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Parenting, deviant peer affiliation, and externalizing behavior during adolescence: processes conditional on sympathetic nervous system reactivity

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Abstract

Background: The present study examined associations between permissive parenting, deviant peer affiliations, and externalizing behavior across mid to late adolescence in a plausible indirect effects model of change over time with deviant peer affiliation serving as the mediator. We also evaluated potential conditional indirect effects wherein these relationships may be moderated by sex and sympathetic nervous system (SNS) activity, indexed by skin conductance level (SCL) reactivity.

Method: Participants included 242 community-sampled adolescents ($M = 15.79$ years; 48% boys; 66% European American, 34% African American) with two additional longitudinal assessments lagged by one year. Permissive parenting, SCL reactivity, and sex were considered as time invariant predictors of repeated measures of deviant peer affiliation and externalizing behavior in latent growth models that tested whether any of the direct or indirect associations were conditional on sex or SCL reactivity.

Results: Evidence was found for indirect effects of permissive parenting on externalizing behavior via deviant peer affiliation, but only for males with lower SCL reactivity to stress. Additionally, these effects were found on latent intercepts, but not slopes indexing change over time, perhaps reflecting established individual differences in relationships among these variables.

Conclusions: Findings are discussed in the context of biosocial models of adolescent development and risk factors that may inform interventions for vulnerable youth.

Keywords

Permissive parenting; deviant peer affiliation; externalizing behavior; sympathetic nervous system reactivity; adolescence

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Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of this article.

Introduction

Parental permissiveness and affiliation with deviant peers are risk factors for externalizing behaviors in adolescence (Trucco, Colder, & Wieczorek, 2011; Trudeau, Mason, Randall, Spoth, & Ralston, 2012). Although parenting, peer affiliation, and externalizing behaviors are interconnected in multiple ways, one relatively well-documented pathway is that permissive parenting predicts deviant peer affiliations which, in turn, predict adolescents' problem behaviors (Chung & Steinberg, 2006; Kiesner, Poulin, & Dishion, 2010). In a recent cross-sectional study, we documented that the existence and strength of this indirect pathway varies based on sympathetic nervous system (SNS) responses to stress (Hinnant, Erath, Tu, & El-Sheikh, 2016). In the present study, we used recently collected longitudinal data from this same project to examine skin conductance level (SCL) reactivity, one index of the SNS, and sex as moderators of the direct and indirect paths linking permissive parenting at age 16 with deviant peer affiliations and externalizing behaviors over time.

SCL reactivity refers to electrodermal activity caused by the sweat glands, which are innervated by the SNS component of the autonomic nervous system (ANS). SCL reactivity is a marker of the Behavioral Inhibition System, a neurophysiological motivational system that promotes inhibition, or caution, in situations that involve threat or potential negative consequences (Beauchaine, 2001). Consistent with fearlessness and stimulation-seeking theories, blunted SCL reactivity is conceptualized as a marker of punishment insensitivity and poor inhibitory self-control (Beauchaine, 2001) and is associated with externalizing behaviors during childhood and adolescence (Beauchaine, Katkin, Strassberg, & Snarr, 2001; Murray-Close, 2013). SCL reactivity is commonly observed when making a high risk-reward decision (Crone, Somsen, Beek, & Van Der Molen, 2004), or when learning under conditions of threat of loss, relative to promise of reward (Dawson, Schell, & Courtney, 2011). Additional evidence shows that SCL reactivity increases when individuals inhibit dominant responses, such as through cognitive reappraisal (Sheppes, Catran, & Meiran, 2009).

Studies have examined whether SCL reactivity moderates associations between parenting practices and externalizing behaviors. For example, harsh parenting and parental power-assertive discipline were more strongly associated with child externalizing behaviors at lower levels of SCL reactivity (Erath, El-Sheikh, & Mark Cummings, 2009; Kochanska, Brock, Chen, Aksan, & Anderson, 2015). In longitudinal analyses, externalizing behaviors were high and stable among boys with lower SCL reactivity (Erath, El-Sheikh, Hinnant, & Cummings, 2011), and power-assertive discipline predicted higher externalizing behaviors among children with lower SCL during laboratory tasks (Kochanska, Brock, & Boldt, 2017). Consistent with the conceptualization of SCL reactivity as a marker of sensitivity to punishment and inhibitory self-control, children with low SCL reactivity may not experience physiological cues that promote cautious behavioral responses to threat, and therefore may display increased opposition and aggression in the context of harsh parenting behaviors (Erath et al., 2011). Additional research has shown that low SCL reactivity operates similarly in the context of direct peer aggression (e.g., victimization), conferring vulnerability to high and stable externalizing behaviors (Erath, Su, & Tu, 2018; Gregson, Tu, & Erath, 2014). Harsh treatment is believed to fuel oppositional and aggressive responses,

particularly when directed at youth who are relatively insensitive to negative consequences and struggle to inhibit impulsive responses (Erath et al., 2011; Gregson et al., 2014).

