-control ($\alpha = .78$).

Analyses

In the current analyses, we employed the Mplus 7.0 program (Muthén & Muthén, 2011) incorporating full information maximum likelihood (FIML; Arbuckle, 2005). FIML has been recommended as a state-of-the-art technique for analyzing data sets that include missing data (Schafer & Graham, 2002). The randomization resulted in a slightly uneven distribution across the active conditions compared with the control condition in terms of gender and educational level. In addition, age was a significant predictor of attrition at every follow-up measurement. All subsequent analyses were therefore conducted with these variables as covariates to control for any possible bias stemming from the imbalance.

First, to examine the direct effect of the interventions on alcohol use at age 15, the intervention dummies (control condition was the reference group) were used to predict the outcome measure. Second, to examine sequential mediation relations of the intervention-induced factors (parental rules about alcohol and self-control) to alcohol use, the bias-corrected bootstrapping method was used (Taylor et al., 2008). This approach has been chosen above the more preferable method implemented frequently in somewhat smaller samples (joint significance test; Taylor et al., 2008) because our study implements a large sample and some variables are non-normally distributed (i.e., alcohol use; MacKinnon, Fairchild, & Fritz, 2007). In the bias-corrected bootstrapping method, regression models are first estimated for the original data. In the context of our study, the first estimated model included the association between intervention condition (independent variable) and parental rules at T1 (mediator 1; step 1). In the second step, self-control (mediator 2) was added to step 1 and was regressed on both intervention condition and parental rules. In the third step, intervention condition, parental rules, and self-control were all included as predictors of alcohol use (dependent variable). The same models are estimated for each drawn bootstrap sample and are used to form the bootstrap distribution. To test whether the indirect effects of the intervention conditions via (a) rules only; (b) self-control only; (c) rules and self-control on alcohol use are significant (step 4), the Model Indirect command was used in Mplus. In all three steps, we controlled for alcohol use on all previous time points, and for the mediating factors at the previous time point, so that actual change could be assessed. The cluster effect was not corrected for because Mplus does not allow multilevel analysis combined with bootstrap analysis. As the intraclass correlation for rules about alcohol (0.06), self-control (0.02), and weekly drinking

(0.003) were rather low, we believe this has not affected our findings.

The percentage mediated effect was calculated as an effect size for the mediated effect (MacKinnon, 2008). As MacKinnon, Warsi, and Dwyer (1995) found, in large samples (i.e., ≥ 500), percentage mediated effect seems to be a reliable measure of the size of the mediated effect. The percentage mediated is the proportion of the total effect of the program exposure (i.e., combined intervention) on the outcome variable (i.e., alcohol use) that is mediated by the mediating variables (i.e., parental rules and self-control), and is calculated by dividing the mediating effect by the total program effect. The percentage mediated provides information on how much of the total program effect is attributable to the mediators. Finally, using the bias-corrected bootstrapping method, we tested an alternative, reciprocal mediation model (i.e., using self-control as mediator 1 and parental rules as mediator 2). Standardized regression coefficients were reported, effects with p values lower than .05 were considered to be significant.

Last, additional analyses were carried out to control for the fact that alcohol use is highly skewed. For this reason, Poisson analyses were conducted following the same steps as described above (using the Count command). To test for mediation of the intervention conditions on alcohol use via rules and/or self-control, the Model Constraint option was used. The bias-corrected bootstrap method is not available with Poisson analyses. Monte Carlo-based confidence intervals is the next best method to test for mediation after bias-corrected bootstrapping (MacKinnon, Lockwood, & Williams, 2004) and were therefore estimated with the Monte Carlo addition to the RMediation program 1.1.2 (Tofighi & MacKinnon, 2011). p values were obtained from the Monte Carlo based confidence intervals by following the steps described by Altman and Bland (2011).

Results

Alcohol Use at Follow-Up

Descriptive data of adolescents participating in the PAS program are depicted in Table 1. On average, adolescents drank 17 glasses ($SD = 2.1$) per week at T3.

Direct Effects of the Intervention on Weekly Drinking

First, the effects of the intervention dummies on the amount of weekly alcohol use at age 15 (T3) were tested. The combined intervention significantly predicted how much adolescents drank on a weekly basis: among these adolescents, the amount of alcohol use was lower than among adolescents in the control condition, $\beta = -.11$, $SE = .44$, $p < .001$, 95% CI [2.86, -1.15]. No significant effect of the separate parent and student intervention on amount of weekly alcohol use was found, respectively, $\beta = -.05$, $SE = .48$, $p = .057$, 95% CI [-1.77, 0.06] and $\beta = -.05$, $SE = .45$, $p = .054$, 95% CI [-1.64, 0.05].

