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The Nonlinear Dynamics of Family Problem Solving in Adolescence: The Predictive Validity of a Peaceful Resolution Attractor

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Abstract

In this study we examined the videotaped family interactions of a community sample of adolescents and their parents. Youths were assessed in early to late adolescence on their levels of antisocial behavior. At age 16–17, youths and their parents were videotaped interacting while completing a variety of tasks, including family problem solving. The interactions were coded and compared for 3 developmental patterns of antisocial behavior: early onset, persistent; adolescence onset; and typically developing. The mean duration of conflict bouts was the only interaction pattern that discriminated the 3 groups. In the prediction of future antisocial behavior, parent and youth reports of transition entropy and conflict resolution interacted to account for antisocial behavior at age 18–19. Families with low entropy and peaceful resolutions predicted low levels of youth antisocial behavior at age 18–19. These findings suggest the need to study both attractors and repellers to understand family dynamics associated with health and social and emotional development.

Keywords

coercion theory; entropy; antisocial behavior; nonlinear dynamics

The developmental cascade leading to adolescent problem behavior includes many transition points (see Dishion & Patterson, 2006). The first shift is from relatively minor forms of noncompliance and temper tantrums in early childhood to overt (i.e., reactive) and covert (i.e., proactive) antisocial behavior in childhood. In early adolescence, youths self-organize into peer groups that actively reinforce deviant talk, which in turn predicts long-term patterns of increasingly serious antisocial behavior (Dishion, Ha, & Véronneau, in press). As youths become more integrated in the peer group in adolescence, their relationships with parents can become more tenuous, and fractures in this relationship can lead to premature autonomy and, often, escalations in problem behavior during middle to late adolescence

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(Dishion, Nelson, & Bullock, 2004). Youngsters' relationships with their parents are crucial regardless of whether they initiate antisocial behavior in childhood or in adolescence.

The delicate nature of parent–adolescent relationships can be appreciated when one considers the responsiveness of families to interventions. In an analysis of long-term outcomes of the Family Check-Up in adolescence, we found that intervention benefits with regard to youth-reported conflict at ages 11, 12, 13, 14, and 16 mediated improvements in parental monitoring, reduced deviant peer involvement, and reduced problem behavior by age 18–19. In two independent prevention trials, improved problem solving outcomes observed while conflict issues were being negotiated before and shortly after intervention predicted reduction in teacher ratings of behavior problems 3 years later (DeGarmo & Forgatch, 2004). In another study with a clinical sample, improved problem-solving outcomes predicted reduction in out-of-home placements and police arrests 2 years later (Patterson & Forgatch, 1995). Studies such as these suggest that parental leadership while negotiating conflict with their youngsters is a critical dimension of parenting and a promising target for helpful interventions. Clearly, conflict resolution through effective problem solving is fundamental to parental influence on adolescent behavior (Forgatch & Patterson, 1989).

Despite the common focus on problem-solving skills in interventions for families with antisocial children and adolescents, surprisingly few studies have examined the dynamic exchanges within problem-solving interactions and the extent to which they predict future antisocial behavior. In our study, we concurrently and prospectively examined the dynamic quality of parent–adolescent problem-solving discussions to evaluate specific patterns associated with adolescent adjustment in a sample of 998 youths and their families. The youths and families were first assessed in early adolescence. In middle adolescence, they were videotaped as they participated in a variety of family interaction tasks, including a problem-solving interaction during which they attempted to resolve a family conflict. A dynamic systems framework was used to code and analyze the videotaped interactions. The youths were followed to age 18–19, when they reported about their involvement in antisocial behavior.

Disrupted parenting in general and coercive family dynamics in particular are core mechanisms in the development of antisocial behavior, as revealed in several longitudinal studies (Dishion & Patterson, 2006; Loeber & Dishion, 1983). Coercion consists of an interpersonal dynamic between parent and child that involves exchange of aversive actions and reactions (Patterson, 1982). Aversive interpersonal events are broad and contextually specific. For example, a parent's directive to clean up could be said in a hostile manner. The youngster's responses (e.g., ignoring, back talk, negative gestures or facial expressions) can be, in turn, experienced by the parent as aversive. A variety of measurement and statistical tools are used to measure coercive family exchanges such as these, but those that statistically capture the escalating dynamic are as valuable as they are rare (e.g., Patterson & Cobb, 1971, 1973; Snyder, Edwards, McGraw, Kilgore, & Holton, 1993). A key issue in the analysis of coercive family interactions is the relatively low base rate of aversive events when even the most troubled clinical families are observed (Patterson, Reid, & Dishion, 1992; Reid, 1978). Pinpointing the coercion dynamic has involved the analysis of sequences of parent–child interaction events, which are difficult to reliably assess using standard Markov models when base rates of aversive behaviors are low (Bakeman & Gottman, 1986).

Despite the low base rate problem, studies of family problem solving reveal that the dynamics of coercive interaction disrupt the family's efforts to resolve their problems peacefully and in the mutual interest of all participants. Assessment of family problem solving has benefited from early studies of marital interactions, when a systematic effort was

made to understand what kinds of interaction tasks differentiated distressed from nondistressed couples. These studies revealed that hypothetical interaction tasks were insensitive to distressed couple dynamics; on the other hand, those that engaged the couple about "real" couple problems (e.g., finances in their relationship) provided substantial discriminative validity (Birchler, Weiss, & Vincent, 1975). This principle of using high-conflict topics to evaluate problem-solving interactions was carried over to tasks for parents and adolescents (Robin & Weiss, 1980).

Analysis of parent–adolescent problem-solving interactions in a community-based, high-risk sample (Forgatch, 1989) clearly revealed that negative emotions (e.g., anger, contempt) were a major disruptor of conflict resolution. In a separate sample, anger and contempt were especially prognostic of poor problem-solving outcomes in families (Capaldi, Forgatch, & Crosby, 1994) and in recently married couples (Gottman, 1993). The expression of such emotions not only predicts a lack of conflict resolution, but also is associated with lax parental monitoring (i.e., parents giving up), which in turn predicts increases in antisocial behavior over time (Forgatch & Stoolmiller, 1994). Of particular interest, however, is the role of positive emotions in family problem-solving interactions in real time. Studies suggest that use of neutral or positive affect are associated with positive problem-solving outcomes (Capaldi et al., 1994; (DeGarmo & Forgatch, 1997; Forgatch & Stoolmiller, 1994).

The ability of parents to constructively address their family conflicts in discussions with other adults plays an important role in effective parenting, which in turn mitigates the likelihood of their youngsters' antisocial behavior. A set of studies of a sample of divorced mothers and an independent sample of divorced fathers examined problem-solving interactions observed between parents and a confidant as they discussed a parenting and a personal problem. In each sample, effective problem-solving outcomes attained by the adult dyad were associated with effective parenting practices observed in parent–child interactions, and more effective parenting was associated with lower levels of antisocial child behavior (DeGarmo & Forgatch, 2011; Forgatch & DeGarmo, 1997). Furthermore, in these two studies more positive affect and less negative affect was associated with effective problem-solving outcomes.

Nonlinear Dynamics Systems Framework

The critical role that positive, neutral, and negative affect and content play in defining the process of conflict resolution in close relationships suggests the promise of a nonlinear dynamics systems (NDS) approach. Conventional approaches to the analysis of family interaction data slice the dynamics into positive, neutral or negative interactions. However, it is possible that the overall dynamic pattern of the exchanges is more telling with regard to health and psychopathology. Rather than focus on the sequences that promote positive problem-solving outcomes, it seems plausible to analyze the dynamic systems of family interaction during problem-solving events. Granic and Lamey (2002) approached data analysis in this way, using a state space grid to consider mother–child movement across various dyadic states, such as "mutual positive," "mutual negative," and the like, among a sample of 33 clinically referred boys, 19 of whom were defined as comorbid for problem behavior and emotional distress, and 14 who showed only problem behavior. Their study is particularly interesting in that during an observational task a perturbation was introduced consisting of a knock on the door and instructions to wrap up and resolve the problem. In response to the perturbation, the comorbid youths and their mothers escalated their interaction into mutual hostility as a reaction to the perturbation, whereas mother–son dyads with a purely antisocial son tended to continue to avoid the problem-solving discussion. The Granic and Lamey (2002) study suggests that there is much to be learned by careful examination of the overall dynamic of parent–child dyadic interaction patterns in the context

of a variety of structured interaction tasks. In a more in-depth theoretical elaboration of the dynamic systems framework as applied to coercion theory, Granic and Patterson (2006) suggested that an NDS framework is optimal for studying the feedback dynamics underlying coercive family interactions associated with growth in children's antisocial behavior. An omission to this discussion was the role of "positive attractors" in family interaction and problem solving, and the possibility that positive feedback loops during problem-solving discussions are associated with low levels of antisocial behavior.

