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Coercive Parent-Adolescent Interactions Predict Substance use and Antisocial Behaviors Through Early Adulthood: A Dynamic Systems Perspective

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Abstract
This study revisits the association between coercive parent-adolescent interactions and adolescent externalizing behaviors. Specifically, we investigate the moment-to-moment coercive exchanges between parents and adolescents and how these dynamic processes map to the long-term development of substance use and antisocial behavior from middle adolescence to early adulthood. We collected videotaped observations with 794 adolescents (ages 16–17 years) and their parents during interactions and coded their real-time behavioral exchanges. State Space Grid analyses were used to measure the proportion of time in which each parent-adolescent dyad engaged in the Dyadic Coercion region as an indicator of rigidity in dyadic coercion. We also measured adolescents' substance use and antisocial behavior at ages 16–17, ages 18–19, and ages 21–22. The enduring impact of parent-adolescent coercive interaction on substance use and antisocial behavior was tested using categorical latent growth curve models and path models. Adolescents with more coercive interactions with parents showed higher rates of increase in alcohol use and higher levels of antisocial behavior through early adulthood. The findings highlight the unique contribution of using intensive data to understand coercive interactions on a microtimescale and how these dynamics influence long-term development in externalizing behaviors. Implications for intervention studies are discussed.

Keywords Coercion · Antisocial behavior · Substance use · Adolescents · Intensive longitudinal data

Adolescence is a time of developmental transitions and is a sensitive period for the development of externalizing behaviors, such as substance use and antisocial behavior (i.e., overt or covert aggressive and destructive behaviors towards others, such as physical aggressions, violence, vandalism, and stealing). Family functioning and family relationships play a significant role in the onset and escalation of externalizing behaviors; children with more negative interactions with parents are at greater risk for earlier onsets and higher levels of externalizing behaviors (Davies & Coe, 2019). Although a wide range of family characteristics and processes may contribute to adverse developmental outcomes in adolescence, one of the most robust risk factors is coercive parent-adolescent interactions (Patterson, 1982; Patterson et al., 1992), in which parents use punitive and controlling behaviors to resolve conflicts which in turn reinforce adolescents' use of aversive behaviors to turn off parents' demands (Smith et al., 2014). Coercive interactions with parents are reliably related to adolescents' externalizing behaviors (LoBraico et al., 2020). However, most studies only used parents' self-reported behaviors or macrosocial coding to measure coercive interactions, which failed to capture the reciprocal exchanges between parents and adolescents. In addition, less is known about how these reciprocal exchanges map onto the developmental trajectory of externalizing problems. To fill this gap, the current study adopted a dynamic systems perspective to capture the behavioral exchanges between parents and adolescents to examine how rigidity in coercive interactions predicted

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growth in substance use and antisocial behavior from middle adolescence to early adulthood.

Substance Use and Antisocial Behavior from Adolescence into Adulthood

While representing distinct behaviors, substance use and antisocial behavior have considerable overlap. These behaviors are very likely to co-occur (Baskin-Sommers & Sommers, 2006; Colder et al., 2013) and typically share a similar onset during adolescence (Young et al., 2002). When exhibited in adolescence, substance use and antisocial behavior are each associated with both immediate and lasting problems. Not only do substance use and antisocial behavior in adolescence predict the persistence of these problems into adulthood (Gray & Squeglia, 2018), but they may also be prognostic of more severe problems into adulthood, including criminality (Satterfield et al., 2007), violence (Van Ryzin & Dishion, 2013), risky sexual behaviors (Ha et al., 2016; Hentges et al., 2018), and academic failure (Lansford et al., 2016). Furthermore, substance use and antisocial behavior share similar risk and protective factors (Adalbjarnardottir & Rafnsson, 2002; Claes et al., 2005; Elam et al., 2021a; Elam, MunElam et al., 2021a, b; Obando et al., 2014), including physiological factors (e.g., genes, neural pathways), individual factors (e.g., personality, emotion regulation capacity), familial factors (e.g., family relationships, family functioning), other contextual factors (e.g., peers, schools). Of all these critical factors, parent- and peer-related factors are often identified to be the most robust predictors (Trucco, 2020). The primary focus of the present study is the role of parent-adolescent interactions as a risk factor that contributes to substance use and antisocial behavior.

Parent-Adolescent Interactions

Adolescence is a transitional period marked by striving for autonomy and independence, which inevitably introduces changes in family relationships and potential conflicts between parents and adolescents. Although increases in conflicts are normative, the way in which family members resolve these conflicts may contribute to variability in developmental trajectories (Fosco, Van Ryzin et al., 2014). From the Social Interaction Learning model (Patterson, 1982; Patterson et al., 1992), coercive interaction is characterized by a reciprocal process that often starts with an adolescent disobeying the parents' request, and the noncompliance results in parents' harshness and elevated emotional responses (e.g., yelling and threats). The adolescent responds using escalated aversive behaviors which further leads to the parents' "giving in" and removing their initial request. Thus, both parents and adolescents are using aggressive and hostile behaviors to deal with conflicts. Adolescents' aversive behaviors are reinforced to terminate conflicts and remove demands placed upon them. Over time, this pattern of interaction may get stabilized through repeated experiences and has been found to be predictive of higher levels of antisocial behavior (Fosco et al., 2014a) and substance use in adulthood (Brook et al., 2010) and carry over into interactions outside of the family, such as peers and romantic partners (Ha et al., 2021). To uncover the long-term effects of coercive interactions, it is important to capture the real-time behavioral exchanges between parents and adolescents.