In addition to harsh interpersonal contexts (e.g., harsh parenting, peer victimization), permissive parenting and deviant peer affiliations are social contexts that may also increase the need for sensitivity to negative consequences and inhibitory self-control. For example, when parents are permissive, youth with higher SCL reactivity may better comprehend the potential negative consequences of deviant peer affiliations or delinquent behaviors and avoid these risks. In contrast, youth with lower SCL reactivity may be drawn into affiliation with deviant peers and delinquent behaviors despite the risks, particularly when parents are permissive and do not impose behavioral controls. An important and novel question, and the focus of the present study, is whether adolescents with low SCL reactivity are especially susceptible to parental permissiveness and deviant peer affiliations in which externalizing behaviors are permitted.

Considering the inverse of parental permissiveness, two recent studies examined interactions between parental behavioral control in the peer domain (i.e., parental directing of friendships) and SCL reactivity as predictors of prosocial and deviant peer affiliations. In these studies, parental directing referred to parental efforts to direct early adolescents toward prosocial friends and away from antisocial friends. Parental directing of friendships predicted more prosocial peer affiliations at lower but not higher levels of SCL reactivity (Tu, Erath, Pettit, & El-Sheikh, 2014). Similarly, Tu, Erath, and El-Sheikh (2017) found that parental directing of friendships predicted lower deviant peer affiliation at lower levels of SCL reactivity. Thus, when parents do not direct adolescents with lower SCL reactivity toward positive peer interactions (e.g., when parents are permissive), these adolescents may be more likely to affiliate with friends who engage in risky behaviors (Tu et al., 2017).

The present study builds on our prior cross-sectional work (Hinnant et al., 2016), which now includes longitudinal data to test a process-based model of permissive parenting, deviant peer affiliations, and externalizing behaviors in adolescence that accounts for pathways of risk conditional on SCL reactivity and sex. The model is supported by empirical research, but largely limited to cross-sectional designs and models that only partially address the putative processes outlined here. We hypothesized that permissive parenting would predict individual differences in externalizing behavior at age 18 and change over time in externalizing behavior from ages 16 to 18 via indirect paths through affiliation with deviant peers at age 17 and change over time in deviant peer affiliation. We also hypothesized that the prospective associations between permissive parenting and deviant peers and between deviant peers and externalizing behavior would be moderated by SCL reactivity such that the relations would be stronger among adolescent boys with lower SCL reactivity. Examining sex as a moderator of risk was exploratory due to mixed evidence from related studies in the literature. However, the evidence seems somewhat stronger for associations between permissive parenting and externalizing behavior for boys (e.g., (Kim, Arnold, Fisher, & Zeljo, 2005; Parent et al., 2011) and for the proposed moderating role of ANS reactivity among boys compared to girls (e.g., El-Sheikh, Keller, & Erath, 2007; Erath et al., 2011; 2009).

Method

Participants

Youth participated in three waves of the Family Stress and Youth Development: Bioregulatory Effects project, a longitudinal study examining relations between family functioning and youth development. Data for this study were based on waves 4–6 of the larger project (collected in 2012–2015) with a 1-year interval between time points. Participants were recruited from schools in Alabama and Georgia in 2005 when they were 8 years old and eligibility criteria required that parents were living together for at least two years (for more detail see (Erath et al., 2011)).

The analytic sample for the study is composed of 242 adolescents (115 boys, 127 girls; 66% European American, 34% African American; M age = 15.79 years, SD = .81) who participated at age 16 with 91% participating at age 17 and 86% participating at age 18. Families in the study were from a wide range of socioeconomic backgrounds according to their income-to-needs ratio (U.S. Department of Commerce, 2013). The majority (82%) of adolescents lived in two-parent households (e.g., biological parents or one biological parent and step-parent/partner), 14% lived in a single-parent household (parents separated or divorced during the study), and 4% lived with a legal guardian(s).

Procedure

The study was approved by the University's Institutional Review Board and consent and assent were obtained. Specific to this report, parents and adolescents visited the university laboratory where adolescents' SCL responses were measured during a three minute resting condition (baseline assessment) while sitting quietly by themselves in a room. This was followed by a three minute stress task in which participants were asked to trace the outline of a star using only the reflection of the star through a mirror as a guide (LaFayette Instrument Company, Lafayette, IN). The task has been used in many studies to evoke ANS reactivity (e.g., El-Sheikh, Keiley, & Hinnant, 2010). Adolescents and parents also completed questionnaires in separate rooms.

Measures

Permissive parenting.—At age 16, adolescents completed the Parent Behavior Inventory (Schwarz, Barton-Henry, & Pruzinsky, 1985) separately for mothers and fathers. Permissive parenting was examined using two reliable dimensions – lax discipline (4 items; e.g., “Lets me off easy when I do something wrong”) and non-enforcement (4 items; e.g., “Doesn't pay much attention to my misbehavior”). Items were rated on a 3- point scale (1 = *not like* to 3 = *like*). Adolescents' reports for mothers and fathers across lax discipline and non-enforcement were highly correlated (r s = .42 and .52, p s < .001; respectively) and were averaged. For adolescents who only reported on one parent (2.5% of participants), only responses for the one parent were used. Further, the two subscales of lax discipline and non-enforcement were correlated (r = .53, p < .001) and averaged to create a single score of permissive parenting (α = .84).

Skin conductance level reactivity (SCL reactivity).