In our study we applied the state space grid method to the analysis of problem-solving interactions in a large community sample of multiethnic adolescents observed while interacting with their parents in a variety of tasks, including a family problem-solving discussion. We hypothesized that

1. observations of the mean duration of conflict and positive/neutral exchange bouts would discriminate interactions between parents and youth defined as early starters, adolescence onset, and typically developing;
2. dynamic indices of the interactive systems would discriminate these three groups, showing that early-starting youths would be more dispersed and more unpredictable (transition entropy) in their problem-solving interactions; and
3. problem-solving interactions that achieve family resolution and that are predictable (low entropy) are prognostic of low levels of antisocial behavior by age 18–19, controlling for the youth's past antisocial behavior.

METHOD

Participants

Participants included 998 adolescents and their families who were recruited in sixth grade from three middle schools in an ethnically diverse metropolitan community in the northwestern United States. Parents of all sixth grade students in two cohorts were approached for participation in the study, and 90% consented. The sample included 526 males (52.7%) and 472 females (47.3%). By youth self-report, there were 423 European Americans (42.3%), 291 African Americans (29.1%), 68 Latinos (6.8%), 52 Asian Americans (5.2%), and 164 (16.4%) other ethnicities (including biracial). Biological fathers were present in 585 families (58.6%). Annual family income ranged from less than $5K to more than $90K, with the median being $30–$40K. Youths were randomly assigned at the individual level to either control (n = 498 youths) or intervention (n = 500) classrooms in the spring of sixth grade. Approximately 80% of youths were retained across the study (sixth grade to 1 year after high school).

Measurement Procedures

In the spring semester, from 6th through 9th grades (Waves 1–4), and again in the 11th grade (Wave 6), students were surveyed with an instrument based upon work done by the Oregon Research Institute (Metzler, Biglan, Rusby, & Sprague, 2001). Assessments were conducted primarily in the schools. If students moved out of their original schools, they were followed up at their new location. When adolescents were age 19 (1 year after high school), they and their parents were surveyed regarding adolescent behaviors (i.e., antisocial behavior).

Measures

Antisocial Behavior Scores—Antisocial behavior scores were computed at each wave of assessment for each participant by taking the mean of the standardized results from a

participant's self-report survey of antisocial behavior and substance use (Dishion & Kavanagh, 2003) at ages 11–12 (Wave 1), 12–13 (Wave 2), 13–14 (Wave 3), 14–15 (Wave 4), and 16–17 (Wave 6). Descriptions of these items follow. Standardization of scores occurred across male and female participants. For each participant, sum antisocial behavior scores were also computed by summing the antisocial behavior scores for each wave.

Early-Onset, Persistent Group—The early-onset, persistently antisocial group (20 male, 20 female) comprised participants with the highest summed antisocial behavior scores of all participants in their gender group from the larger sample of 998. Furthermore, each participant had greater than the median antisocial behavior scores at each wave of assessment. In addition to self-reported antisocial behavior, 20 participants (10 male, 10 female) in the persistently antisocial group had one or more documented arrests, 15 had no documented arrests, and 5 members did not give consent to access their court records. The early-onset antisocial group comprised 50% European Americans, 27.5% African Americans, 5% Latinos, 2.5% Asian Americans, 2.5% Native Americans, and 12.5% other ethnic combinations, and their families had a median annual household income of $30,000 to $39,000.

Adolescence-Onset Group—The adolescence-onset group (20 male, 20 female) comprised participants with antisocial behavior scores below the median at Waves 1, 2, and 3, but above the median scores at Wave 6. In the adolescence-onset group, 7 (3 male, 4 female) had one or more documented arrests, 28 had no documented arrests, and 5 did not give consent to access their court records. The adolescence-onset group comprised 67.5% European Americans, 17.5% African Americans, 2.5% Asian Americans, 2.5% Latinos, 2.5% Native Americans, and 7.5% other ethnic combinations. The families' median annual household income ranged from $50,000 to $59,000.

Typically Developing Group—The typically developing group (20 male, 20 female) comprised participants with the lowest sum antisocial behavior scores of the group who also had below the median antisocial behavior scores during all waves. Participants in this group also had a grade point average of greater than 2.0 (C average). One participant in the normative group had a documented arrest, 37 had no documented arrests, and 2 declined to give their consent to access their records. The normative group comprised 65% European Americans, 12.5% African Americans, 10% Asian Americans, 5% Native Americans, 2.5% Latinos, and 5% other ethnic combinations, and their families had a median annual household income of $40,000 to $49,000.

Youth antisocial behavior at age 19 was measured using the Externalizing subscale of the Adult Self-Report on the Adult Behavior Checklist (ASR ABCL; Achenbach, 2003). This widely used measure consists of 123 items rated on the extent to which each item accurately describes the youth's behavior in the past 6 months, including 0 (*rarely/never*), 1 (*somewhat or sometimes true*), and 2 (*very or often true*) in terms of aggressive, disruptive, or delinquent behaviors (35-item subscale). Good internal reliability was found for this scale (αs = .89 for youth and .93 and .94 for maternal and paternal reports, respectively).

Family Problem Solving—At youth age 16–17, families were videotaped interacting in the home. Participating parents and the target child were asked to complete eight discussion tasks of 5 to 8 minutes in length. The first task was a simple warm-up task and was not coded. The seven tasks that were subsequently coded included the (a) encouragement task, during which parents were asked to discuss an area of school in which they would like to encourage their adolescent; (b) monitoring task, during which parents and adolescents discussed a time when the adolescent was with friends and away from adult supervision; (c)

family conflict task, involving a discussion of a time when the parent and adolescent had a conflict; (d) problem-solving tasks, when the parent and youth were asked to solve a problem that both had identified as a "hot topic" on a previously administered questionnaire; (e) substance-use task, during which the parent and child discussed norms for adolescent substance use; (f) family activity task that involved the parent and adolescent discussing a fun activity they could potentially do in the next week; and (g) positive recognition task, when the parent and adolescent were asked to express appreciation for each family member present.

Problem-Solving Outcome Measure—This measure was based on a similar measure used by Forgatch (1989) in the assessment of problem resolution. It consists of six items involving a family problem. Respondents first identify the problem and then answer a variety of questions regarding the family discussion of the problem. Using a 5-point scale, respondents are asked to rate items such as "How well did you understand what the problem was?" and "Do you think you solved the problem during the discussion?"

Relationship Affect Coding System (RACS)—The RACS (Peterson, Winter, Jabson, & Dishion, 2008) was used to code all family interaction tasks, including the family problem-solving task. The code consists of three behavior streams: verbal, physical, and affect. Verbal codes range from positive verbal, neutral talk, to negative verbal and also include behavior change verbal codes, such as positive structuring, neutral, and negative directive. Physical behavior (e.g., handing over an object, pat on the arm) was coded as positive, neutral, and negative. Affect codes include anger/disgust, distress, stonewalling/ignoring, validation, and positive affect. All three streams have "off" codes. Coder reliability for the RACS was 94% agreement, with a kappa of .93.

The content and affect codes were combined to create four behavior clusters, described as negative engagement, positive engagement, directives, and converse (neutral). Negative engagement included all negative physical, negative verbal, negative directive, and negative affect (anger/disgust, distress, ignore). Positive engagement included positive verbal, positive physical, positive affect, and validation. Directives were simple commands or requests without negative affect. All other behaviors were deemed converse and included neutral verbal and nonverbal behavior, neutral physical or no physical, and neutral affect. Because the behavior streams allow multiple behaviors to be coded at one time, priority rules were required for creating summary scores. For example, negative behaviors always trumped all the others, in that any negative behavior within a behavior stream defined the behavior as negative engagement. Mean duration scores were created to define these interactive behavior scores for both the parent(s) and youth.