Coercive Interactions from a Dynamic Systems Perspective

A growing body of research has incorporated the dynamic systems framework in understanding coercion interactions (Dishion et al., 2012; Granic et al., 2003). The dynamic systems framework offers theoretical insights and methodological strengths to the understanding of coercion. Specifically, the framework emphasizes the interrelations between real-time changes on smaller timescales (e.g., second-to-second exchanges) and long-term development (e.g., externalizing problems). Guided by this framework, coercive interactions are characterized by behavioral exchanges between family members and the changes in these behavioral exchanges over time. A dynamic systems framework requires intensive longitudinal data describing each individual's behavior in the context of an interaction to uncover the dynamics of coercion (Bamberger, 2016).

Given the dynamic nature of a coercive exchange, behavioral observation is typically considered the gold standard operationalization of coercion interactions (Granic & Patterson, 2006). According to the dynamic systems theory, most adaptive parent-child interactions are flexible, indicating that these interactions are able to shift in and out of negative states. As Granic and Hollenstein (2003) found, it is not the avoidance of negativity or coercion but the ability to regulate and cope with coercion that is predictive of future problem behaviors. When parents and children are "stuck" in coercive interactions, it signifies coercion as an attractor state (i.e., a state a dyad is easily drawn toward and frequently returns to after experiencing stressful events), and they are less likely to move into more positive interactions (i.e., high levels of rigidity in negative states).

Notably, the majority of prior studies have relied upon global/macro-social coding to measure the overall level of coercion over a period of observation without capturing the

specific behaviors each individual displays in real time. Relative to macro-coding, micro-social coding of parent-adolescent interactions captures not only the type of behavior on a smaller timescale (e.g., positive affect, verbal encouragement, lecturing) but also the onset and offset of each behavior. In this way, micro coding provides a more specific measurement of a variety of behaviors (e.g., positive, negative, and neutral behaviors) and captures the processes of dyads moving in and out of the coercive states throughout the observation. While all observational coding is subject to potential coder biases, micro-social approaches may help limit coder bias relative to macro coding by focusing on discrete, observable behaviors that rely less on coder judgment or interpretation (Chorney et al., 2015).

One of the most significant benefits of micro-coding is that it allows for more fine-grained analyses of ongoing behavioral exchanges between family members. State Space Grids (SSGs; Granic and Hollenstein, 2003) are an analytical and visualization tool to illustrate dyadic behavioral dynamics. As is shown in Fig. 1, parents' and adolescents' behaviors are plotted in real-time (see more detailed information in the Method section) allowing for an illustration of how each dyad may transition in and out of various dyadic states (e.g., dyadic positive engagement, dyadic non-engagement). In this study, the duration in which each dyad engaged in the Dyadic Coercion (DC) region is used as an indicator of the level of coercive interaction, which captures (a) one responses to the other's aggressive behaviors by persisting and escalating coercive behaviors or (b) one gives in when the other escalates aversive behaviors. This approach has been used in examining the association of parent-child coercion and aggressive behaviors in early childhood, and coercive parent-child interactions have been found to reinforce children's noncompliance behaviors (Smith et al., 2014; Sitnick et al., 2015a, b). However, less is known about how coercion dynamics between parents and adolescents affect long-term development and whether coercion continues to contribute to externalizing outcomes through early adulthood.

The Present Study

Coercion has been conceptualized on a smaller timescale with emphasis on the moment-to-moment behavioral reciprocity and escalation between parents and children. The development of externalizing problems is often observed over years or developmental stages. Although the association between coercive interactions and adolescent externalizing problems (e.g., antisocial behavior and substance use) has been found in a range of studies (Goagoses & Schipper, 2021; Kader & Roman, 2018; LoBraico et al., 2020; Saxbe et al., 2014), most of them used a static measure of coercion and examined the two concepts on the same timescale. Less