At age 16, data acquisition for SCL followed standard guidelines and was obtained using the Mindware BioNex system (Mindware Technologies, Ltd., Gahanna, OH, USA). SCL was measured using two disposable silver/silver-chloride (Ag-AgCl) electrodes (1" x 1" foam, 0% chloride gel) placed on the palms of the non-dominant hand. SCL values (units = microsiemens or μS) were quantified in 1-minute intervals using MindWare Technologies EDA analysis software. Reactivity was computed by subtracting average levels (across three minutes) of SCL at rest from average levels of SCL during the star-tracing task such that higher scores reflect increased SCL from resting state to task.

Deviant peer affiliation.—Youth reported on the frequency of their association with deviant peers in the past week using a subscale of the psychometrically sound Community Action for Successful Youth (Metzler, Biglan, Ary, & Li, 1998). Four items assessed the frequency with which adolescents engaged with deviant peers (e.g., “How many times did you get together with friends who fight a lot?”) using a 7-point scale (1 = *never* to 7 = *more than 7 times*). Across time points, the measure demonstrated stability ($r_s = .32 - .38$, $p_s < .001$) and reliability ($\alpha_s = .66 - .84$). Mean scores at each time point were used in analyses.

Externalizing behavior.—Adolescents reported on their externalizing behaviors during the past six months using the Youth Self-Report (Achenbach & Rescorla, 2001). The Externalizing scale (32 items) is comprised of the sum of two subscales: aggressive behavior (e.g., “I get in many fights) and rule-breaking (e.g., “I cut classes or skip school”). Items are rated on a 3-point scale (1 = *not true* to 3 = *very often or often true*). This measure demonstrated stability ($r_s = .64 - .76$, $p_s < .001$) and reliability ($\alpha_s = .85 - .92$).

Results

Analysis overview

Unconditional parallel growth models were defined to evaluate between-individual variance in the latent intercepts and slopes of deviant peer affiliation and externalizing behaviors. Time coding of the slope for deviant peer affiliation was set to -1 , 0 , and 1 , setting the intercept to age 17, while time coding for the slope of externalizing behavior was set to -2 , -1 , 0 , setting the intercept to age 18. This allowed us to predict individual differences in deviant peer affiliation and externalizing behavior at later time points in subsequent models. Family income-to-needs, sex, resting SCL, SCL reactivity, and permissive parenting were considered as time invariant predictors at age 16. Both intercepts and slopes of deviant peer affiliation and externalizing behavior over time were considered as outcomes, thus providing two potential indirect pathways linking permissive parenting with externalizing behavior through deviant peer affiliation. Indirect effects through intercepts, representing levels of a variable at a specific time point, would suggest that any significant relationships are developmentally stable at the between-individual level. Indirect effects through slopes, representing change over time in variables, would suggest that any significant relationships are more developmentally dynamic (i.e., indirect effects are found in change in behavior, rather than level of behavior at a specific time). Conditional indirect effects in these growth

models were assessed with interaction terms involving sex and SCL reactivity on *a* and *b* paths. Our analytic model is depicted in Figure 1¹

Following recommended practices in evaluating indirect and moderated indirect effects (Preacher, Rucker, & Hayes, 2007), all conditional model parameters were estimated simultaneously. Analyses were conducted in *Mplus 7.31* (Muthén & Muthén, 2012). Maximum likelihood estimation was used to handle missing data. Model fit was evaluated according to recommended standards (Jackson, Gillasp, & Purc-Stephenson, 2009) with standardized root mean square residual (SRMR) values of .06 or less, chi-square divided by degrees of freedom ratio (χ^2/dof) values less than three, and Bentler's comparative fit index (CFI) values of .95 or higher indicating good fit.

Potential indirect effects were then evaluated using the model indirect command in *Mplus*, which provides a standard Sobel test. Conditional indirect effects (i.e., moderated indirect effects) were evaluated with a moderator centering approach wherein significant moderation effects on paths *a* and *b* were probed post-hoc at conditional values (± 1 *SD*) of the moderator(s) (Preacher et al., 2007).

Preliminary analyses

Descriptive statistics and bivariate correlations for all study variables are presented in Table 1. Consistent with the law of initial values (Wilder, 2014), resting SCL and SCL reactivity were negatively associated ($r = -.28, p = .001$) and thus resting SCL was included as a covariate. Race was initially considered as a covariate but was not related to any of the main variables, and thus was not considered further. Little's (1988) missing data analysis also indicated that data were not missing completely at random ($\chi^2 = 334.37, df = 286, p = .03$) and appropriate follow-up *t*-tests showed that participants missing permissive parenting scores had lower deviant peer affiliation scores at age 16 and lower resting SCL. Notably, maximum likelihood estimation is the recommended procedure for handling missing completely at random or missing at random data (Enders & Bandalos, 2001).