To capture the duration of the parent and youth's dyadic behavior, we created two interaction-bout scores: conflict bout and positive interaction bout. We defined a conflict bout as a continuous interaction involving both the parent and the youth, involving at least one negative engagement behavior, and no longer than a 10-second interruption of either positive engagement or converse behavior. Thus, a criticism of the parent, which was responded to initially with converse behavior, but was followed by another criticism (before 10 seconds elapsed) would be considered part of a conflict bout episode. We defined conflict bouts in this way because of the salience of negative interpersonal behavior and the tendency for conflicts to be interspersed with positive or neutral comments. The bout was considered to be continuing as long as there was an exchange of negative engagement behaviors. The average duration of a conflict bout was used as a score to describe the family's tendency to engage in conflict.

We defined a positive interaction bout to be the average duration of parent–youth interactions that included positive engagement and converse behavior, without interruption by a directive or a negative engagement. Conflict and positive interaction bouts were calculated for each task and for the entire, coded observation session.

Transition Entropy

Transition entropy describes the predictability of an interaction between two or more people, conceptualized as an action and reaction (lag 1). Low entropy describes a predictable and organized interaction pattern in which actions and reactions follow a predictable pattern. Low transition entropy also reflects a constrained dynamic in which two interacting persons use a small region of the state space grid, corresponding to the concept of an attractor (Dishion, Nelson, Winter, & Bullock, 2004). High levels of entropy describe a less predictable, chaotic, and disorganized interaction pattern, when the action and reaction pattern is probabilistically uncertain. To create a transition entropy score, it was necessary to structure the data into a series of turn-taking sequences. The behavior stream for each interactant was first clustered into four types of behaviors: (a) negative engagement, behaviors that were defined a priori as negative, or neutral and positive content codes that were in negative affect; (b) positive engagement, including codes defined a priori as positive and neutral codes in positive affects; (c) directives, that is, codes reflecting commands or directions in neutral or positive affect; and (d) converse, which is primarily the exchange of information in neutral or positive affect. Thus, each family member's behavior was recoded as negative engagement, positive engagement, directive, or converse. Again, behaviors that might be experienced as aversive were given priority in the following manner: first, negatives; then directives; then positives; and last, converse. The entropy associated with sequential interactions between family members was calculated using the formula given by Krippendorff (1986) for transitional entropy:

$$H(AB) = -\sum_{a}\sum_{b} p_{ab} \log_2 p_{ab}$$

in which *a* is Time 1 behavior and *b* is Time 2 behavior, and *pab* the probability of *b* following *a,* given the total number of behaviors in a matrix.

Dispersion

Interactive temporal dispersion describes the number of interactive states used by an individual or an interactive unit, such as a dyad or triad. Dispersion can be seen as an index of flexibility in interpersonal behavior (Granic, Hollenstein, Dishion, & Patterson, 2002; Hollenstein, 2007). The formula is as follows:

$$1 - [(n\Sigma\ (di/D)2) - 1]/n\text{-}1$$

in which D is the total duration of the interaction, di is the duration in Cell I, and n is the total number of cells visited by the dyad.

Analysis Plan

We initially examined the interaction patterns across the seven tasks for the early-starting, late-starting, and typically developing groups for the four basic clusters: negative engagement, positive engagement, directives, and converse. Then we compared the three developmental groups with respect to the two region scores of interest, including the mean duration of conflict bouts and positive interactive bouts, considering all seven tasks for the three groups.

We then tested the hypothesis that a family's approach to problem solving in particular was prognostic of increases in youth antisocial behavior by age 18–19 years. We first examined the correlations between the interactive bouts and problem-solving outcomes as perceived by the youth and parent(s). We then used a multivariate approach to test the longitudinal hypothesis using structural equation modeling. We first created a latent construct representing family problem solving at age 16, then used this variable, along with our measure of entropy at age 16, to predict antisocial behavior at age 17, controlling for antisocial behavior at age 12. In the next step, we created an interaction term between problem solving and entropy and inserted it into the model.

All modeling was conducted using Mplus (Muthén & Muthén, 2006). For the initial model, standard measures of fit are reported, including the chi-square (χ^2), comparative fit index (CFI), nonnormed or Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA). CFI values greater than .95, TLI values greater than .90, RMSEA values less than .05, and a nonsignificant χ^2 (or a ratio of $\chi^2/df < 3.0$) indicate good fit (Bentler, 1990; Bentler & Bonett, 1980; Hu & Bentler, 1999). When creating an interaction term that includes a latent variable (using the XWITH command), Mplus does not generate fit indices such as CFI, TLI, and RMSEA, so none are reported for this model.

RESULTS

Developmental Pattern

The first set of analyses describes the extent to which the videotaped family interactions varied as a function of the youth's status as early onset, adolescence onset, or typically developing. Figs. 1 and 2 provide the mean durations of conflict and positive exchange bouts for each of the groups for the seven coded family interaction tasks. As can be seen in Fig. 1, families with early-starting youth engaged in longer conflicts in general ($F = 4.82$, $p < .001$). The interaction task also was associated with variation in the length of conflict bouts (Wilks lambda = .80, $p < .001$). Inspection of Fig. 1 reveals that the problem-solving discussion task, as expected, resulted in longer conflict bouts than did the six other tasks for the early-onset group. Interestingly, for adolescence onset and typically developing, the conflict discussion was associated with longer conflict bouts than were the other tasks. For adolescence-onset families, the encouraging growth task resulted in longer conflict bouts than did most other tasks. It is noteworthy that parents were specifically asked to "encourage" the adolescent, but the discussion was often turned into a critical review of the youth's shortcomings, which clearly evoked negative exchanges between the parent and the youth.

Figure 2 displays the average duration of the positive exchange bouts for the three developmental patterns across the seven coded tasks. As shown in the figure, the three groups did not reliably vary in the length of positive exchanges when compared across tasks. In comparison with the length of conflict bouts, the length of positive exchanges was much greater, ranging from 28 to 50 seconds in duration, compared with conflict bouts, which ranged from 0 to 10 seconds in duration. The length of positive exchanges varied significantly by task (Wilks' lambda = .80, $p < .001$), with the longest durations in the family activity task and the shortest durations in the conflict and problem-solving discussion.

The average level of dispersion across the 16 potential dyadic states is summarized in Fig. 3. The three groups did not differ in their behavioral flexibility in general; however, the specific tasks were reliably different (Wilks' lambda =. 82, $p < .001$). Inspection of Fig. 3 suggests a general increase in dispersion over the course of the videotaped interaction sessions, with a notable dip during the monitoring and the family activity discussions. These

discussions were also characterized by longer positive exchanges, which explain the reductions in dispersion during these interactive tasks.

Figure 4 shows the mean level of lag 1 transition entropy for each of the family interaction tasks. Again, there are no reliable group differences in transition entropy across the seven tasks, although one can see that the early-starting group becomes more unpredictable after the conflict and the problem-solving discussions than do the adolescence-onset and typically developing groups. This trend suggests that the early-onset group has more difficulty "recovering" from a conflict discussion and continues to be dysregulated even during positive discussions (Granic, O'Hara, Pepler, & Lewis, 2007). There was a significant effect for tasks (Wilks' Lambda = .73, $p < .001$), with the conflict and the problem-solving discussions generally associated with high levels of entropy, which also corresponds to the longer conflict bouts during these discussions.

Future Antisocial Behavior

We then tested the hypothesis that the problem-solving discussions in particular were prognostic of youths' future antisocial behavior. The correlations between conflict bouts, positive exchanges, and dispersion and transition entropy specific to the problem-solving discussions are summarized in Table 1. The mean duration of conflict bouts modestly predicted lower mother and youth ratings of conflict resolution and positively predicted future antisocial behavior ($r = .13$, $p < .05$). In contrast, the mean duration of positive exchange bouts did not predict family members' reports of conflict resolution or of antisocial behavior. Transition entropy predicted both conflict resolution and antisocial behavior 2 years later, in the direction of high entropy (unpredictability) being prognostic of lower conflict resolution and more antisocial behavior. The negative correlation between dispersion and father-reported resolution was statistically reliable, with higher levels of dispersion (flexibility) predicting fathers' report of lower conflict resolution.