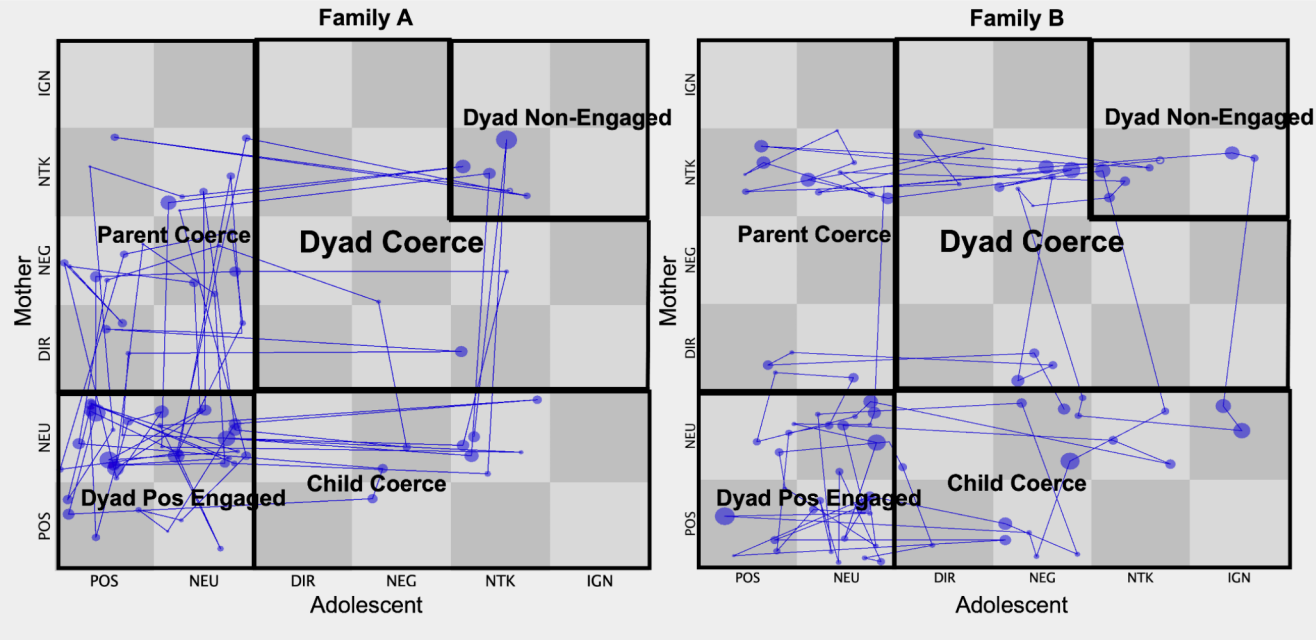

Fig. 1 Sample state space grids of parent-adolescent dyads with a lower proportion of time engaged in the "Dyad Coerce" region (Family **A**) and a higher proportion of time engaged in the "Dyad Coerce" region (Family **B**)

Notes. Pos = Positive Engagement, Neu = Neutral Engagement, Dir = Directive, Neg = Negative Engagement, Ntk = No Talk, Ign = Ignore.

is known about how developmental processes unfold across different timescales and whether the small-scale behavioral exchange would influence large-scale developmental trajectories. Therefore, this study aims to "zoom in" on coercive interactions by examining the behaviors of each individual on a micro-timescale and dyadic exchanges of those behaviors and "zoom out" and map these behavioral exchanges onto adolescents' developmental processes of externalizing problems. We conducted micro-social coding of participants' behaviors during a range of interaction tasks and applied the SSGs approach to investigate the dynamics of coercion interactions. The intensive longitudinal approach provides a more fine-grained and ecologically valid measure of coercive interactions. The link between within-dyad dynamics and long-term development in externalizing problems offers unique insights into the impact of family processes as a risk factor. To unpack this link from a developmental perspective, we examined the association between parent-adolescent dyadic coercion and adolescents' growth trajectories of externalizing problems through early adulthood. We hypothesized that higher levels of dyadic coercive interaction would be associated with steeper increases in substance use and antisocial behavior.

Method

Participants

This study is a secondary analysis of data from Project Alliance, a randomized control trial of the Family Check-Up intervention (Dishion & Stormshak, 2007). The goal of the intervention was to reduce adolescent problem behavior by improving effective parenting practices. The original sample was composed of 998 adolescents and their families recruited in sixth grade. They were randomly assigned to either the intervention condition or the control condition. The present study included all participants (n = 794) who were retained in the study at ages 16–17, the first time point used in the current analyses. Of the 794 adolescents in the current study, 49.2% were females and an average of 16.99 years of age (*SD* = 0.77). They self-identified as European American (43.8%), African American (29.9%), Native American (1.8%), Hispanic or Latinx (5.9%), Asian American (4.4%), Pacific Islander (0.8%), Biracial/mixed ethnicity (11.8%), or other ethnicities (1.8%). Annual household income ranged from $5,000 to more than $90,000, with the median between $30,000 and $40,000. In this sample, 388 adolescents were in the intervention condition (48.9%) while the rest were in the control condition.

Procedure

In the original study, participants were recruited from three middle schools in an ethnically diverse community in the northwestern United States in two cohorts. Cohort 1 (n = 676) was recruited in 1997–1998 and cohort 2 (n = 323) was recruited in 1998–1999. All participants and their parents or legal guardians consented to participate in the study and all procedures were approved by the University of Oregon's Internal Review Board. Half of the sample was randomized to the intervention condition which was delivered at three levels: the universal level involved parent-centered services and six in-class sessions called the SHAPe curriculum; the selective level (offered to families with high-risk youths) involved offering the Family Check-Up, a three-session intervention including an initial interview, an assessment session, and a feedback session conducted by family consultants. Some participants who received the Family Check-Up also received more intensive intervention programs, including the Everyday Parenting curriculum (EPC; Dishion et al., 2011). Participants assigned to the control condition received middle school curriculums as usual. More detailed descriptions of the Family Check-Up intervention are available in prior publications (Dishion & Kavanagh, 2003; Dishion et al., 2011; Dishion & Stormshak, 2007).

Participants were followed longitudinally until approximate ages 28–30, with about 80% retention across all waves of data collection. For this study, we examined data collected at ages 16–17 (T1), ages 18–19 (T2), and ages 21–22 (T3). Most assessments at T1 took place in the schools. Participants were also invited to complete a series of video-recorded parent-adolescent interaction tasks. For assessments at T2 and T3, participants were mailed questionnaires. Participants were compensated for their time at each wave.

Measures

Parent-Adolescent Coercion (T1)

Adolescents and their parents were invited to participate in seven interaction tasks (ranging from 5 to 8 min in length) at home, and 649 families completed this assessment. They were instructed to discuss different topics during each task: task (1) adolescent-led discussion of an area of growth, task (2) parental monitoring and listening, task (3) a family conflict and how it was solved, task (4) family problem-solving, task (5) individual beliefs regarding substance use, task (6) planning a fun family activity, task (7) positive recognition of family members. The interactions were video-recorded. An initial warm-up task, which asked parents to discuss

the growth of their child, was not coded nor included in the analysis.