Mediation Analyses

The results of the intervention conditions on mediating factors (self-control and perceived rules about alcohol) as well as on the amount of drinking are depicted in Table 2 and Figure 2 (only the combined intervention). Based on Hu and Bentler's (1999) cut-off

Table 2
Relations Between Variables That Were Included in the Mediation Model

Variables (<i>M, SD</i>)	Rules T1 (4.45, 0.69)		Self-control T2 (3.45, 0.59)		Alcohol use T3 (3.83, 7.96)	
	β (95% CI)	SE	β (95% CI)	SE	β (95% CI)	SE
Parent intervention	.04 (0.01–0.11)	.03	-.04 (–0.11–0.02)	.02	–.04 (–1.56–0.08)	.42
Student intervention	.04 (–0.06–0.05)	.03	-.05 (–0.11–0.01)	.02	-.05 (–1.70–0.12)	.42
Combined intervention	.10 (0.10–0.22)	.03	–.02 (–0.08–0.03)	.03	-.07 (–2.06–0.44)	.41
Rules T1	X		.08 (0.04–0.10)	.02	-.17 (–2.69–1.22)	.37
Self-control T2	Not included		X		-.12 (–2.17–0.92)	.32

Note. CI = confidence interval. Adjusted for confounders (age, level of education, and gender). Bold numbers indicate a significant effect.

criteria for fit indexes, the model had an acceptable/good fit, CFI = 0.94, RMSEA = .045, $\chi^2 = 220(29)$, $p < .001$. To eventually test the full model of sequential mediation, we first tested the effect of the intervention conditions on rules about alcohol and rules about alcohol on weekly drinking (step 1), in step 2 we included self-control at T2 to the previous step, and in step 3 rules about alcohol and self-control were regressed on alcohol use, where after in step 4 all indirect effects were tested.

Step 1: Effect of Intervention Conditions on Rules About Alcohol

The combined intervention significantly increased the level of strict rule setting at T1, $\beta = .10$, $SE = .03$, $p < .001$, 95% CI [0.10, 0.22]. The effect of the parent intervention on the perceived rules about alcohol was marginally significant, $\beta = .04$, $SE = .03$, $p = .05$, 95% CI [0.01, 0.11]. No significant effect of the student intervention on the rules about alcohol at T1 was found, $\beta = -.001$, $SE = .03$, $p = .94$, 95% CI [–0.06, 0.06].

Step 2: Effect of Intervention Conditions on Self-Control

The separate parent ($\beta = -.04$, $SE = .02$, $p = .02$, 95% CI [–0.11, –0.02]) and student intervention ($\beta = -.05$, $SE = .02$, $p = .01$, 95% CI [–0.11, –0.01]) significantly predicted changes

in adolescents' self-control at T2, that is, in these conditions, adolescents reported having lower self-control than those in the control condition. The combined intervention did not change the level of self-control in adolescents' at T2, $\beta = -.02$, $SE = .03$, $p = .38$, 95% CI [–0.08, 0.03]. Strict parental rules significantly predict a higher level of self-control in adolescents, $\beta = .08$, $SE = .02$, $p < .001$, 95% CI [0.04, 0.10].

Step 3: Effect of Rules About Alcohol and Self-Control on Weekly Drinking

Adolescents who reported more strict rules about alcohol at T1 drank less alcohol at T3, $\beta = -.17$, $SE = .37$, $p < .00$, 95% CI [–2.69, –1.22]. And, adolescents' self-control predicted the amount of drinking at T3; higher self-control was related to less drinking, $\beta = -.12$, $SE = .32$, $p < .001$, 95% CI [–2.17, –0.92].

Step 4: Indirect Effects of Intervention Condition on Weekly Drinking

A significant total indirect effect of the combined intervention on alcohol use was found, indirect = $-.02$, $SE = .01$, $p = .01$, 95% CI [–0.50, –0.14]. Two significant specific indirect effects were found. First, an effect of the combined intervention on alcohol use at T3 via an increase in strict parental rule setting at T1, indirect = $-.02$, $SE = .09$, $p < .001$, 95% CI [–0.52, –0.18]. The percentage mediated effect by the parental rules mediator was 18%. Second, the indirect effect of the combined intervention via an increase in strict rule setting at T1 and a subsequent increase in self-control at T2 resulted in lower rates of drinking at T3, indirect = $-.01$, $SE = .01$, $p < .00$, 95% CI [–0.03, –0.01].¹ The percentage mediated effect by the parental rules and self-control mediators was 9%.

Poisson analyses revealed identical results with regard to sequential mediation effects. That is, significant indirect effects were found for the combined intervention on alcohol use through an increase in strict rule setting at T1, indirect = $.01$, $SE = .01$, $p = .01$, 95% CI [–0.09, –0.05] and via an increase and strict rule setting (T1) and subsequent increase in adolescents' self-control at T2, indirect = $.002$, $SE = .001$, $p = .02$, 95% CI [–0.03, –0.01].