Finally, we modeled the prediction of future antisocial behavior as a function of the family's report of conflict resolution and the entropy of the sequential interaction, as shown in Fig. 5. The means, standard deviations, and intercorrelations for all variables used in this analysis can be found in Table 2. Inspection of the covariation among variables reveals that there is excellent convergence among family members on the quality of the problem-solving discussion and sense of resolution. In addition, perceived problem resolution was predictive of future antisocial behavior, in the expected direction. More-predictable discussions and family members' satisfaction were associated with lower levels of antisocial behavior 2 years later.

The multivariate model was used to test the longitudinal effects of the problem-solving discussion on later antisocial behavior, controlling for the youth's antisocial behavior at age 11. We first tested the main effects and then tested the interaction between problem-solving outcome and transition entropy. Our initial model fit the data well, $\chi^2(6) = 7.18$, *ns*, CFI = .99, TLI = .99, RMSEA = .014 (.000|.045). As can be seen in Table 3, family problem solving predicted a significant decrease in antisocial behavior, but entropy had no direct effect.

We then added the interaction between family problem solving and transition entropy and found that it was significant ($B = .75$, $SE = .32$, $p < .05$). The graph of this interaction can be seen in Fig. 6; high and low values for problem solving and entropy were considered to be 1 standard deviation above and below the mean, respectively. Adolescents from families characterized by lower transition entropy (predictability) and higher levels of problem resolution were those less likely to increase antisocial behavior in the ensuing 2 years.

To convey a sense of the nonlinear aspect of the interaction pattern for the findings reported in the previous paragraphs, we provide individual state space grids for two randomly selected families that fit the patterns summarized in Figs. 7 and 8. In Fig. 7 we show a low-entropy, high–problem resolution family. Note that the family had long durations in the neutral–neutral and the positive–positive cells of the grid. Especially noteworthy is the complete lack of conflict during the problem-solving discussion for this dyad. This family managed to resolve a conflict without resorting to criticism, directives, or physical negatives. In contrast, Fig. 8 shows a high-entropy and low–conflict resolution family. This family also spent long durations in the neutral–neutral region, but also spent considerable time in the parent neutral and youth negative region. The state space grid reveals the potentially disruptive effect of conflict on the overall level of predictability and on perceived satisfaction with the problem-solving discussion.

DISCUSSION

This study is unusual because of its large sample size, diversity of the families, and the fact that it involved a community sample. The data support some basic tenets of coercion theory, in that youths defined as early starting, persistent in antisocial behavior were those with the highest level of conflict, compared with adolescence-onset and typically developing youths. The groups were not discriminated by duration of positive exchange bouts, transition entropy, or dispersion. However, as illustrated by Figs. 1 through 4, the interaction tasks had quite different interactive qualities, and some of these dynamics seemed to vary as a function of the youth's developmental history.

In the analysis of future behavior, we found weak prediction for the direct observation of conflict bouts ($r = .13$, $p < .05$) with regard to future antisocial behavior. This low-level prediction is not surprising, for two reasons. First, the sample in these analyses was quite large ($N > 500$), and it was multiethnic. Microsocial coding of negative behaviors in such a large, multiethnic sample could mask significant heterogeneity in family dynamics relevant to adolescent adjustment. The second major reason why observed conflict may have a low level of prediction of future antisocial behavior is the role of peers in the amplification of problem behavior in adolescence. As we have seen in several studies, youth engagement in a deviant peer group can account for amplification of problem behavior in middle adolescence (Patterson, Dishion, & Yoeger, 2000). In this sense, future research would benefit from clustering adolescents by virtue of their engagement in a deviant peer group and consider the possibility that once youths are fully engaged in a peer group, parent–child interactions have less predictive validity.

In addition to studying the coded process, we focused more narrowly on the family members' report of conflict resolution and the dynamic quality of the family interaction. Unpredictability, high transition entropy was correlated with each family member's perception of poor conflict resolution outcomes. As would be expected, duration of conflict bouts appears to also disrupt conflict resolution, as has been found in previous research (Forgatch, 1989). Conversely, families who were well organized, predictable, and moved toward resolution had the best outcomes. Perusal of the state space grids supports the identification of an attractor, in which case families stick within the positive and neutral zone in their discussions of a problem and assiduously avoid conflict regions. Thus, when facing the problem peacefully, families move toward a solution.

Use of a dynamic indicator of entropy suggests the need to consider energy flow in family interactions (Campbell, 1982). Low entropy requires energy, and when energy dissipates, a system moves toward chaos. Specifically, when an interpersonal conflict is being resolved peacefully, it seems plausible that a considerable amount of emotional regulation is required

to prevent the discussion from turning into a conflict, and relinquishing emotional regulation may run the risk of emotionally reactive behaviors that lead to insults, criticism, and the like, all behaviors that increase the likelihood of a mutually negative reaction. Thus, the coercion cycle evolves and the family problem remains unresolved, or worsens.

This perspective on peaceful conflict resolution fits well with the clinical literature, in which interventions "train" parents and adolescents to bring up problems constructively, brainstorm solutions, and cooperatively select a solution that can be tried for a week (Dishion, Stormshak, & Kavanagh, 2011; Forgatch & Patterson, 2010). This behavioral strategy is designed to directly address conflict in neutral and/or positive affect, and to move toward a solution. It is thought that successful practice and execution of this strategy will cause it to become reinforced and eventually automatic Families will not rigidly stick to the problem-solving structure learned in therapy, but rather, they will eventually incorporate the principles into everyday life. The study data suggest that those families who are able to manage problem-solving discussions tend to use a very limited region of the overall state space matrix. Perhaps this could be seen as an attractor for peaceful resolution, or alternatively, a repeller for conflict. Perusal of the many state space grids for this community sample indeed suggests that very few of any of the families could be described as caught up in a conflict attractor. Although clearly some families had more conflict than others, the length of these exchanges tended to be short, and the vast majority remained in the neutral and positive region.

Several theorists of close relationship emphasize that conflict is not inherently negative, and that it is sometimes necessary to engage in conflict to resolve relationship issues. But the findings that suggest that overt conflict in a marriage contributes to the health of the marriage appear to be statistically flawed (Woody & Constanzo, 1990). It seems safe to conjecture, however, that avoiding the discussion of a conflict is likely to undermine any family relationship. It does appear that a peaceful, nonaversive approach to addressing and resolving conflicts is ideal. As discussed previously, ample experimental evidence suggests that randomization to family interventions that promote peaceful conflict negotiation benefits children and families.

The findings from our study suggest the need to consider both the dynamic of the interaction and the content of the discussion. Human beings have unique abilities to process and respond to language (Hayes, 1989), yet these abilities are often ignored in studies of relationship interactions. Simply looking at the positive exchanges between a parent and a youth during the problem-solving discussion did not predict well. However, it would have been interesting to break down the content of the verbal exchange and perhaps code the words themselves as relevant to the task of peaceful negotiation and coping. Words of kindness, understanding, and those suggesting flexibility and openness to solutions could function as stimulus control for a phase shift into peaceful negotiation and mutual cooperation. It is odd that researchers in development and psychopathology continue to focus on pathology in the relationship interaction and rarely study and document the dynamics of healthy and peaceful family living. It seems likely that identifying healthy attactor dynamics could easily provide the key to understanding how many families not only survive, but also thrive in the connection with those they love. To quote Tolstoy, "Happy families are all alike; every unhappy family is unhappy in its own way."