The Relationship Affect Coding System (RACS; Peterson et al., 2009), a micro-social coding system, was used to code three dimensions of behaviors (i.e., verbal, physical behaviors, and affect) during each interaction task. The codes were recorded using Noldus Observer XT, Version 11.0. Verbal codes reflect general conversation (e.g., positive verbal, negative verbal) and attempt to change others' behaviors (e.g., negative directive, positive structuring). Physical behaviors reflect dyadic physical interactions (e.g., positive physical contact, negative physical contact). Affect codes reflect the affect displayed during interactions (e.g., anger/disgust, distress, positive affect). At each given moment, the parent and child can have one code from each of the three behavior dimensions, which resulted in three data streams for each person in the interaction with the real-time onset and offset of each code. Different combinations of the three data streams of each person were then categorized into six behavioral clusters: positive, neutral, directives, negative, no talk, and ignore. For example, a combination of positive verbal (verbal code), no physical contact (physical code), and neutral affect (affect code) at a given time would be categorized into the positive behavioral cluster; a combination of no talk (verbal code), negative physical (physical code), and angry/disgust (affect code) at a given time would be categorized into the negative behavioral cluster. When positive and negative codes coexist, the categorization process would follow a hierarchical system, such that negative behaviors would trump positive behaviors. For example, if a caregiver shows negative physical behaviors while showing positive affect, the behavior would be included in the negative engagement cluster. The code hierarchy is as follows: ignore, negative, positive, directive, no talk, and neutral behavior. The hierarchy is guided by theory and research on relationship dynamics, and negative behaviors are found to be more salient in defining the interpersonal impact than positive behaviors. Following the hierarchy rules, the behavioral clusters were mutually exclusive, and each family member had a summary stream indicating the onset and offset of behavioral clusters. More detailed descriptions of the Relationship Affect Coding System are available in Peterson et al. (2009). Mothers were present for the majority of the families (94.0%) and thus, mother-adolescent dyadic interactions were the primary focus of this study. When fathers were present in the interaction, this was controlled as a covariate. Approximately 20% of the interactions were coded by two coders with an overall interrater agreement of 94% and an overall Kappa score of 0.93 across all codes.

The ongoing dyadic interaction between a mother and adolescent could be captured and visualized using State Space Grids (Granic & Hollenstein, 2003), with adolescents' behaviors depicted on the x-axis and mothers' behaviors depicted on the y-axis (see Fig. 1). Similar to previous studies (Dishion et al., 2017; Panza, 2015; Sitnick et al., 2015a, b), the region of Dyadic Coercion (DC) included interactions in which one member of the dyad either showed directive (DIR) or negative engagement (NEG) while the other responded with directive (DIR), negative engagement (NEG), not talking (NTK), or ignoring (IGN). The Dyadic Coercion area included 12 out of 36 possible cells on the grid. A duration proportion score (i.e., duration per event score) was created by dividing the total duration of each dyadic observed in the DC region by the overall session time, which measures the rigidity in dyadic coercive states. A higher duration proportion score indicates a greater degree of getting "stuck" in the dyadic coercive states (i.e., less flexibility to move into other states).

Substance Use (T1, T2, and T3)

Adolescents' tobacco, alcohol, and cannabis use were collected at each time point through the Community Action for Successful Youth survey (Metzler et al., 2001). Adolescents reported how many cigarettes they had smoked, how many drinks of alcohol they had consumed, and how often they had smoked cannabis within the past three months on a scale ranging from 0 (*never*) to 7 (*2–3 times a day*). Responses were then rescaled to reflect the frequency of use for each substance in a 1-month period on a 5-point scale (0 = *never*, 1 = *one to two times per month*, 2 = *three to six times per month*, 3 = *seven to ten times per month*, and 4 = eleven to twenty times per month).

Antisocial Behaviors (T1, T2, and T3)

In order to measure antisocial behaviors in a developmentally appropriate manner, slightly different scales were utilized at each of the three time points. The Child and Family Center Youth Questionnaire (Child and Family Center, 2001) was used to measure antisocial behaviors at T1. Adolescents reported the number of times they engaged in each antisocial behavior (e.g., "intentionally hit or threatened to hit someone at school", "purposely damaged or tried to damage property") in the last month on a scale from 0 (*never*) to 6 (*more than 20 times*). The Cronbach's alpha for this scale was slightly below an optimal level at 0.69. Antisocial behaviors were measured through a subscale of the Adult Self-Report (ASR; Achenbach and Rescorla, 2003) at T2. A Likert scale of 0 (*not true*), 1 (*somewhat or sometimes true*), and 2 (*very true or often true*) was used to measure participants' antisocial behaviors (e.g., "I steal", "I do things that may cause me trouble with the law"). Cronbach's alpha was 0.81. A subscale of the Project Alliance Young Adult Survey

was used to measure antisocial behaviors in young adults at T3, which included 20 items accessing frequency of antisocial behaviors in the past three months, such as "carry a weapon such as a handgun", "get arrested for any offense". They rated on a Likert scale ranging from 0 (*never*) to 3 (*every day*). Cronbach's alpha was 0.72.

Covariates

Socioeconomic status (SES) was measured using a combination of parent reports of employment status, parental education, household income, housing status, and financial assistance status. Family substance use was measured through adolescents' self-reports on the extent to which family members (i.e., parents and siblings) use substances. Intervention status (0 = control, 1 = intervention), child age, child gender (1 = male, 2 = female), child race (1 = White, 2 = non-White). All these covariates are controlled in predicting the growth in substance use, and only demographic variables (i.e., SES, child age, child gender, and child race) and intervention status were controlled in predicting antisocial behaviors.