Unconditional parallel growth model

Repeated measures of deviant peer affiliation and externalizing behavior were evaluated simultaneously, and model parameters are provided in Table 2. Intercepts (i.e., estimated scores of deviant peer affiliation at age 17 and externalizing behavior at age 18) evidenced significant between-individual variance. The slope of deviant peer affiliation was negative, indicating a significant decline over time. However, there was not significant between-individual variability in the slope of deviant peer affiliation, indicating that all adolescents were declining in their deviant peer affiliation at similar rates. Originally, this variance was estimated as negative (an impossible solution) and so was constrained to be zero. This lack of between-individual variability in the slope of deviant peer affiliation precluded using it as a potential mediator of indirect effects in conditional model analyses. The slope of externalizing behavior was negative, but not significantly different from zero, indicating no

¹An alternate model was tested and included as Supplementary Figure S1 and Table S1 wherein the roles of deviant peer affiliation and externalizing behavior were "flipped" and externalizing behavior and its change over time were considered as the mediators in indirect and conditional indirect links between permissive parenting and deviant peer affiliation at age 18.

change in externalizing behavior over time, on average. The slope of externalizing behavior did have significant between-individual variability ($\sigma^2 = 5.60$, $p = .01$), indicating that adolescents' externalizing behavior was changing over time at different rates. Not shown in Table 2, the intercept of deviant peer affiliation was positively associated with the intercept of externalizing behavior ($r = .66$, $p < .001$) while the slope of externalizing behavior was not associated with either intercept.

Main indirect effects growth model

We next considered whether permissive parenting had an indirect effect on the intercept of externalizing behavior (scores at age 18) or the slope of externalizing behavior (change over time) through the potential mediator of the deviant peer affiliation intercept (scores at age 17), but not the deviant peer affiliation slope (recall that this variable lacked significant between-individual variability). Parameter estimates and model fit are shown in Table 3 under Conditional Model 1. There was not a significant association between permissive parenting and the intercept of deviant peer behavior (path a1). The intercept of deviant peer affiliation was positively associated with the intercept (path b1; $B = 2.21$, $p < .001$) but not the slope (path b2) of externalizing behavior. Permissive parenting was not associated with either the intercept or slope of externalizing behavior (paths c'1 and c'2). The indirect effects of permissive parenting on the intercept and slope of externalizing behavior through the potential mediator of the intercept of deviant peer affiliation were not significant ($B_{indirect} = .77$, $p = .09$ and $B_{indirect} = .05$, $p = .37$, respectively). Predictors accounted for 15% of the variance in the intercept of deviant peer affiliation, 53% of the variance in the intercept of externalizing behavior, and 9% of the variance in the slope of externalizing behavior.

Conditional indirect effects growth model

Next, we considered whether permissive parenting had a conditional indirect effect on the intercept (scores at age 18) or the slope (change over time) of externalizing behavior through the potential mediator of the deviant peer affiliation intercept (scores at age 17). More specifically, we investigated whether there might be indirect effects conditional upon sex, SCL reactivity, and the Sex x SCL reactivity interaction. Parameter estimates and model fit are shown in Table 3 under Conditional Model 2.

Inclusion of sex and SCL reactivity as moderators in showed that there were conditional effects on *a* and *b* paths, which were explored in post-hoc analyses as conditional indirect effects. The association between permissive parenting and the intercept of deviant peer affiliation was moderated by both sex and SCL reactivity ($B = -.81$, $p = .05$; Figure 2). While males with greater SCL reactivity had higher deviant peer affiliation on average, the only significant conditional relationship between permissive parenting and deviant peer affiliation was for males with lower SCL reactivity (conditional path $a_{1\text{male, low SCL reactivity}}$; $B = .62$, $SE = .29$, $p = .03$). Similarly, the association between deviant peer affiliation and the intercept of externalizing behavior was moderated by both sex and SCL reactivity ($B = .86$, $p = .004$; Figure 3).

In these conditional b1 paths, all slopes were positive and significantly different from zero, though the strength of the relationship did vary. Of greatest interest for potential conditional indirect effects, the strongest relationship between permissive parenting and deviant peer affiliation was for males with lower SCL reactivity (conditional path $b1_{\text{male, low SCL reactivity}}$; $B = 2.07$, $SE = .50$, $p < .001$). Testing the indirect effect of conditional a x b paths, accounting for c', the only significant conditional indirect effect of permissive parenting on the intercept of externalizing behavior via the mediator of deviant peer affiliation was for males with lower SCL reactivity ($B = 1.28$, $SE = .63$, $p = .04$). Predictors accounted for 23% of the variance in the intercept of deviant peer affiliation, 59% of the variance in the intercept of externalizing behavior, and 14% of the variance in the slope of externalizing behavior.

Discussion

Our goal was to explicate a process-based model of parenting, deviant peer affiliation, and externalizing behavior in adolescence that begins to take into account potential individual difference moderators of associations. While process-based models of parenting-peer affiliation-behavior associations are logical, highly appealing, and widely supported by theories of adolescent development (Trucco et al., 2011; Trudeau et al., 2012), it is also likely that the strength of some of these associations varies by individual differences. Specifically, physiological self-regulation has been theorized to play a moderating role in context-behavior relationships (Beauchaine, 2001). SCL reactivity has been found to moderate some of the pathways between parenting, deviant peer affiliation, and externalizing behavior (Erath et al., 2011; Hinnant et al., 2016; Kochanska et al., 2017). However, only pieces of a process-based model of parenting-peer affiliation-behavior conditional on physiological regulation have been adequately tested. Thus, a significant contribution of this study is identifying direct and indirect links between permissive parenting, deviant peer affiliation, and externalizing behavior over time that are conditional upon biological variables (i.e., SCL reactivity and sex).