Acknowledgments

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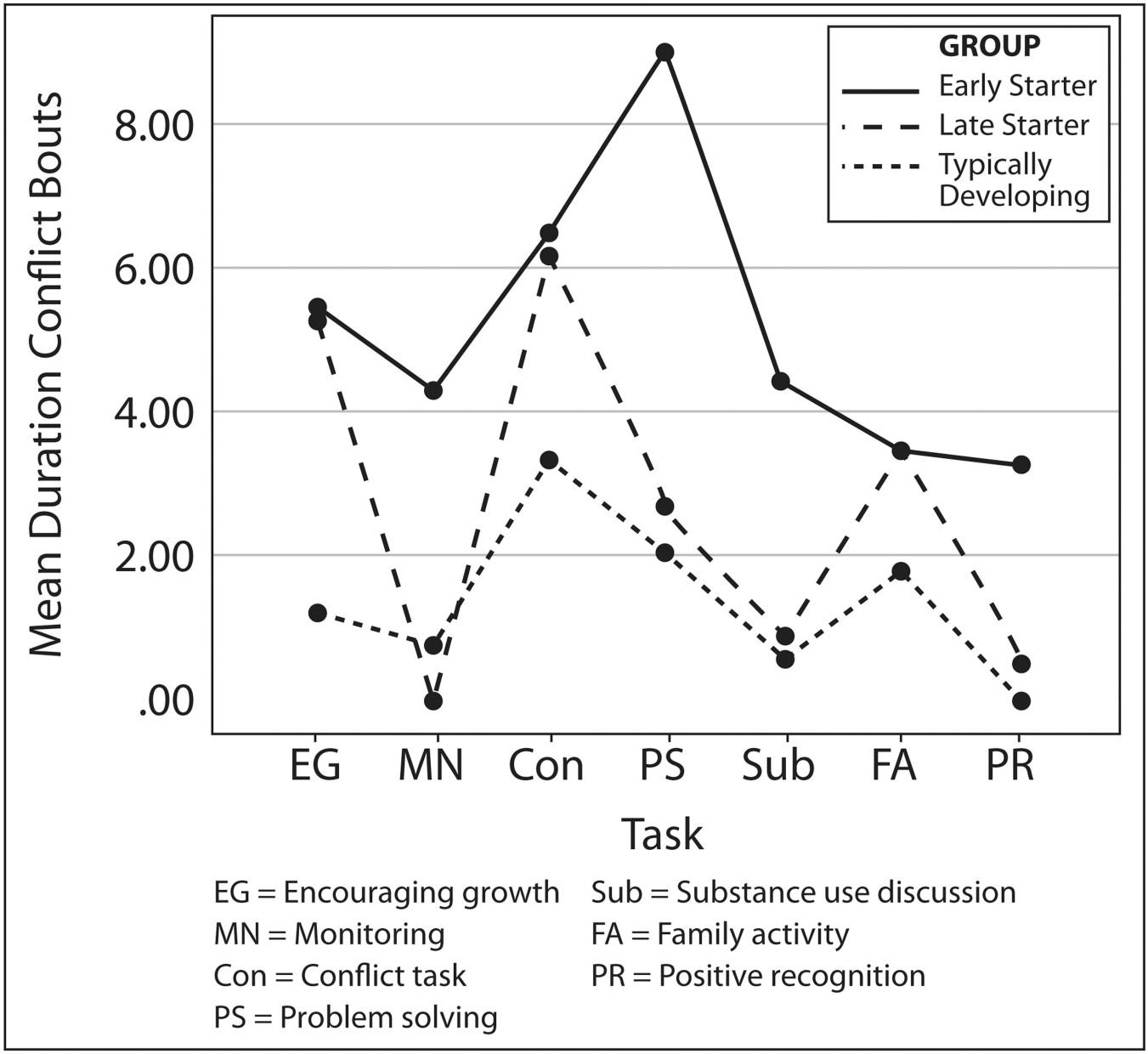

Figure 1.
Mean duration of interactive conflict bouts (negative–negative) across videotaped tasks.

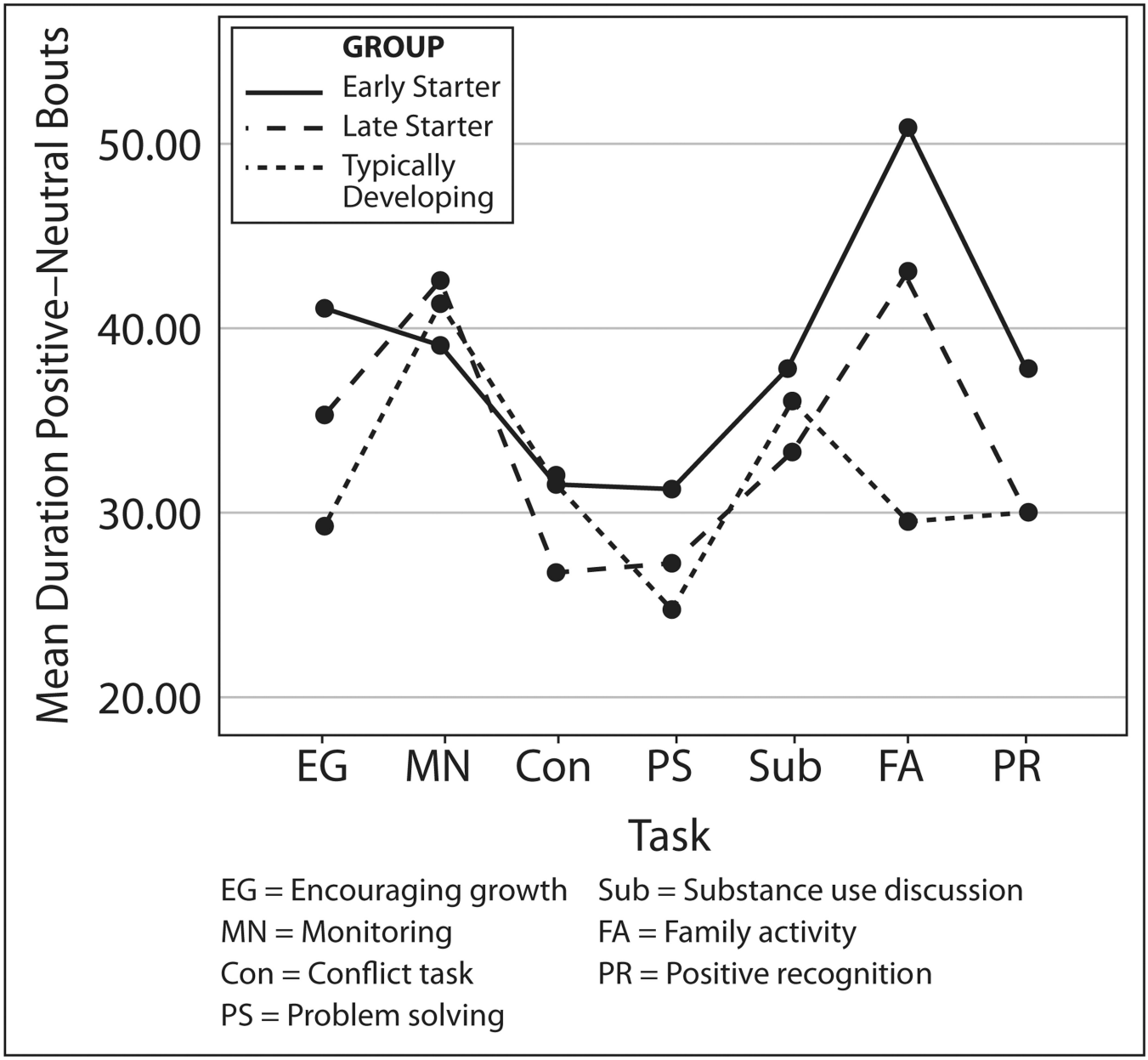

Figure 2.
Mean duration of positive exchange bouts (positive–neutral) across videotaped tasks.