Data Analytic Plan

To examine the long-term impact of parent-adolescent coercive interaction on the developmental trajectory of externalizing problems from adolescence to early adulthood, we first calculated the proportion of the total task duration in which each dyad engaged in the Dyadic Coercion region as an indicator of parent-adolescent coercion. Given that conflict tasks and problem-solving tasks are more likely to elicit dyadic coercion and negative emotions whereas coercive behaviors are less likely to arise in positive tasks (e.g., planning a fun family activity), we calculated the duration proportion score for positive tasks (i.e., task 1, task 2, task 6 and task 7) and negative tasks (i.e., task 3, task 4, and task 5) separately. The duration proportion scores were then used to predict substance use and antisocial behaviors in separate models. Given the ordinal nature of the substance use variables, categorical latent growth curve models (Lee et al., 2018; Masyn et al., 2018) were used to test changes in substance use from T1 to T3 (see Fig. 2) using weighted least squares with mean and variance adjusted estimator (WLSMV). For latent growth curve models with categorical outcomes, it was assumed that there were continuous latent variables that underlie the observed categorical

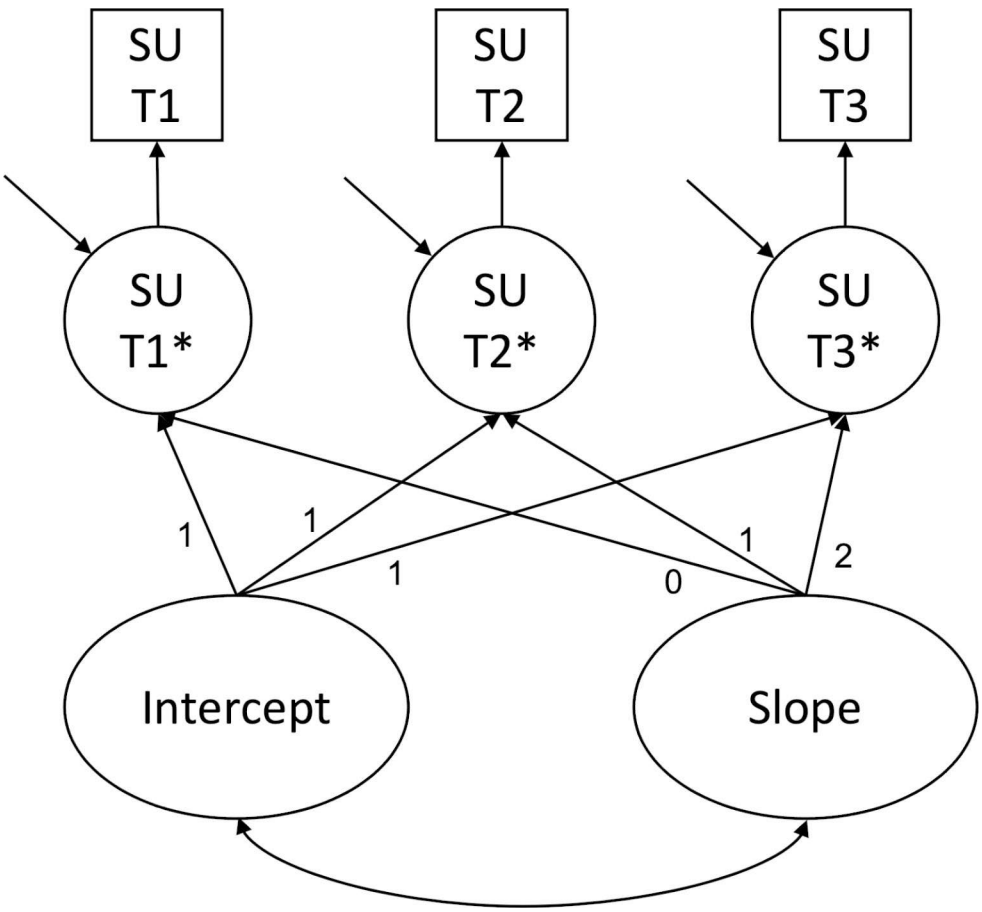

Fig. 2 A conceptual model illustrating the latent growth curve model with categorical substance use indicators
Notes. Asterisks (*) represent latent response variables. SU = Substance use variables

outcomes (e.g., 0-never, 1-one to two times, 2-three to six times, 3-seven to twenty times, 4-greater than twenty times). Therefore, these categorical responses were transformed into normally distributed continuous latent response variables (LRV) with thresholds serving as cut-points that separate the latent variables. Thresholds were constrained to ensure that the same constructs were assessed across time. The mean of the latent intercept was fixed at zero for model identification. The latent linear slope represents rates of linear change over time.

We first estimated three unconditional categorical latent growth curve models for each substance use variable without including any independent variables or covariates. Consistent with prior findings (Véronneau et al., 2016), preliminary analyses revealed a significant linear slope. Therefore, we subsequently fitted linear growth curve models with parent-adolescent coercion and covariates adding to the unconditional model to predict both intercept and slope. Since potential intervention effects were not the focus of this study, intervention status was controlled for in all analyses. To evaluate the goodness-of-fit, we used both relative and absolute fit indexes, specifically, Confirmatory Fit Index (CFI), Root Mean Squared Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). The specified model is considered acceptable if the CFI is higher than 0.90, RMSEA is lower than 0.06 and the SRMR is lower than 0.08 (Hu & Bentler, 1999).

Because adolescents' antisocial behaviors were measured using different scales at each time point, path analyses were used to test the association between parent-adolescent coercion and antisocial behaviors measured in late adolescence and early adulthood (T2 and T3 respectively) controlling for antisocial behaviors in middle adolescence (T1). All analyses were conducted in Mplus 8.1 (Muthén & Muthén, 1998–2018). Missing data were managed using the Full Information Maximum Likelihood estimation (FIML; Enders and Bandalos, 2001).

