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A Sequential Analysis of the Mother–Adolescent Interactions of ADHD, ADHD/ODD, and Normal Teenagers During Neutral and Conflict Discussions

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The sequential interactions of three groups of teenagers conversing with their mothers during both neutral and conflict discussion situations were evaluated. Groups consisted of (1) attention deficit hyperactivity disorder (ADHD) alone (n = 21), (2) ADHD with comorbid oppositional defiant disorder (ADHD/ODD; n = 40), and (3) a community control group of adolescents (n = 49). All groups had been followed concurrently for the past 8 to 10 years before being reevaluated in this study. Results indicated that (1) teens and parents in all groups interacted in a tightly linked manner, with the behavior of each member being significantly related only to the immediate antecedent behavior of the other; (2) mothers in all groups were more likely than teens to initiate positive behaviors; (3) teen interactions could be characterized as tit-for-tat while mothers could be typified as be-nice-and-forgive; (4) mother–teen dyads in the ADHD/ODD group displayed significantly higher rates of conflict behaviors than dyads in the other two groups, who did not differ significantly from each other on most measures; and (5) mothers in the ADHD/ODD group responded in a manner similar to their teens (greater negativity) and less like that of mothers in the other groups. The majority of conflict between ADHD children and their parents seemed due to comorbid ODD and such ODD is a family, not just a teen, characteristic.

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The family interaction patterns of children with hyperactivity or attention deficit hyperactivity disorder (ADHD) have been the subject of a number of studies over the past 20 years (see Danforth, Barkley, & Stokes, 1991, for a recent review). This research suggests that the inattentive and uninhibited behavior comprising this disorder is often associated with less compliance, less sustained compliance, and greater negativity in the social interactions of such children with their parents than is seen in normal or non-ADHD children (Barkley, Karlsson, & Pollard, 1985; Cunningham & Barkley, 1979; Mash & Johnston, 1982). The hyperactive or ADHD children are also more likely to request assistance from their parents during task performance (Campbell, 1973, 1975). These same studies indicate that parents of children having ADHD give more commands, repeat their commands more frequently, and use more hostile behavior, such as reprimands and punishment, during their interactions with their children than do parents of normal or non-ADHD children. These parents may also be less responsive to the interactions initiated by these children toward them than are parents of normal children.

A number of variables seem to affect the extent to which differences will be noted between the parent–child interactions of hyperactive or ADHD children and those of normal children. One important variable may be the presence of co-morbid oppositional defiant disorder (ODD). ODD, or social aggression, reflects a relatively chronic pattern of hostile–defiant behavior toward others and quick-temperedness (American Psychiatric Association, 1987). It is characterized by coercive intrafamilial interactions (Patterson, 1982) and is commonly associated with ADHD, occurring in as many as 45 to 70 percent (Barkley, 1990). None of the past studies using children with hyperactivity or ADHD have examined whether their findings were a function of the degree to which comorbid ODD was present in the samples of hyperactive children. Two recent studies of the interactions of mothers with their adolescents suggest that such may be the case (Barkley, Anastopoulos, Guevremont, & Fletcher, 1992; Barkley, Fisher, Edelbrock, & Smallish, 1991).

All of these past studies have coded and analyzed these interactions using absolute frequency counts or very brief event sequences of interactions. Lengthier sequences of interaction events have not been examined, yet such interaction sequences may reveal important information about the nature of the disturbances in the family interactions of those with ADHD beyond that which can be extracted from single antecedent–consequent event pairs (Patterson, 1982). Both ADHD and ODD have previously been hypothesized to involve such abnormal interactions (Barkley, 1981, 1985;

Danforth et al., 1991; Patterson, 1982). The present study, therefore, undertook an analysis of longer interaction sequences than have been previously studied with this disorder. It was also interested in determining the extent to which comorbid ODD influenced these interaction sequences.