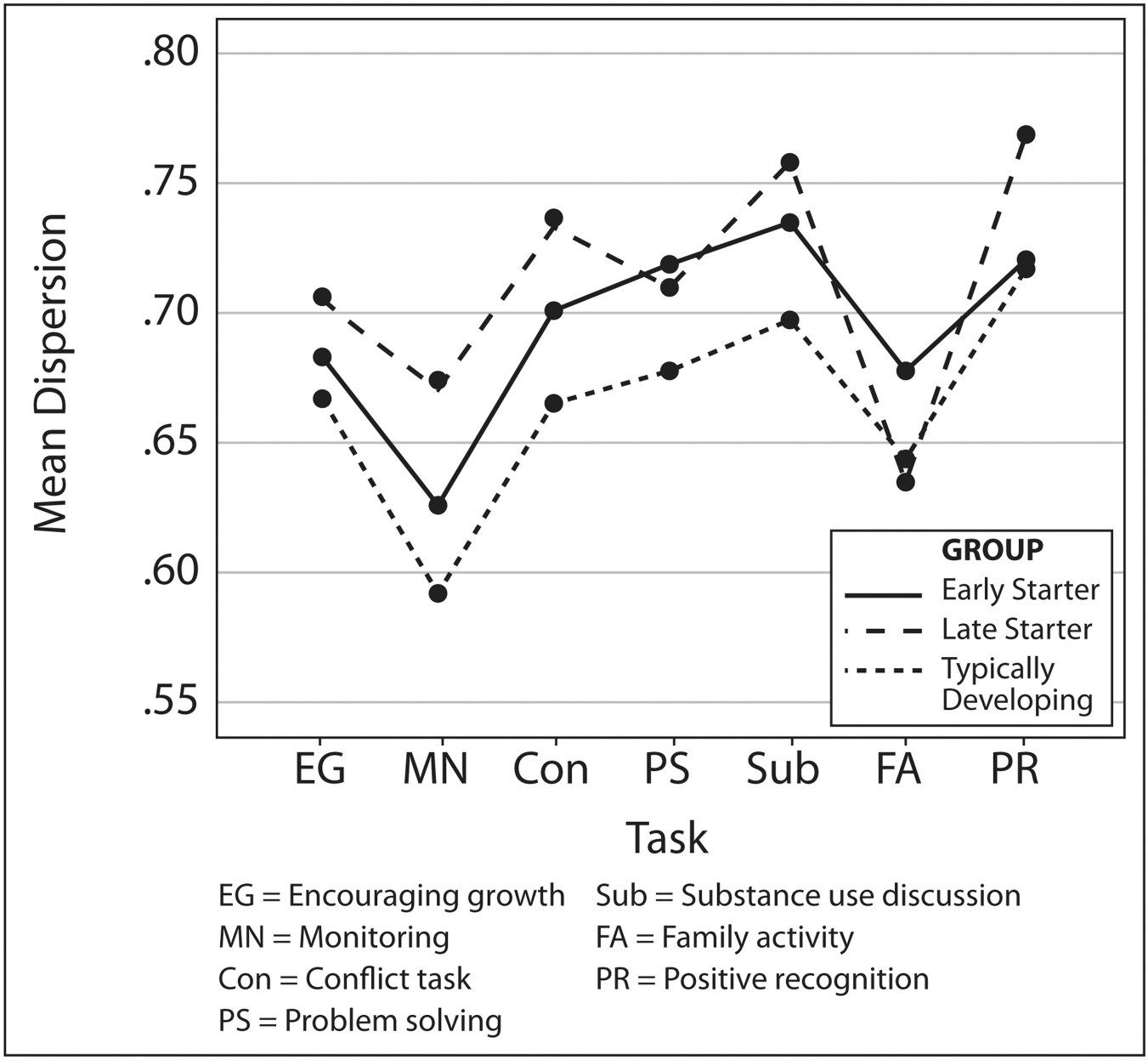

Figure 3.
Mean level of dispersion across videotaped tasks.

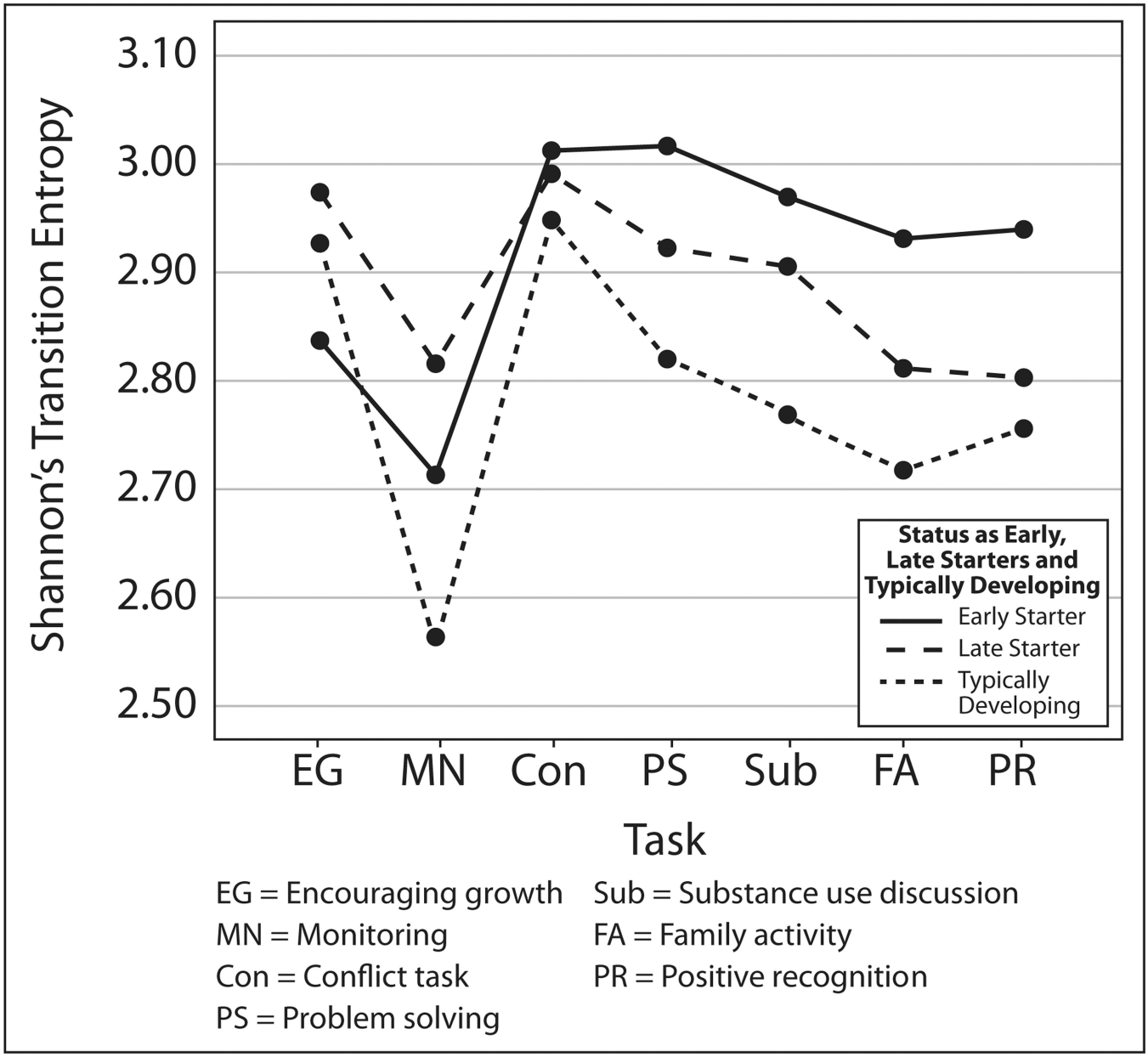

Figure 4.
Mean levels of Shannon's transition entropy across videotaped tasks.