Results

Descriptive Results

The descriptive statistics for all study variables are presented in Table 1. Dyadic coercion observed during negative tasks at T1 was associated with more antisocial behaviors at all time points (rs = 0.10-0.13) as well as greater substance use at T3. However, dyadic coercion observed during positive tasks was not significantly associated with any outcome variable at any time point. Dyadic coercion variables were also negatively associated with child gender and SES, suggesting that families with boys and families with lower SES tended to show higher levels of dyadic coercion. All substance use variables were positively associated with antisocial behavior variables (rs = 0.14 − 0.58). Only dyadic coercion observed during negative tasks was included in the following analyses due to its strong association with externalizing outcomes.

Dyadic Coercion and Substance Use

Categorical latent growth curve models were established to examine the association between dyadic coercion and growth in tobacco, alcohol, and cannabis from late adolescence to early adulthood. The unconditional growth curve models showed adequate model fit (tobacco: CFI = 0.996, RMSEA = 0.036, SRMR = 0.012; alcohol: CFI = 0.921, RMSEA = 0.094, SRMR = 0.027; cannabis: CFI = 0.988, RMSEA = 0.052, SRMR = 0.013). The frequency of use in all three types of substances steadily increased from T1 to T3. The intercepts and linear slopes were negatively associated in all three models (rs = − 0.27 ~ − 0.14), suggesting that adolescents with a lower initial level of substance use tended to show a higher rate of linear slope from adolescence to young adulthood.

The conditional latent growth curve models also showed adequate model fit (tobacco: CFI = 0.996, RMSEA = 0.022, SRMR = 0.023; alcohol: CFI = 1.000, RMSEA = 0.000, SRMR = 0.024; cannabis: CFI = 0.981, RMSEA = 0.038, SRMR = 0.025). Dyadic coercion was significantly associated with the rate of linear increase in alcohol use (B = 3.07, SE = 1.40, p = .03). Consistent with our hypotheses, adolescents with more coercive interactions with parents showed steeper increases in alcohol use from adolescence to young adulthood, compared to those showed less coercive interactions. However, the association was not found for either tobacco use (B = 2.04, SE = 1.42, p > .05) or cannabis use (B = 2.68, SE = 2.39, p > .05). Nevertheless, we found a marginally significant intervention effect on the rate of increase in cannabis use (B = − 0.30, SE = 0.16, p = .06), which suggested that adolescents in intervention condition showed a slower increase in cannabis use compared to those assigned to the control condition. In addition, high family socioeconomic status (SES) was associated with greater growth in cannabis use relative to families with low SES. High parental substance use was associated with higher levels of alcohol use and cannabis use at T1. All results for the conditional models are displayed in Table 2. A post-hoc analysis was conducted to examine the direct association between dyadic coercion and substance use at T2 and T3 controlling for the level of substance use at T1 and the results were not statistically significant in any models.

Table 1 Bivariate correlation of key study variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. DC_Positive T1	—																			
2. DC_Negative T1	0.55**	—																		
3. Tobacco Use T1	−0.01	0.01	—																	
4. Marijuana Use T1	0.01	0.10*	0.39**	—																
5. Alcohol Use T1	−0.06	−0.02	0.35**	0.49**	—															
6. Tobacco Use T2	0.03	0.08	0.59**	0.34**	0.24**	—														
7. Marijuana Use T2	0.00	0.05	0.23**	0.53**	0.35**	0.33**	—													
8. Alcohol Use T2	−0.06	0.06	0.17**	0.35**	0.45**	0.34**	0.49**	—												
9. Tobacco Use T3	−0.04	0.14**	0.44**	0.28**	0.19**	0.63**	0.28**	0.24**	—											
10. Marijuana Use T3	−0.02	0.10*	0.12**	0.42**	0.30**	0.26**	0.61**	0.37**	0.40**	—										
11. Alcohol Use T3	−0.03	0.09*	0.01	0.25**	0.26**	0.19**	0.28**	0.45**	0.24**	0.38**	—									
12. Antisocial Behaviors T1	0.05	0.10*	0.22**	0.24**	0.32**	0.19**	0.23**	0.22**	0.16**	0.19**	0.14**	—								
13. Antisocial Behaviors T2	0.05	0.10*	0.16**	0.25**	0.26**	0.27**	0.30**	0.33**	0.23**	0.27**	0.15**	0.36**	—							
14. Antisocial Behaviors T3	0.05	0.13**	0.11**	0.36**	0.33**	0.23**	0.46**	0.43**	0.24**	0.58**	0.45**	0.25**	0.39**	—						
15. Intervention	−0.06	−0.01	0.05	0.03	0.03	0.02	−0.05	0.02	0.05	−0.09*	−0.05	−0.01	−0.04	−0.03	—					
16. Child Age	0.05	0.01	0.18**	0.10**	0.09**	0.10**	−0.02	0.00	0.13**	−0.01	−0.03	−0.02	0.00	−0.11**	−0.04	—				
17. Child Gender	−0.11**	−0.14**	0.06	−0.03	0.02	−0.01	−0.08*	−0.13**	−0.09*	−0.14**	−0.22**	−0.08*	−0.07	−0.22**	0.00	−0.03	—			
18. Child Ethnicity	0.09*	0.00	−0.08*	−0.06	−0.20**	−0.12**	−0.10**	−0.22**	−0.07	−0.13**	−0.24**	−0.03	0.01	−0.16**	−0.01	0.10**	0.04	—		
19. SES	−0.12**	−0.13**	−0.04	0.01	0.12**	−0.04	0.07	0.18**	−0.09*	0.12**	0.21**	−0.01	0.02	0.14**	0.03	−0.05	−0.04	−0.38**	—	
20. Family Substance Use	−0.03	0.07	0.23**	0.30**	0.28**	0.20**	0.21**	0.16**	0.22**	0.20**	0.09*	0.15**	0.12**	0.16**	−0.02	0.04	0.06	−0.09**	0.05	—