METHODS

Subjects

The initial sample comprised 158 hyperactive children and 81 normal children between 4 and 12 years of age. All of the children were initially recruited between 1979 and 1980. The hyperactive group consisted of consecutive referrals to a child psychology service specializing in the treatment of hyperactive children at Milwaukee Children's Hospital and the Medical College of Wisconsin. The normal children were recruited using a "snowball" technique in which the parents of the hyperactive children were asked to provide the names of their friends who had children within the age range of interest to the study. Details concerning the recruitment and selection criteria for these groups have been reported elsewhere (Barkley, Fischer, Edelbrock, & Smallish, 1990, 1991; Fischer, Barkley, Edelbrock, & Smallish, 1990; Fischer, Barkley, Fletcher, & Smallish, 1993).

For this study, the parents of these children were relocated and contacted about participation in this follow-up study an average of 8 to 10 years after participation in the initial evaluation. Over 87% of the original sample was relocated. A total of 123 hyperactive children and 66 normal children were located and agreed to participate in the follow-up. A small group declined to complete the in-clinic observations described in this article. Thus, the return rate for those being described in the present article represents 62% (n = 98) of the hyperactive children and 75% (n = 61) of the normal control children.

At this 8 to 10-year follow-up (Barkley et al., 1991), 72% of the originally hyperactive children now met the Diagnostic and Statistical Manual of Mental Disorders (3rd ed., rev.) (DSM-III-R) criteria for ADHD at follow-up, 59% for ODD, and 45% for conduct disorder (CD) (APA, 1987). The percentages of the normal control group receiving these diagnoses at follow-up was 3, 12, and 1.6, respectively. These diagnoses were based upon a structured parent interview created for this evaluation which incorporated all of the symptom lists and criteria for the disruptive behavior disorders given in DSM-III-R. The interviewer held a master's degree in clinical psychology and was trained by the second and third authors in the use of this instrument and in clinical interviewing in general.

We subdivided the hyperactives into three subgroups based on whether or not they met criteria for ADHD and ODD at outcome: (a) those who were neither ADHD nor ODD (n = 21); (b) those who were only ADHD but not ODD (n = 25); and (c) those who were both ADHD and ODD (n = 53). ODD was used instead of CD because it is viewed as the first stage of CD (Loeber, 1990), is characterized by high levels of parent–child conflict (Patterson, 1982), and provided us with the largest possible sample of boys for this subgroup for our analyses. The first group of subjects (not ADHD or ODD) were not considered any further for the present analysis. The normal group (n = 66) was reduced by removing those subjects currently meeting diagnostic criteria for ADHD, ODD, or conduct disorder (n = 12). This left 54 normal adolescents in this group.

Not all adolescent–mother dyads completed the full PAICS procedure (see below for definition and explanation of abbreviation). Six of the subjects in the ADHD and ODD group did not, leaving 47 who did. One of the ADHD-only subjects did not complete the full PAICS procedure, leaving 24 who did. One of the normal dyads did not complete the PAICs, leaving 53 who did. Finally, one dyad from each group whose interactions in either discussion produced fewer than 50 interchanges were dropped from the analysis. Final sample sizes were 23 ADHD only (22 males, 1 female), 46 ADHD/ODD (43 males, 3 females), and 52 normal control adolescents (49 males, 3 females) and their mothers.

Procedures

The subjects received a lengthy battery including structured interviews, rating scales, tests, parental self-report measures, and standardized observations of parent–child interactions. The results for the observations are reported here. Arrangements were made with prescribing physicians for all subjects taking stimulant medication to discontinue this medication 48 hours before the evaluation appointment.

Parent-Adolescent Interaction Coding System (PAICS.) Parent and teen dyads were placed in a clinic room with one-way observation mirror and intercom. The room contained comfortable chairs and an end-table with lamp and several pictures hung on the walls. The mother and teen participated in two types of discussions which were videotaped. The first discussion was to plan a vacation given unlimited funds. This situation lasted approximately 10 min and is referred to here as the Neutral Discussion consistent with its use by the developers (Robin & Foster, 1989). The next situation lasted 15 min, and was called the Conflict Discussion. It required the mother and adolescent to discuss and attempt to resolve the five most