The reciprocal mediation model (see Figure 3), testing an effect of the intervention on alcohol use via a change in self-control and

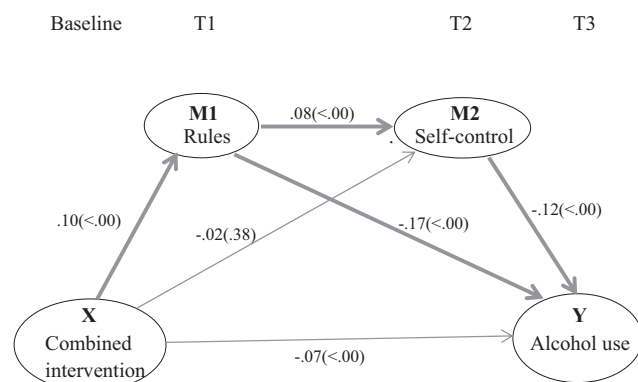


Figure 2. Effect of the combined intervention on alcohol use via rules about alcohol and self-control (β , p). Bold lines indicate significant mediation.

¹ Performing joint-significance test analyses (Taylor et al., 2008) revealed identical results.

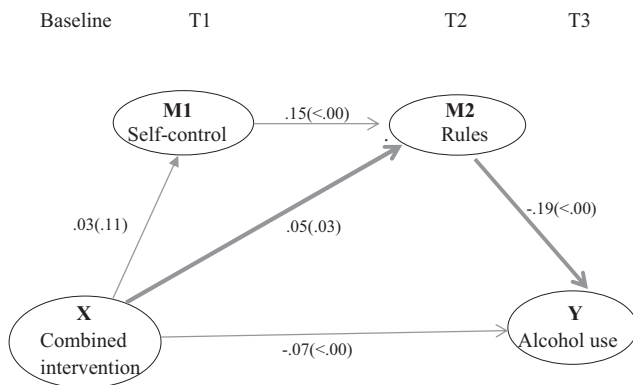


Figure 3. Reverse sequential mediation: Effect of the combined intervention on alcohol use via self-control and rules about alcohol (β , p). Bold lines indicate significant mediation.

subsequent parental rule setting, revealed a poor model fit ($CFI = 0.69$, $RMSEA = .112$, $\chi^2 = 1405(34)$, $p = .00$). None of the interventions influenced the level of self-control at T1. The parent and combined intervention did increase strict rule setting at T2, respectively, $\beta = .04$, $SE = .04$, $p = .02$, 95% CI $[0.01, 0.15]$ and $\beta = .05$, $SE = .04$, $p = .03$, 95% CI $[0.01, 0.16]$. The only significant indirect effect was found for the combined intervention on alcohol use via strict parental rule setting, indirect = $-.01$, $SE = .01$, $p = .04$, 95% CI $[-0.31, -0.02]$.

Discussion

This study investigated the sequential mediation effects of an alcohol prevention program targeting parents and adolescents separately and jointly. Our hypothesis was supported; the combined parent–student intervention increased parental strictness that in turn increased adolescents’ self-control, which reduced their subsequent drinking behavior. Nine percent of the total program effect was mediated by parental strictness and self-control. No significant indirect effects were found for the separate parent or student intervention, nor did the study show a reciprocal mediation effect. Thus, parents’ behavior should be changed in order to foster change in their offspring. The current study is one of the few testing sequential mediation in a longitudinal intervention trial and has important implications for program implementation.

Our results are in accordance with the sequence wherein the interventions are carried out and show that the increase in adolescents’ self-control is due to more strict parental rule setting as a result of the combined intervention. This finding approves that parents play a pivotal role in the development of self-control in adolescents (Gottfredson & Hirschi, 1990; Pratt & Cullen, 2000; Ryan & Deci, 2000). For example, according to the self-determination theory (Ryan & Deci, 2000), autonomy-supportive parenting (a combination of control and support) enables adolescents to develop self-regulation skills. Likewise, alcohol-specific rules influenced adolescents’ drinking via an increase in their self-control, but only when these rules were combined with qualitative conversations about alcohol (Koning et al., 2014). The lack of reciprocal mediation effects, that is, intervention $\rightarrow$ self-control $\rightarrow$ rules $\rightarrow$ alcohol use, further corroborates the importance of altering parents’

behavior first in order to enable change in adolescents. That is, the increase in parental strictness by the parent intervention is followed by an increase in adolescents’ self-control, which is targeted by the student intervention. This result is consistent with theory that adolescents need restrictions regarding the use of alcohol first, which in turn enables them to optimally benefit from an intervention to increase their refusal skills.