Table 1 (continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
M	0.01	0.02	0.64	0.51	0.53	1.02	0.72	0.91	1.63	1.17	1.88	1.30	56.04	0.30	0.49	16.99	1.49	1.56	0.01	0.16
SD	0.02	0.03	1.35	1.06	0.77	1.62	1.30	1.02	1.78	1.58	1.26	0.39	7.10	0.22	0.50	0.77	0.50	0.50	0.75	0.13

Notes. DC = Dyadic Coercion
$^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$

Dyadic Coercion and Antisocial Behaviors

Path analyses were used to examine the association between dyadic coercion and antisocial behaviors at T2 and T3 in separate models. Both models were just identified with zero degrees of freedom. Controlling for antisocial behaviors at T1, dyadic coercion was significantly associated with antisocial behaviors at T2 ($B = 16.55$, $SE = 7.83$, $\beta = 0.09$, $p = .03$) and T3 ($B = 0.68$, $SE = 0.31$, $\beta = 0.09$, $p = .03$). The results suggested that adolescents with more coercive interactions with parents demonstrated more antisocial behaviors in both late adolescence and early adulthood. In addition, adolescents with higher SES reported more antisocial behaviors at T3 ($B = 0.04$, $SE = 0.01$, $\beta = 0.14$, $p < .01$) relative to adolescents with lower SES. Males reported more antisocial behaviors than females ($B = -0.08$, $SE = 0.02$, $\beta = -0.17$, $p < .01$). Please see Table 3 for results for other covariates.

Discussion

The current study examined how parent-adolescent coercive interactions in adolescence were associated with substance use and antisocial behavior through early adulthood. Although coercive interactions within the family context have been found to be a risk factor for long-term development in externalizing behaviors such as aggression, antisocial behavior, and substance use in prior studies (e.g., LoBraico et al., 2020; Saxbe et al., 2014), there have been limitations in the measurement of coercion in this prior work. These studies measured coercion using either participants' perceptions of family conflict or a limited range of relevant behaviors without attention to adolescent-initiated coercion. This study is the first to adopt a dynamic systems approach to better elucidate coercive exchanges (e.g., one showing aversive behaviors with the other escalating or one showing aversive behaviors with the other giving in) between parents and adolescents. The findings provided a unique contribution to the existing literature by demonstrating how coercive interaction unfolds within dyads and how those dyadic characteristics contribute to long-term development in externalizing problems from middle adolescence to early adulthood.

Guided by the social interaction learning theory and the dynamic systems framework, we coded the real-time behavioral exchanges between parents and adolescents to evaluate coercive interactions. The intensive longitudinal data drawn from the continuous coding of behaviors displayed by parents and adolescents created a unique opportunity to capture behavioral changes over a short time period. Moreover, we used state-space grids to visualize reciprocal dyadic interaction processes. In accordance with dynamic systems theory,

Table 2 Categorical latent growth curve models examining the association between dyadic coercion at T1 and substance use outcomes from T1 to T3

	Tobacco Use				Alcohol Use				Cannabis Use			
	Intercept		Linear Slope		Intercept		Linear Slope		Intercept		Linear Slope	
	B	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
Dyadic Coercion	−0.163	2.246	2.042	1.416	-1.802	1.821	3.066*	1.403	1.302	1.943	1.185	1.054
Intervention	0.095	0.124	0.029	0.069	−0.021	0.107	−0.040	0.068	0.060	0.115	−0.134	0.070
Sibling Substance Use	1.491**	0.470	0.005	0.241	0.192	0.439	−0.129	0.294	0.774	0.465	−0.010	0.304
Parent Substance Use	0.996	0.650	−0.561	0.357	2.732***	0.588	−0.964*	0.383	2.766***	0.611	−0.708	0.397
SES	−0.117	0.087	−0.033	0.047	0.071	0.073	0.090*	0.045	−0.008	0.076	0.141**	0.049
Gender	0.043	0.127	−0.121	0.072	−0.037	0.110	−0.179**	0.068	−0.261*	0.122	−0.005	0.073
Race	−0.477**	0.139	0.039	0.075	−0.432***	0.115	−0.012	0.072	−0.131	0.133	−0.025	0.077
Age	0.266**	0.094	−0.032	0.052	0.095	0.073	−0.063	0.047	0.054	0.088	−0.052	0.052

Notes. Intervention status (0 = control, 1 = intervention), child gender (1 = male, 2 = female), child race (1 = White, 2 = non-White)

***$p < .001$, **$p < .01$, *$p < .05$

we included a duration per event score of coercion which taps into parent-child levels of coercion as an attractor state. We hypothesized that less flexibility, that is dyads that were less likely to move out of coercion and spent longer periods in coercion, would predict increases in substance and antisocial behaviors over time. Indeed, we found that adolescents with more coercive interactions with parents showed higher rates of increase in alcohol use and higher levels of antisocial behavior through early adulthood. However, the association with coercive interaction was not found in adolescent tobacco use or cannabis use. The results shed light on the role of coercive parent-adolescent interactions in the escalation of externalizing problems from adolescence to early adulthood.