angry conflicts the mother had reported on the Issues Checklist. The Issues Checklist is a rating scale assessing the topics on which parents and teens may disagree, the frequency of disagreements, and how angry the exchanges are perceived to be (see Barkley, 1990, or Robin & Foster, 1989). All utterances by the mothers and adolescents were then transcribed from these videotapes and were coded into six behavior categories for each participant separately (see Robin & Foster, 1989, for details). These categories were Commands/Put Downs, Defends/Complains, Problem Solution, Facilitates, Defines/Evaluates, and Talks. Utterances were defined by the developers as verbalizations that were separated from each other by a verbalization by the other person. Thus, while a person may have made several utterances in succession before the other person spoke, these utterances were treated as a single utterance for coding purposes. Where such situations occurred, the multiple utterances of that person were coded into a single category with the highest priority category occurring within these utterances being assigned. These priorities were arranged in the order the behavior categories are listed above (e.g., Commands/Put Downs were highest priority while Talks was the lowest priority). If a person spoke over the other person, this was treated as ending the first person's utterance, resulting in it being coded at this point. The second person's interruptive utterance would then be coded as well. This procedure ensured that the coded interaction sequences always occurred in an alternating arrangement between the mother and teen such that no behavior category coded for one person was ever followed by another behavior category for that same person. The percentage occurrences of each of these behavior categories for these groups of subjects have been reported elsewhere along with their relationship to measures of mother–child interactions taken during the initial childhood evaluation approximately 8 years earlier (Barkley et al., 1991).

The coder was extensively trained by one of the developers (Robin) of this coding system (Robin & Foster, 1989) to a level of reliability of .80 (agreements/total coded interactions) and thereafter met weekly with one of the investigators (M.E.F.), also trained in this system, for further training, problem-solving discussions, and periodic intercoder reliability checks. While the coder was not blind to whether or not the subjects were previously hyperactive or normal, the coder was blind to the current diagnostic status of the hyperactive subjects (i.e., whether or not they were ADHD or ADHD with ODD).

Because the coder was not blind to group membership, formal intercoder reliability was conducted on 20 videotapes from a separate study of ADHD adolescents and their interactions with their mothers that employed this identical coding system and methodology (Barkley et al., 1992). These tapes were coded blind by the coder in this study and reliability was

checked with the second coder, also trained in this coding system by Robin, working at a geographically separate site. This second coder was entirely blind to group and diagnostic membership of the subjects. Reliability was first calculated as the number of agreements divided by the total number of interactions coded (agreements plus disagreements) across all categories and was 75.9% in the Neutral Discussion and 74.4% in the Conflict Discussion. A kappa coefficient was then calculated for all coded interactions ($n = 3, 498$) and was .68, $z = 74.47$, $p < .001$.

To reduce the number of behavior codes for the present analysis, we collapsed the behavior categories into Negative, Positive, and Neutral. The Commands/Put Downs and Defends/Complains categories were combined into the Negative category. Problem Solution, Facilitates, and Defines/Evaluates were collapsed into the Positive category, and Talk was reclassified as Neutral.

Statistical Analysis. The interactions of each mother and adolescent dyad were analyzed using a Markov chain model of sequential dependence. This model assumes that the present state of an interaction is dependent upon earlier states (Gottman & Roy, 1990; Lichtenberg & Heck, 1986). If events at time t are dependent upon immediately preceding events at time t-1, this is known as first-order dependency. If events at time t are dependent upon events twice removed, at time t-2, this is known as second-order dependency. Sequences can be tested for their order of dependency using a likelihood ratio chi squares ($LR\chi^2$; Anderson & Goodman, 1957; Gottman & Roy, 1990) and comparing, first, zero-order versus first-order sequences (e.g., no sequential connection between comments vs. comment-to-comment connections). A significant $LR\chi^2$ indicates at least first-order dependency. If there is no first-order dependency, no sequential analysis is called for. If the first-order dependency is significant, comparing first-order to second-order sequences provides a test of second-order dependency, and so on.

Markov chain models also assume that the patterns of interactions do not change over the course of the interaction, that is, that the patterns are similar in the first half and the second half of a conversation. This is called the assumption of stationarity (Gottman & Roy, 1990; Lichtenberg & Heck, 1986). It is tested by dividing interactions into sections—such as halves—and using the Anderson and Goodman $LR\chi^2$. Nonsignificant results indicate that the interactions are stationary.