We did not find evidence for a direct link between permissive parenting and deviant peer affiliation, a result that contrasts with a related prior cross-sectional study (Hinnant et al., 2016) that could be attributed to the time lag between the assessments of these variables. However, the relation between deviant peer affiliation and externalizing behavior did replicate longitudinally. Our conditional indirect effects hypothesis was supported in that the only significant indirect effect of permissive parenting on externalizing behavior via deviant peer affiliation was for males with less SCL reactivity. Supplementary analyses provided some evidence for bidirectional effects consistent with other studies (e.g., Curran, Stice, & Chassin, 1997). Specifically, in an alternate model we found that externalizing behavior at age 17 predicted deviant peer affiliation at age 18, though there was no evidence for indirect, conditional, or conditional indirect effects when alternate regression pathways were explored.¹

While a carefully controlled experiment would be needed to establish cause-effect relationships, the current model extends work in this area and allows for stronger inferences about how these processes unfold. Overall, findings support the proposition that youth with

poorer inhibitory control, reflected in lower SCL reactivity, may be at heightened risk for developing externalizing problems in permissive parenting or deviant peer contexts that allow for or promote disinhibitory tendencies.

Limitations

Although deviant peer affiliation and externalizing behavior were both considered longitudinally, some key variables including permissive parenting and SCL reactivity were considered as time invariant. Thus, the models may incompletely capture the true dynamics of developmental associations. Practical limitations dictated these model assumptions; permissive parenting data was not available at all time points and the sample size precluded a more complex model. Further, our permissive parenting measure was composed of subscales that tap expectations and demands for adolescent behavior, which is separate from the responsivity dimension that may be implied by Baumrind's (1967) typology of parenting. The emotional tone of warmth or hostility characterizing parental style was not considered in this study, but plays a role in adolescent adaptation (Spera, 2005).

Finally, the task used in this study to elicit physiological reactivity, the star-tracer, is well known for inducing frustration but also requires both motor and cognitive inhibitory control (i.e., each movement is reversed because of the mirror). Tasks measuring physiological reactivity to peer pressure or social threat could also be important for understanding conditional associations between peer affiliation and externalizing behavior. A related point is that results may vary based on the nature and context of externalizing behavior. For example, SCL reactivity has been negatively associated with proactive aggression whereas SCL reactivity has been positively associated with reactive aggression during tasks designed to elicit these types of aggression (Hubbard, McAuliffe, Morrow, & Romano, 2010). Finally, we used adolescent self-reports for most of the key variables which may overestimate associations. However, our primary question of interest involved testing associations that were thought to be conditional upon biological characteristics as moderators in theory-driven hypotheses. The conditional indirect effects reported here, combined with the converging evidence from other studies, boosts our confidence in the findings. However, we also note that our model was complex and power intensive; thus, some caution is warranted and attempts to replicate results of the present study will be important before strong conclusions can be drawn.

Future directions and conclusion

All associations were limited to intercept effects (i.e., in predicting individual differences in levels of deviant peer affiliation at age 17 and levels of externalizing behavior at age 18). This pattern of intercept-specific relationships along with the lack of slope effects suggests that our results are reflecting relations among stable individual differences rather than dynamic change over time. In other words, these findings may reflect longitudinal associations that are canalized by mid to late adolescence. Thus, a potentially important direction for research is to identify the time periods when: (1) deviant peer affiliations are forming and social bonds are more malleable; and (2) change over time in these processes are predicted by key variables of interest. The practical implication is that it may be easier to redirect maladaptive social relationships in earlier developmental periods to effect changes

in externalizing behavior. Earlier intervention requires better detection, and our findings converge with several other studies to suggest that blunted SCL reactivity, especially for males, could be a reliable moderator of biopsychosocial processes that contribute to externalizing problems. Biological markers will never serve a deductive, and indeed reductive, role in clinical science. They are, however, sufficiently studied that several biomarkers could serve an inductive role, providing important clues to guide the efforts of clinicians. For example, clinicians have used biomarkers to help choose alternative or supplementary treatments for youth that are non-responsive to the normal curriculum of interventions (Beauchaine et al., 2013). Future research could further expand on basic and applied work in this area by applying longitudinal designs to better capture and understand biopsychosocial processes in adolescence.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