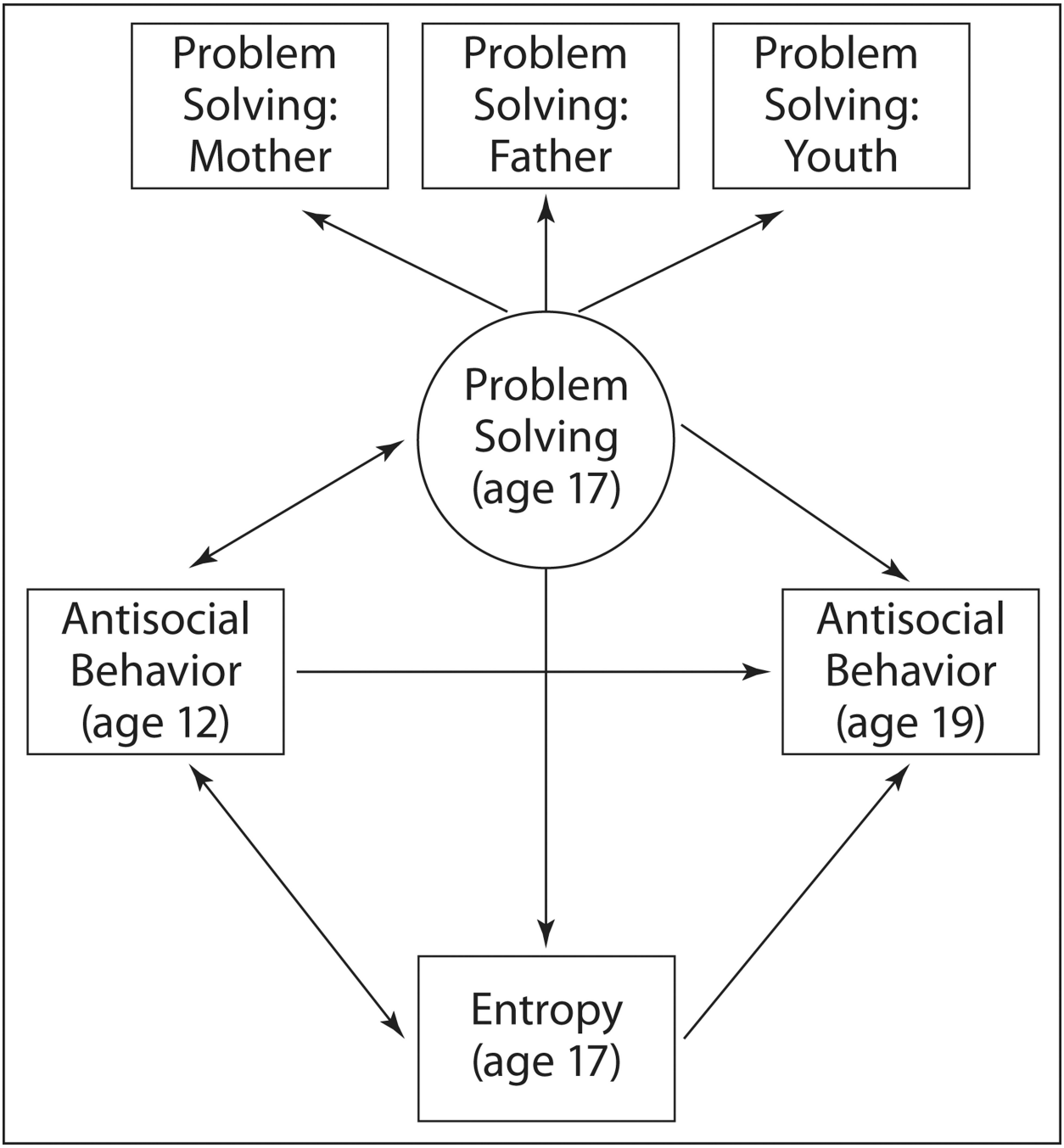

Figure 5.
Prediction of future antisocial behavior as a function of reported conflict resolution and transition entropy.

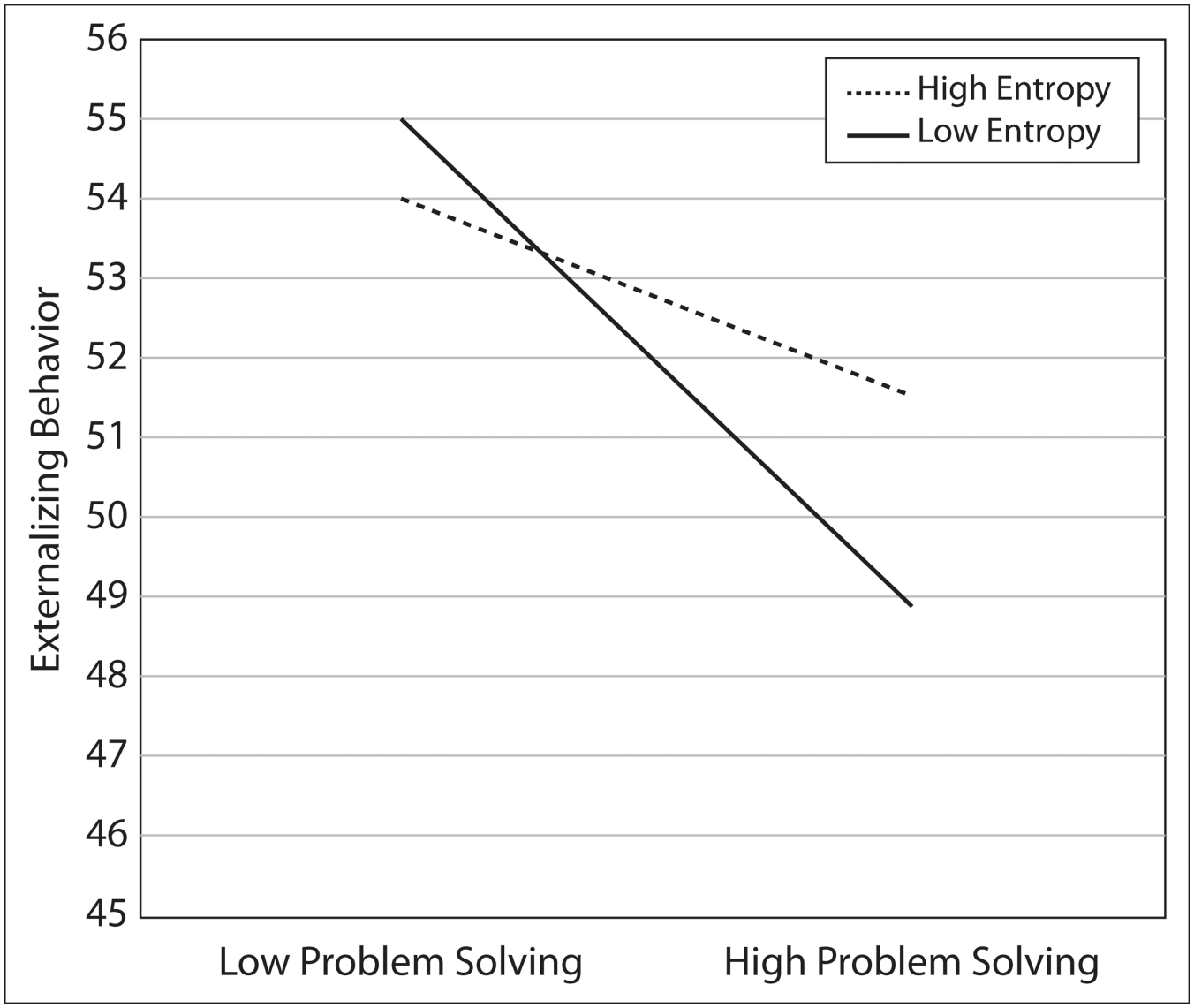

Figure 6.
The interaction between reported conflict resolution and transition entropy.