Gottman and Roy (1990) pointed out that there are two goals in sequential analysis. The first is to discover whether or not there are discernible patterns of interactions in the data. This goal encompasses the determination of the order of interactions and the patterns of sequences that characterize the data. The second goal of sequential analysis is to es-

timate the effect of explanatory factors on the sequential structure. In the data discussed below, factors such as group membership and who is speaking are considered. Before the impact of explanatory factors such as group membership can be assessed, it is recommended that homogeneity of variance be established within each group. Once again the Anderson and Goodman $LR\chi^2$ is used to test this assumption, with nonsignificant results indicating homogeneity.

The assessment of the explanatory factors can be accomplished in several ways. Gottman and Roy (1990) recommended the use of hierarchical log-linear analysis. Hierarchical log-linear analysis was used in this study to determine an optimal model of the factors that influenced the conversational interactions for the three groups of dyads in the two conversational conditions. Five factors were considered in the model building: Discussion (neutral vs. conflict), Group (ADHD/ODD, ADHD only, and normals), the Starter of each two comment sequence (mother or adolescent), the Initial Comment (negative, neutral, or positive), and the Response Comment (negative, neutral, or positive). The full, saturated model was thus a $2 \times 3 \times 2 \times 3 \times 3$ design comprised of 108 cells of first-order sequences of comments.

In hierarchical log-linear models, if any interaction is included in the model, then all of the main effects associated with that interaction must also be included. For instance, if a Discussion × Group interaction is included in the model, both Discussion and Group main effects must be included. In addition, if higher-order interactions are included, then all lower-order interactions also must be included. For example, if a Discussion × Group × Starter interaction is included in the model, then the Discussion × Group, Discussion × Starter, and Group × Starter interactions also must be included. These considerations allow a model to be specified by the highest-order interactions and/or main effects that are included in the model. Thus, in the current study, the model that includes all possible interaction and main effects—the "saturated" model—would be specified simply by noting that the highest order is a five-way interaction.

It is conventional to write a model using capital letters associated with each factor. In the current case, D designates the Discussion factor, G the Group factor, S the Starter of the conversational interaction, I the Initial Comment of the Starter, and R the Response Comment of the other person in the dyad. The saturated model would then be noted simply by indicating the five-way interaction, thusly, DGSIR. In a similar manner, the Discussion × Group × Starter × Response four-way interaction would be designated by DGSR, and the three-way interaction of Discussion × Starter × Response Comment would be designated by DSR. These conventions will be followed when discussing the model-building process below.

Models are tested by fitting a series of different models to the data and making note of the resulting $LR\chi^2$ values. Since the goal of model fitting is to find a simple, parsimonious, and interesting model that fits the data, the $LR\chi^2$ for the full model must be nonsignificant, indicating that the model fits the data. Using this criterion, it is possible to fit several models to the data. Since hierarchical models are arranged in hierarchies, models are contained within models. This allows one model to be tested against another using the difference in the $LR\chi^2$ values for each model, as discussed in more detail in the Results section below.

RESULTS

As noted above, conversations were coded as alternating comments between mother and adolescent, and thus codes associated with each participant could not logically follow each other. As a result, timetables (of transition frequencies and probabilities) included 18 logical (or structural) zeros. When structural zeros were present in timetables, they were taken into account by subtracting 18 from the degrees of freedom, as suggested by Gottman and Roy (1990) and Fienberg (1980).