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References

- Achenbach TM, & Rescorla L (2001). ASEBA School-Age Forms & Profiles. Burlington, VT: Aseba.
- Baumrind D (1967). Child care practices anteceding three patterns of preschool behavior. *Genetic Psychology Monographs*, 75(1), 43–88. [PubMed: 6032134]
- Beauchaine TP (2001). Vagal tone, development, and Gray's motivational theory: Toward an integrated model of autonomic nervous system functioning in psychopathology. *Developmental Psychopathology*, 13, 183–214. doi:10.1017/S0954579401002012
- Beauchaine TP, Gatzke-Kopp L, Neuhaus E, Chipman J, Reid MJ, & Webster-Stratton C (2013). Sympathetic- and parasympathetic-linked cardiac function and prediction of externalizing behavior, emotion regulation, and prosocial behavior among preschoolers treated for ADHD. *Journal of Consulting and Clinical Psychology*, 81(3), 481–493. doi:10.1037/a0032302 [PubMed: 23544677]
- Beauchaine TP, Katkin ES, Strassberg Z, & Snarr J (2001). Disinhibitory psychopathology in male adolescents: Discriminating conduct disorder from attention-deficit/hyperactivity disorder through concurrent assessment of multiple autonomic states. *Journal of Abnormal Psychology*, 110(4), 610–624. doi:10.1037/0021-843X.110.4.610 [PubMed: 11727950]
- Chung HL, & Steinberg L (2006). Relations between neighborhood factors, parenting behaviors, peer deviance, and delinquency among serious juvenile offenders. *Developmental Psychology*, 42(2), 319–331. doi:10.1037/0012-1649.42.2.319 [PubMed: 16569170]
- Crone EA, Somsen RJM, Beek BV, & Van Der Molen MW (2004). Heart rate and skin conductance analysis of antecedents and consequences of decision making. *Psychophysiology*, 41(4), 531–540. doi:10.1111/j.1469-8986.2004.00197.x [PubMed: 15189476]
- Curran PJ, Stice E, & Chassin L (1997). The relation between adolescent alcohol use and peer alcohol use: A longitudinal random coefficients model. *Journal of Consulting and Clinical Psychology*, 65(1), 130–140. doi:10.1037/0022-006X.65.1.130 [PubMed: 9103742]

- Dawson ME, Schell AM, & Courtney CG (2011). The skin conductance response, anticipation, and decision-making. *Journal of Neuroscience, Psychology, and Economics*, 4(2), 111–116. doi: 10.1037/a0022619
- El-Sheikh M, Keiley M, & Hinnant JB (2010). Developmental trajectories of skin conductance level in middle childhood: Sex, race, and externalizing behavior problems as predictors of growth. *Biological Psychology*, 83(2), 116–124. doi:10.1016/j.biopsycho.2009.11.009 [PubMed: 19945501]
- El-Sheikh M, Keller PS, & Erath SA (2007). Marital conflict and risk for child maladjustment over time: Skin conductance level reactivity as a vulnerability factor. *Journal of Abnormal Child Psychology*, 35(5), 715–727. doi:10.1007/s10802-007-9127-2 [PubMed: 17503176]
- Enders CK, & Bandalos DL (2001). The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Structural Equation Modeling*, 8(3), 430–457. doi:10.1207/s15328007sem0803_5
- Erath SA, El-Sheikh M, Hinnant JB, & Cummings EM (2011). Skin conductance level reactivity moderates the association between harsh parenting and growth in child externalizing behavior. *Developmental Psychology*, 47, 693–706. doi:10.1037/a0021909 [PubMed: 21142369]
- Erath SA, El-Sheikh M, & Mark Cummings E (2009). Harsh parenting and child externalizing behavior: Skin conductance level reactivity as a moderator. *Child Development*, 80(2), 578–592. doi:10.1111/j.1467-8624.2009.01280.x [PubMed: 19467012]
- Erath SA, Su S, & Tu KM (2018). Electrodermal reactivity moderates the prospective association between peer victimization and depressive symptoms in early adolescence. *Journal of Clinical Child & Adolescent Psychology*, 47(6), 992–1003. doi:10.1080/15374416.2016.1197838 [PubMed: 27586583]
- Gregson KD, Tu KM, & Erath SA (2014). Sweating under pressure: Skin conductance level reactivity moderates the association between peer victimization and externalizing behavior. *Journal of Child Psychology and Psychiatry*, 55(1), 22–30. doi:10.1111/jcpp.12086 [PubMed: 23734821]
- Hinnant JB, Erath SA, Tu KM, & El-Sheikh M (2016). Permissive parenting, deviant peer affiliations, and delinquent behavior in adolescence: The moderating role of sympathetic nervous system reactivity. *Journal of Abnormal Child Psychology*, 44(6), 1071–1081. doi:10.1007/s10802-015-0114-8 [PubMed: 26667026]
- Hubbard JA, McAuliffe MD, Morrow MT, & Romano LJ (2010). Reactive and proactive aggression in childhood and adolescence: Precursors, outcomes, processes, experiences, and measurement. *Journal of Personality*, 78(1), 95–118. doi:10.1111/j.1467-6494.2009.00610.x [PubMed: 20433614]
- Jackson DL, Gillaspay JA Jr., & Purc-Stephenson R (2009). Reporting practices in confirmatory factor analysis: An overview and some recommendations. *Psychological Methods*, 14(1), 6–23. doi: 10.1037/a0014694 [PubMed: 19271845]
- Kiesner J, Poulin F, & Dishion TJ (2010). Adolescent substance use with friends: Moderating and mediating effects of parental monitoring and peer activity contexts. *Merrill-Palmer Quarterly*, 56(4), 529–556. [PubMed: 21165170]
- Kim H-J, Arnold DH, Fisher PH, & Zeljo A (2005). Parenting and preschoolers' symptoms as a function of child gender and SES. *Child & Family Behavior Therapy*, 27(2), 23–41. doi:10.1300/J019v27n02_03
- Kochanska G, Brock RL, & Boldt LJ (2017). A cascade from disregard for rules of conduct at preschool age to parental power assertion at early school age to antisocial behavior in early preadolescence: Interplay with the child's skin conductance level. *Development and Psychopathology*, 29(3), 875–885. doi:10.1017/S0954579416000547 [PubMed: 27417305]
- Kochanska G, Brock RL, Chen K-H, Aksan N, & Anderson SW (2015). Paths from mother-child and father-child relationships to externalizing behavior problems in children differing in electrodermal reactivity: A longitudinal study from infancy to age 10. *Journal of Abnormal Child Psychology*, 43(4), 721–734. doi:10.1007/s10802-014-9938-x [PubMed: 25218772]
- Little RJA (1988). A test of missing completely at random for multivariate data with missing values. *Journal of the American Statistical Association*, 83(404), 1198–1202. doi: 10.1080/01621459.1988.10478722