The longitudinal association between parent-adolescent coercive interactions and adolescent externalizing behavior was partially supported. We first examined how real-time dynamics during a series of family interactions were linked to the development of substance use, and the association was only found in alcohol use but not tobacco use or cannabis use. Although the concurrence of alcohol, tobacco, and cannabis use is relatively prevalent (Cohn et al., 2016; Moss et al., 2014), different processes are often found to be supportive of each substance (e.g., Piehler et al., 2012). Because of the social context that is most common for alcohol use, it may be that the relationally based risk factors such as coercion are particularly salient. We then found that higher levels of dyadic coercion were associated with more antisocial behaviors in late adolescence and early adulthood, which suggests that coercive interactions in the family context in adolescence continue to contribute to the development of antisocial behaviors beyond the well-established associations in early and middle childhood (Lansford et al., 2011; Smith et al., 2014).

While not a focus of this study, the enduring impact of parent-adolescent coercive interactions may be mediated by deviant peer relationships. Given the robust influence of deviant peer relationships on the emergence of adolescent substance use and antisocial behavior (Fergusson et al., 2002; Lacourse et al., 2006) as well as the progression from adolescence to adulthood (Van Ryzin & Dishion, 2014), coercive family interactions and deviant peer affiliation may exert a synergistic impact on adolescent developmental outcomes (Dishion et al., 2019; Otten & Ha, 2022). Specifically, adolescents who have coercive conflicts with parents may be at risk to disengage from family relationships and seek acceptance from deviant peer groups, which in turn increases the likelihood of alcohol use (Dishion et al., 2004; Nash et al., 2005; Van Ryzin et al., 2012). Similarly, Van Ryzin and Dishion (2013) found the coercive joining process in peer interactions (i.e., dominant behavior and obscene language) as a central mechanism explaining the

Table 3 Path models examining the association between dyadic coercion at T1 and antisocial behaviors at T2 and T3

	Antisocial behaviors T2			Antisocial behaviors T3		
	B	*SE*	*β*	*B*	*SE*	*β*
Antisocial Behaviors T1	3.932	0.576	0.275***	0.149	0.022	0.265***
Dyadic Coercion	16.552	7.833	0.087*	0.681	0.308	0.089*
Intervention	−0.227	0.458	−0.020	−0.026	0.018	−0.059
SES	−0.033	0.332	−0.004	0.040	0.013	0.136**
Gender	0.839	0.464	0.073	−0.076	0.018	−0.169***
Race	0.716	0.501	0.063	−0.034	0.019	−0.077
Age	−0.066	0.318	−0.008	−0.031	0.012	−0.099**

Notes. Intervention status (0 = control, 1 = intervention), child gender (1 = male, 2 = female), child race (1 = White, 2 = non-White)
***$p < .001$, **$p < .01$, *$p < .05$

relationship between family coercion and violent behavior in adulthood. Future work may investigate the role of deviant peer affiliation in the relationship between family interactions and externalizing problems.

Limitations and Implications

This study has several limitations. First, the measures of antisocial behavior used in this analysis include items that, from a critical perspective (e.g., How, 2017), may not reflect true antisocial behavior, such as having sex with multiple partners (Grunt-Mejer & Campbell, 2016). While these items may have been considered antisocial behavior at the time the scales were written, it is important that we, as a scientific community, begin to examine our definition of antisocial behavior with a critical lens to create a definition that is not solely representative of the societal majority (Huzik, 2021). In addition, the reliability of the antisocial behavior measure at T1 was suboptimal. Second, we only focused on the duration proportion of dyadic interaction within the specific dyadic coercion (DC) region. While this approach captures the extent of coercion, it does not evaluate specific sequences of dyadic behaviors. An innovative approach to describing how each dyad moves around the state space grid is the grid-sequence analysis (Brinberg et al., 2017). Future studies could examine the sequence of dyadic behaviors as well as identify the specific types of sequences that are particularly associated with adolescent developmental outcomes. Third, we used the early childhood literature to define the DC region in the state space grids (Dishion et al., 2017). However, there might be unique interaction patterns in adolescents that are especially relevant to the development of externalizing problems not captured by the approach used in evaluating coercion in younger children. For example, an adolescent's display of negative behaviors while the parent stays neutral may mark the initiation of the coercive cycle. Future studies would benefit from investigating how coercive interactions in adolescents may differ from those in children and may redefine the dyadic coercion region in the context of parent-adolescent interaction.

Our findings highlight the risks of coercive interactions for adolescent development; therefore, this study has significant implications for family-based interventions. While several studies demonstrate the risk of coercion in parent-child interactions in early childhood, our study highlights the impact these interactions continue to have in later adolescence and early adulthood. These interaction patterns may be most malleable in childhood, but our findings stress the importance of addressing coercion in adolescence as well. Programs that focus on preventing adolescent substance use and antisocial behavior should integrate components that improve family functioning and reduce coercive interactions between adolescents and caregivers. Methodologically, this study demonstrated the contribution of using intensive longitudinal data (i.e., micro-coding of dyadic behaviors) in understanding the growth of adolescent externalizing behaviors. The moment-to-moment behavioral exchanges with parents are the "materials" out of which adolescent externalizing behaviors emerge and develop. An in-depth investigation of the behavioral exchanges may inform intervention programs that target changes in real-time interaction patterns.

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Compliance with Ethical Standards

Conflict of Interest All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Ethical Approval and Informed Consent All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee

and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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