Initial Tests for Order in the Dyadic Interaction Sequences

The order of each of the 121 dyads was assessed separately using Arundale's (1982) computer program, SAMPLE. All of the likelihood ratio chi-squares (Anderson & Goodman, 1957) tests of zero-order versus first-order sequences (e.g., no sequential connection between comments vs. comment-to-comment connections) were significant for both the neutral conversation and the conflict conversation, with an average $LR\chi^2 = 228.47$, $df = 25$, $p < .001$, for the neutral conversations, and an average $LR\chi^2 = 214.75$, $df = 25$, $p < .001$, for the conflict conversations. This provides evidence of a significant contingent relationship between one coded comment and the next in both conversational conditions. Tests of first-order versus second-order sequences (mother–adolescent and adolescent–mother comment connections vs. mother–adolescent–mother and adolescent–mother–adolescent comment connections) were nonsignificant for all dyads, with an average $LR\chi^2 = 22.81$, $df = 150$, for the neutral conversations, and an average $LR\chi^2 = 25.75$, $df = 150$, for the conflict conversations. Thus, all conversations can be characterized as having a first-order contingent connection but not a second-order connection.

Tests for Stationarity of Each Dyadic Conversation

Arundale's (1982) program SAMPLE was also used to determine the stationarity of each dyad's conversation, that is, whether or not the type of interactions within individual dyads changed over time. This was done by dividing each dyadic conversation into two halves and testing the resulting timetables matrices against the overall timetable for the full conversation. This results in individual $LR\chi^2$ values for each of the 121 dyads in each of the two conversational conditions, all of which were evaluated with 12 degrees of freedom. In order to control for Type I error with 121 dyads in each of two conditions, each $LR\chi^2$ was evaluated with a p-value < .001. Two dyads produced $LR\chi^2$ values that exceeded the $p < .001$ limit of 32.91 during the neutral conversation, with the $LR\chi^2$ of one dyad in the ADHD-only group = 35.83, and one in the ADHD and ODD group = 38.16. Overall, the average $LR\chi^2$ for stationarity during the neutral conversation was 12.77, n.s. During the conflict conversation, one dyad—in the normal group—produced an $LR\chi^2$ that exceeded the $p < .001$ mark = 37.05. Overall, the average $LR\chi^2$ for stationarity during the conflict conversation was 12.32, n.s. Because structural zeros tend to inflate the $LR\chi^2$ (Fienberg, 1980), and because most of the dyads in both conversational conditions were clearly stationary, all dyads were treated as if they were stationary in the analysis of group differences.

Tests for Homogeneity of Interaction Structure Within Groups

The 121 dyads were divided into three groups, as described above: 46 ADHD/ODD, 23 ADHD only, and 52 normal adolescents and their mothers. Each group was tested for homogeneity of the sequential structure within each conversational condition, using the Anderson and Goodman (1957) $LR\chi^2$ (Gottman & Roy, 1990). Transition matrices output from Arundale's (1982) SAMPLE program were analyzed for homogeneity of their sequential structures using a custom SPSS/PC+ (Norusis, 1990) command file. In order to account for nonstructural zeroes, 0.5 was added to each cell before computing the $LR\chi^2$ (Fienberg, 1980). All resulting $LR\chi^2$ values for homogeneity were evaluated at the $p = .01$ level. None of the resulting $LR\chi^2$ values for homogeneity for any group was significant during the neutral conversation—1424.00 for the ADHD and oppositional group (df = 1,332), 510.29 for the ADHD-only group (df = 642), and 888.83 for the normal group (df = 1,512). This indicates that the sequential structure for all groups during the neutral conversation was homogeneous. During the conflict conversation, however, all three groups were found to have

significant LRχ^2 values for homogeneity—1711.10 for the ADHD and oppositional group (df = 1,332), 790.28 for the ADHD-only group (df = 642), and 1769.89 for the normal group (df = 1,512).

There is little guidance available about how to approach the problem of heterogeneity in sequential analyses using log-linear modeling. Gottman and Roy (1990) suggested that introducing other factors into the analysis can create homogeneous groups. Attempts were made to discover such factors in this data, to no avail. Rather than not attempt a log-linear analysis in the light of the apparent heterogeneity of the groups in the conflict conversation condition, and thus lose the analysis of explanatory factors for which log-linear modeling is required, another method of reducing heterogeneity was used. Those subjects that contributed excessively to the variability of their respective groups during the conflict situation were removed, one at a time, until homogeneity was established in each group. This resulted in the loss of six dyads in the ADHD and oppositional group, one in the ADHD-only group, and three in the normal control group. Hierarchical log-linear analyses were then conducted using these reduced groups. Because of the reduced numbers in each group, and the unusual procedure, parallel hierarchical log-linear analyses were conducted disregarding the heterogeneity within groups in the conflict situation, using all 121 dyads. Both analyses produced the same best model. Therefore, the results of the analysis using all 121 dyads are presented below.