- Metzler CW, Biglan A, Ary DV, & Li F (1998). The stability and validity of early adolescents' reports of parenting constructs. *Journal of Family Psychology*, 12, 600–619. doi: 10.1037/0893-3200.12.4.600
- Murray-Close D (2013). Psychophysiology of adolescent peer relations I: Theory and research findings. *Journal of Research on Adolescence*, 23(2), 236–259. doi:doi:10.1111/j.1532-7795.2012.00828.x
- Muthén LK, & Muthén BO (2012). *Mplus User's Guide* (Seventh ed.). Los Angeles, CA: Muthén & Muthén.
- Parent J, Forehand R, Merchant MJ, Edwards MC, Conners-Burrow NA, Long N, & Jones DJ (2011). The relation of harsh and permissive discipline with child disruptive behaviors: Does child gender make a difference in an at-risk sample? *Journal of Family Violence*, 26(7), 527. doi:10.1007/s10896-011-9388-y
- Preacher KJ, Rucker DD, & Hayes AF (2007). Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research*, 42(1), 185–227. doi: 10.1080/00273170701341316 [PubMed: 26821081]
- Schwarz JC, Barton-Henry ML, & Pruzinsky T (1985). Assessing child-rearing behaviors: A comparison of ratings made by mother, father, child, and sibling on the CRPBI. *Child Development*, 56(2), 462–479. doi:10.2307/1129734 [PubMed: 3987419]
- Sheppes G, Catran E, & Meiran N (2009). Reappraisal (but not distraction) is going to make you sweat: Physiological evidence for self-control effort. *International Journal of Psychophysiology*, 71(2), 91–96. doi:10.1016/j.ijpsycho.2008.06.006 [PubMed: 18625273]
- Spera C (2005). A review of the relationship among parenting practices, parenting styles, and adolescent school achievement. *Educational Psychology Review*, 17(2), 125–146. doi:10.1007/s10648-005-3950-1
- Trucco EM, Colder CR, & Wieczorek WF (2011). Vulnerability to peer influence: A moderated mediation study of early adolescent alcohol use initiation. *Addictive Behaviors*, 36(7), 729–736. doi:10.1016/j.addbeh.2011.02.008 [PubMed: 21420241]
- Trudeau L, Mason WA, Randall GK, Spoth R, & Ralston E (2012). Effects of parenting and deviant peers on early to mid-adolescent conduct problems. *Journal of Abnormal Child Psychology*, 40, 1249–1264. doi:10.1007/s10802-012-9648-1 [PubMed: 22648200]
- Tu KM, Erath SA, & El-Sheikh M (2017). Parental management of peers and autonomic nervous system reactivity in predicting adolescent peer relationships. *Developmental Psychology*, 53(3), 540–551. doi:10.1037/dev0000248 [PubMed: 27854467]
- Tu KM, Erath SA, Pettit GS, & El-Sheikh M (2014). Physiological reactivity moderates the association between parental directing and young adolescent friendship adjustment. *Developmental Psychology*, 50(12), 2644–2653. doi:10.1037/a0038263 [PubMed: 25365119]
- U.S. Department of Commerce. (2013). How the Census Bureau measures poverty. Retrieved from <http://www.census.gov/hhes/www/poverty/about/overview/measure.html>
- Wilder J (2014). *Stimulus and response: The law of initial value*: Elsevier.

Key Points

- The relationships between permissive parenting, deviant peer affiliations, and externalizing behavior are stronger for boys who are less physiologically responsive to stress
- Findings help to illustrate family and peer social processes by which problem behaviors develop
- Permissive parenting and deviant peer affiliations may be pathways to externalizing behavior for boys who more impulsive or less sensitive to punishment (as indexed through electrophysiology)
- Understanding individual differences in parenting-peer-behavior processes may lead to earlier detection or more targeted and effective intervention

Figure 1.

Conceptual model of conditional indirect effects between permissive parenting, deviant peer affiliation, and externalizing behavior. Solid lines indicate direct and indirect relationships among variables. Dot-dash lines indicate conditional relationships among variables. Dashed lines indicate factor loadings in growth models.

Figure 2.

The interaction between permissive parenting, SCL reactivity, and sex predicts deviant peer affiliation at age 17.

Figure 3.

The interaction between deviant peer affiliation, SCL reactivity, and sex predicts externalizing symptoms at age 18.

Table 1.