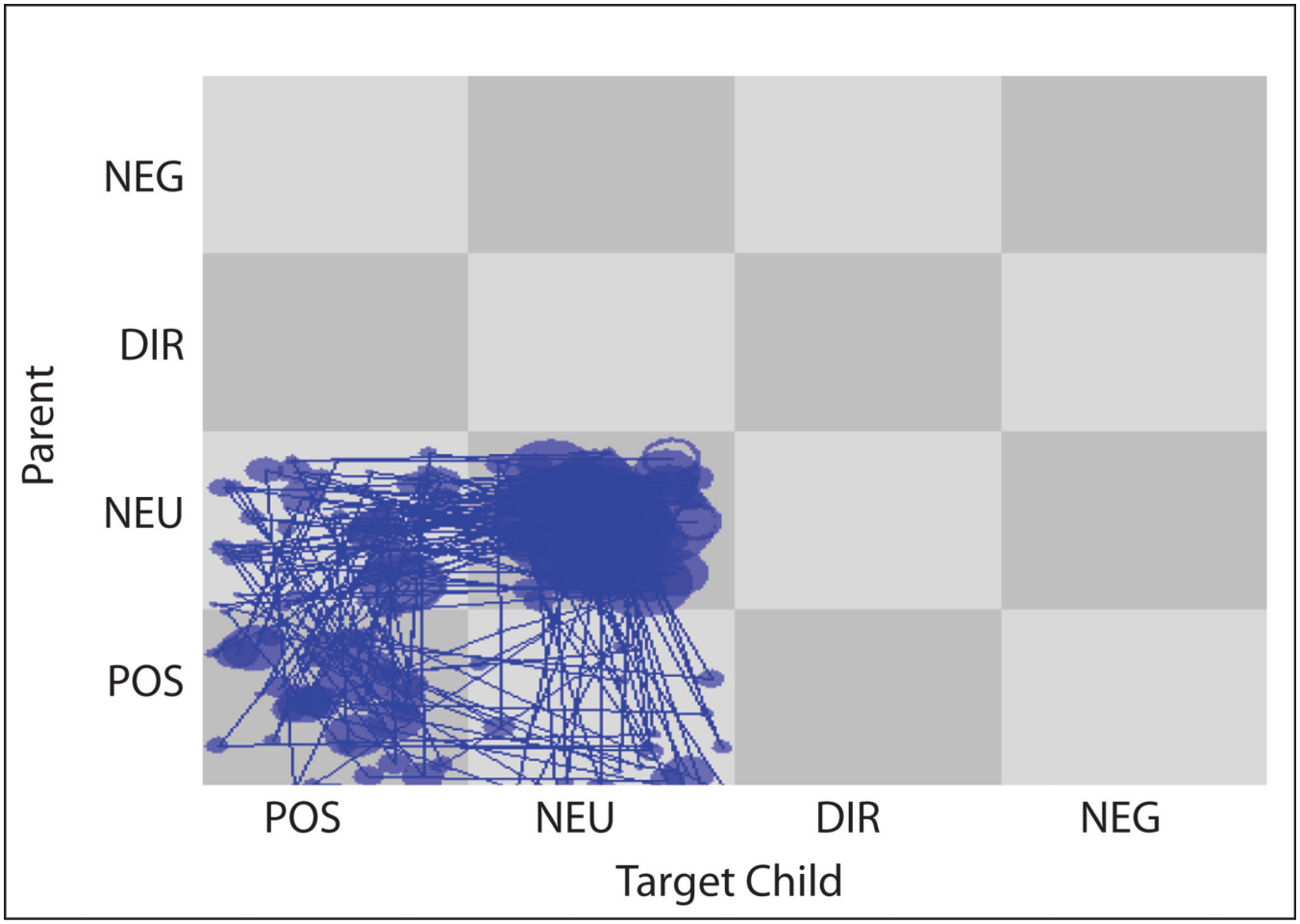

Figure 7.
Dynamic quality of a low-entropy interaction with reported conflict resolution.

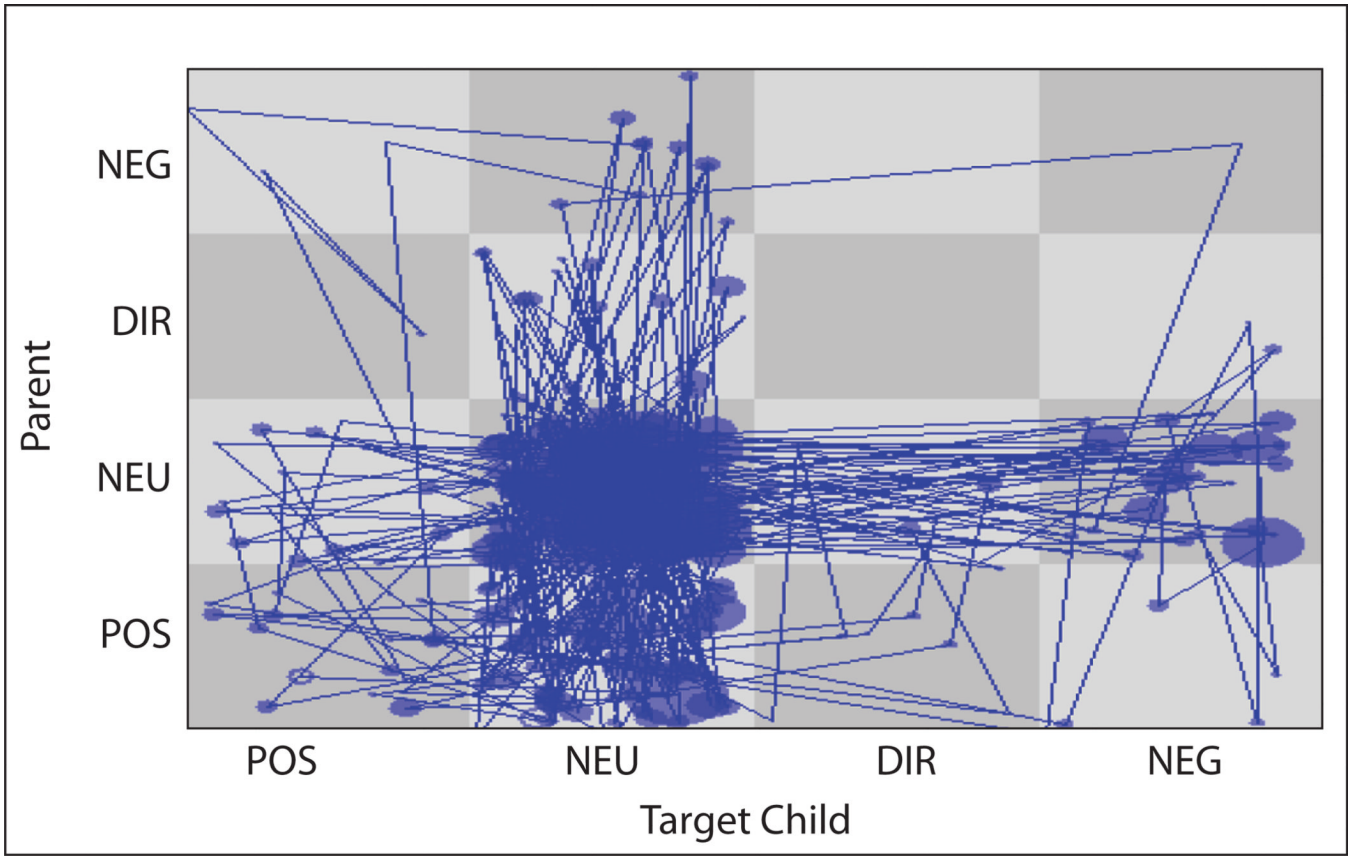

Figure 8.
Dynamic quality of a high-entropy interaction with reports of unresolved conflict.

Table 1

Convergent and Predictive Validity of Problem-Solving Interactions to Reported Conflict Resolution and Antisocial Behavior at Age 18–19

	Convergent validity			Predictive validity
	Conflict resolution			Youth report
Parent–adolescent interaction	**Mother-reported (*n* = 594)**	**Father-reported (*n* = 303)**	**Youth-reported (*n* = 640)**	**Antisocial at 18–19 years (*n* = 604)**
Conflict bouts	−.10*	−.06	−.11*	.13*
Positive exchange bouts	−.02	.10†	.04	.05
Transition entropy	−.15*	−.20*	−.14*	.08*
Dispersion	−.02	−.16*	−.06	.02

† $p < .10$,

* $p < .05$

Table 2

Correlations and Sample Descriptives

Variable	1	2	3	4	5	6
1. Antisocial behavior (age 12)	—					
2. Problem solving: mother (age 17)	.01	—				
3. Problem solving: father (age 17)	.06	.66***	—			
4. Problem solving: youth (age 17)	.03	.62***	.62***	—		
5. Entropy (age 17)	−.01	−.15***	−.20***	−.14***	—	
6. Antisocial behavior (age 19)	.19***	−.17***	−.13***	−.20***	.24***	.08*
N	992	597	305	643	649	807
M	1.41	14.11	13.78	14.44	3.22	52.43
SD	.59	3.67	3.48	3.53	.43	10.04

* $p < .05$,

*** $p < .001$.

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Table 3

Model Coefficients for Initial Model

Factor loadings for problem solving at age 17 (β)	
Mother report	.82
Father report	.81
Youth report	.75
Key model paths (β)	
Problem solving at 17→antisocial behavior at 19	−.22***
Entropy at 17→antisocial behavior at 19	.04
Antisocial behavior at 12→antisocial behavior at 19	.22***
Correlations (β)	
Antisocial behavior at 12→problem solving at 17	.04
Antisocial behavior at 12→entropy at 17	−.01
Entropy at 17→problem solving at 17	−.20***

*** $p < .001$