Hierarchical Log-Linear Analysis

It is not possible to derive a LRχ^2 for the fully saturated DGSIR model. However, fitting the full four-way model—DGSI/DGSR/DGIR/DSIR/GSIR—produces a LRχ^2 = 12.34, df = 8, which is nonsignificant, indicating that this model fits the data. This is not a very parsimonious model, however, so other models are tested by dropping terms from this model. Any model that contains fewer interactions than this model can be tested against it using the LRχ^2 associated with each model.

The LRχ^2 is used in two different ways to assess the appropriateness of the new model. First, the new LRχ^2 is assessed for significance. Thus, if the GSIR term is dropped from the full four-way model, resulting in a DGSI/DGSR/DGIR/DSIR model, the new LRχ^2 = 18.26, df = 16, n.s. This model still fits the data. We can also test whether or not the dropped interaction contributes significantly to the data by comparing the LRχ^2 of this model to that of the higher-order model that includes the dropped interaction. This is accomplished by subtracting the LRχ^2 of the original model from that of the lower-order model and testing the resulting change

in $LR\chi^2$ using the difference in degrees of freedom associated with each model. In this case, the change in $LR\chi^2 = 18.26–12.34 = 5.92$, which is not significant with 16–8 = 8 degrees of freedom. The GSIR interaction does not appear to contribute significantly to the data. If the change in $LR\chi^2$ from one model to the next had been significant, this would have indicated that the GSIR term should be retained in the model.

There are several strategies for determining where to begin in the model building. It is possible, for instance, to test the hypothesis that all *k*th- and higher-order effects are zero. In the current situation, the test that all fourth- and fifth-order effects are zero produced a $LR\chi^2 = 47.00$, $df = 36$, which is nonsignificant, indicating that the hypothesis cannot be rejected. On the other hand, the test that third-order and higher-order effects are zero produced an $LR\chi^2 = 610.19$, $df = 74$, $p < .001$. This suggests that at least some of the third-order effects should be retained in the final model. It is also possible to test whether or not *k*-way order effects are zero. The $LR\chi^2$ for the fifth-order effect was 12.34, $df = 8$, which is nonsignificant. The $LR\chi^2$ for the fourth-order effects was 36.67, $df = 28$, which is also nonsignificant. The $LR\chi^2$ for third-order effects was 563.19, $df = 38$, $p < .001$. Thus, both of these tests suggest that some third-order effects must be included in the final model.

The model building process was begun with all third-order effects in the model. This model was designated as DGI/DGR/DSI/DSR/DIR/GSI/GSR/GIR/SIR. The model had an $LR\chi^2 = 47.00$, $df = 38$, n.s. so it fits the data. Next, models that reflected the effect of dropping each of the three-way interactions were tested against the above model, which included all three-way interactions. All of these models produced significant $LR\chi^2$ values for the model and for the change from the base model with all three-way interactions included, indicating that none of these models sufficiently accounted for the data compared to the base model. It was thus concluded that the log-linear model that best describes the data includes all three-way interactions.

A discussion of the final model will concern each of the three-way effects that defined Model 1. To aid in the interpretation, the parameter estimates and *z*-values for each parameter associated with the effects in the model are presented in Table I. Significant standardized values for the estimated log-linear model parameters can help pinpoint those cells that contributed to the effect under consideration.