The combined intervention also curbed weekly drinking via an increase in rule setting only (18% of the total effect mediated). This may imply that there are other factors as well that are affected by parents’ strict rule setting, in addition to adolescents’ self-control. For example, adolescents with strict parents have less favorable attitudes toward alcohol (Koning, Engels, Verdurmen, & Vollebergh, 2010) and have more nondrinking peers (Kiesner et al., 2010), both factors associated with drinking (Allen, Chango, Szewdo, Schad, & Marston, 2012; Kiesner et al., 2010; Koning, Engels et al., 2010). More research on the application of potential factors intervening the relation between rules about alcohol and alcohol use is warranted.

The percentage mediated effect by parental rules and self-control mediators can be considered as relatively small. Besides methodological explanations for this result (i.e., the model contains two mediators and the indirect effect is a product of three coefficients as opposed to two), it is also possible that these two mediators intervene in a sequence and explain this much of combined program effects. Moreover, our results suggest that joined sequential and single-mediated effects (i.e., two indirect effects added/total effect) explain around one third of the total program effect indicating other potential mediating variables might be influencing program outcomes. As mentioned in the introduction, youth psychosocial interventions may exhibit their effects through multiple individual, family, school, and contextual factors (e.g., MacKinnon, 2008), and it is possible that still some other mediators may be important in explaining the combined intervention effects such as peer substance use and norms about alcohol. Nevertheless, our findings are interesting as they support the suggestion that changes in parental rule setting lead to changes in self-control, and that this in turn leads to a delayed onset of adolescent alcohol use (i.e., no evidence was found for the reciprocal model).

It was found that the separate student and parent intervention had a negative effect on adolescents’ self-control 2 years later, while the combined intervention had a positive effect. In a previous report that tested a multiple mediation model (Koning, van den Eijnden, Engels et al., 2011), the separate parent and student interventions did not change adolescents’ self-control 10 months later. We can only speculate about the decrease in adolescents’ self-control due to the separate parent and student intervention. It is likely that, particularly in a sequential mediation model including multiple mediators, the magnitude of the separate interventions on self-control is increased due to so-called suppression (MacKinnon, Krull, & Lockwood, 2000). In this case, suppression would indicate that the increase in the magnitude of the interventions on self-control at T2 occurred because rules about alcohol at T0 and T1 explained variability in adolescents’ self-control; that is, the development of refusal skills requires strict parental rules to enable an increase in refusal skills. This assumption is supported by the results of this study; joint efforts of both adolescents and parents are needed for positive change to occur. It seems that parents

contribute to the development of resistance skills in their offspring and should therefore be targeted in alcohol prevention.

Limitations and Suggestions for Future Research

The current findings should be considered in light of some limitations. First, the results are based on data self-reported by adolescents. Although multiple informant data is preferred, self-reported measures have been found to be a reliable method (Del Boca & Darkes, 2003; Koning, Harakeh et al., 2010) and are often used in alcohol research. Second, in this study, annual measurement waves were used. Parameter estimates in autoregressive models depend on the amount of time elapsed between measurements (e.g., Oud & Delsing, 2010). However, because of practical reasons relating to intervention implementation and school facilities, having more waves was not possible. In addition, having more narrow intervals between the waves could inform us about the direct postintervention effects. Yet, this aspect of the study design may also lend support to the robustness of the findings because effects were found with such a long lag. Third, a measurement model was not used due to the complexity of modeling highly skewed data on several items assessing rules about alcohol and applying bootstrapping in conjunction with Poisson analyses. This could have led to an underestimation of the mediation effects (Kline, 2010). It is unlikely that this would change our conclusions. Fourth, in line with the self-determination theory, prior research underlines the relevance of strict rule setting within a positive environment (Koning et al., 2014; Pratt & Cullen, 2000). In the current study, we have not included moderation of, for example, the quality of communication between parents and adolescents, and so we can only partially support the self-determination theory. Fifth, although the design of the current study allowed for a test of sequential mediation, more definite conclusions about sequential relations would be facilitated via a design in which the sequence of the parent and student intervention is reversed, and assessment between the parent and student intervention is included. Still, the current study is the first that investigates sequential mediation in a large longitudinal alcohol prevention trial and in youth intervention studies more broadly.

Implications

In conclusion, the results suggest that the PAS intervention was able to successfully influence early adolescents' drinking behavior when both parents and adolescents were targeted. Importantly for this study, understanding the sequence of changes in core mechanisms underlying the PAS intervention has direct implications for the implementation of effective intervention components into clinical and community settings. The results of this study suggest that the maximum delay in adolescent drinking behavior can best be achieved through administration of both parent and student intervention components and, ideally, change parenting behavior prior to changing adolescents' self-control. Further, through the study of PAS mediators, enhancement of our understanding of adolescent drinking behavior can be achieved, and theories implying the important role of parents in the development of adolescent self-control can be supported (e.g., self-determination theory; Ryan & Deci, 2000).

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