Descriptive statistics and correlations among study variables

	1	2	3	4	5	6	7	8
1. Permissive Parenting, 16	–							
2. SCL reactivity, 16	.05	–						
3. Deviant Peer Affiliation, 16	.09	–.05	–					
4. Deviant Peer Affiliation, 17	.15*	.18	.32***	–				
5. Deviant Peer Affiliation, 18	.01	–.03	.38***	.38***	–			
6. Externalizing Behavior, 16	.07	–.01	.35***	.37***	.23**	–		
7. Externalizing Behavior, 17	.07	–.06	.18*	.40***	.20**	.67***	–	
8. Externalizing Behavior, 18	.07	–.07	.30***	.42***	.42***	.64***	.76***	–
Mean	6.37	1.81	6.61	6.20	5.80	10.48	9.06	9.45
(SD)	(1.48)	(2.35)	(4.59)	(4.01)	(3.10)	(7.92)	(6.93)	(6.87)

Note. SCL reactivity = Skin conductance level reactivity.

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

Table 2.

Parameter estimates for unconditional parallel growth model of deviant peer affiliation and externalizing behavior.

Variable	Unconditional Model 1			
	Deviant peer affiliation		Externalizing behavior	
	Intercept	Slope	Intercept	Slope
Estimate	6.23 *** [5.85, 6.64]	-.42 ** [-.71, -.13]	9.61 *** [8.65, 10.57]	-.30 [-.66, .06]
Model fit indices				
SRMR	.05			
χ^2/DoF	2.41			
CFI	.95			

Note.

*
 $p < .05$.

**
 $p < .01$.

 $p < .001$.

SRMR = Standardized Root Mean square Residual. CFI = Comparative Fit Index. DoF = Degrees of Freedom. Estimates are unstandardized coefficients followed by standard errors in parentheses. Deviant peer affiliation was centered at age 17. Externalizing behavior was centered at age 18. Estimates are unstandardized coefficients. 95% confidence intervals for estimates in brackets.

Table 3.

Parameter estimates for main indirect effects (model 1) and conditional indirect effects (model 2) growth models of deviant peer affiliation and externalizing behavior.

Variable	Conditional Model 1				Conditional Model 2			
	Deviant peer affiliation		Externalizing behavior		Deviant peer affiliation		Externalizing behavior	
	Intercept	Slope	Intercept	Slope	Intercept	Slope	Intercept	Slope
Predictors								
Income	-.70*** [-1.10, -.30]	-	-.23 [-1.36, .89]	-.27 [-.75, .22]	-.75*** [-1.12, -.38]	-	-.28 [-1.37, .81]	-.26 [-.78, .27]
Sex	.97* [.22, 1.73]	-	-2.41* [-4.43, -.38]	-.10 [-1.00, .80]	.99* [.21, 1.76]	-	-1.87 [-6.16, 2.42]	1.06 [-.71, 2.83]
Resting SCL	.23 [-.32, .79]	-	-.62 [-1.96, .73]	.27 [-.28, .83]	.18 [-.34, .70]	-	-.40 [-1.68, .88]	.23 [-.30, .77]
SCL Reactivity	.18 [-.38, .73]	-	-1.28 [-2.59, .04]	-.33 [-.88, .23]	.03 [-.65, .71]	-	-1.64 [-3.67, .38]	.15 [-.79, 1.10]
Permissive parenting	.35 [-.04, .73]	-	-.40 [.50]	-.16 [-.60, .28]	.14 [-.30, .58]	-	.14 [-.98, 1.26]	.02 [-.43, .47]
Deviant peers	-	-	2.21*** [1.43, 3.00]	.15 [-.13, .42]	-	-	2.18*** [1.22, 3.15]	.21 [-.16, .57]
PP x Sex	-	-	-	-	.39 [-.40, 1.17]	-	-	-
PP x SCLR	-	-	-	-	.26 [-.14, .66]	-	-	-
Sex x SCLR	-	-	-	-	.75 [-.55, 2.06]	-	-7.05** [-11.50, -2.60]	-1.29 [-3.37, .80]
PP x Sex x SCLR	-	-	-	-	-.81* [-1.62, -.01]	-	-	-
DP x Sex	-	-	-	-	-	-	-.14 [-.86, .58]	-.20 [-.48, .07]
DP x SCLR	-	-	-	-	-	-	.09 [-.20, .37]	-.06 [-.16, .04]
DP x SCLR x sex	-	-	-	-	-	-	.86** [.27, 1.45]	.12 [-.12, .37]
Model fit indices								

Variable	Conditional Model 1						Conditional Model 2					
	Deviant peer affiliation			Externalizing behavior			Deviant peer affiliation			Externalizing behavior		
	Intercept	Slope		Intercept	Slope		Intercept	Slope		Intercept	Slope	
Predictors												
SRMR		.05						.05				
χ^2/DoF		2.40						2.17				
CFI		.94						.88				
Note.												
* $p < .05$.												
** $p < .01$.												
*** $p < .001$.												
SRMR = Standardized Root Mean square Residual. CFI = Comparative Fit Index. DoF = Degrees of Freedom. PP = permissive parenting. DP = deviant peer affiliations. SCLR = skin conductance level reactivity. Deviant peer affiliation was lefted at age 17. Externalizing behavior was lefted at age 18. Estimates are unstandardized coefficients. 95% confidence intervals for estimates in brackets.												