It should be noted that the *z*-values for the parameters in Table I can serve only as guides to the discovery of important parameters (Upton, 1978). There are several reasons for this. First, to remove redundancies in the model, so that the number of estimated parameters does not exceed the number of cells, all levels of each factor must sum to zero. Thus, in

Table I. Final Parameter Estimates and *Z*-Values for Lag 1 Interactions

Factor level[a]	Parameter	*z*-value	Factor level[a]	Parameter	*z*-value
D			SI		
1	−.23	−24.63[b]	11	−.32	−23.02[b]
			12	.02	2.15[b]
G			SR		
1	.36	31.44[b]	11	.33	24.02[b]
2	−.51	−33.92[b]	12	−.02	−2.07[b]
S			IR		
1	−.008	−0.92	11	.84	41.33[b]
			12	−.47	−22.83[b]
			21	−.44	−21.59[b]
			22	.59	37.42[b]
I			SIR		
1	−.56	−37.85[b]	111	.01	0.90
2	.05	3.78[b]	112	−.00	−0.11
			121	−.01	−0.56
			122	.04	2.59[b]
R			DSR		
1	−.54	−36.77[b]	111	−.02	−1.76
2	.04	3.36[b]	112	−.04	−4.27[b]
DG			DSI		
11	.16	15.27[b]	111	.03	2.08[b]
12	−.05	−3.31[b]	112	.04	4.27[b]
DS			DGR		
11	.001	0.11	111	.10	5.86[b]
			112	−.04	−3.17[b]
			121	−.03	−1.48
			122	.04	2.74[b]
DI			DGI		
11	−.47	−33.99[b]	111	.09	5.67[b]
	.24	20.48[b]	112	−.04	−12.72[b]
			121	−.03	−1.47
			122	.05	2.82[b]
DR			DIR		
11	−.49	−34.20[b]	111	.13	7.11[b]
12	.24	19.92[b]	112	−.06	−3.46[b]
			121	−.07	−3.71[b]
			122	.06	4.16[b]
GS			GSR		
11	.000	0.04	111	−.09	−6.35[b]
21	−.001	−0.06	112	.04	3.20[b]
			211	.02	1.72
			212	−.01	−0.77

Table I. Continued.

Factor level[a]	Parameter	z-value	Factor level[a]	Parameter	z-value
GI			GSI		
11	.35	20.80[b]	111	.09	6.11[b]
12	–.20	–14.14[b]	112	–.04	–3.02[b]
21	–.05	–2.46[b]	211	–.02	–1.06
22	.02	1.27	212	.01	0.61
GR			GIR		
11	.36	21.00[b]	111	–.09	–4.38[b]
12	–.20	–13.92[b]	112	.05	2.30[b]
21	–.05	–2.28[b]	121	.06	2.61[b]
22	.01	0.68	122	–.02	–1.15
			211	.02	0.58
			212	–.01	–0.27
			221	.02	0.68
			222	.02	20.70[b]

[a]D = Discussion (1 = neutral, 2 = conflict), G = Group (1 = ADHD/ODD, 2 = ADHD only, 3 = Normals), S = Starter (1 = mother, 2 = teen), I = initial and R = Response Comments (1 = negative, 2 = neutral, 3 = positive). ADHD = Attention deficit hyperactivity disorder; ODD = Oppositional defiant disorder.
[b]$p \leq .05$.

Table I parameters are reported for all levels of each factor *minus one parameter per level.* Because of this constraint, the remaining levels can be computed from those provided in Table I. Thus, the parameter for Level 1 of D (the neutral conversation) is listed as –.23 in the table. The parameter for Level 2 (the conflict discussion) must thus equal .23. Similarly, only parameters for two of six possible levels are listed in Table I for the DG effect—the 11 effect (neutral conversation and ADHD/ODD group) = .16 and the 12 effect (neutral conversation and ADHD-only group) = –.05. The parameters from the four remaining levels can be computed from these two. Thus, the 13 effect (neutral conversation and normals group) = 0–.16–(–.05) = –.11, and the 21 effect (conflict conversation and ADHD/ODD group) = –.16, and so on.

Other reasons the z-values in Table I can only serve as guides to the most important parameters have to do with the fact that we are dealing with polytomous variables and third-order effects. Both of these reasons, when combined with the constraint that parameters of levels sum to zero, make it difficult to tell from the z-values not only the direction of, but also the particular configuration of, parameters involved. Fortunately, in the current situation by combining the z-values in Table I with the outcomes

described in the subsequent tables and illustrated in the accompanying graphs, it is possible to describe each of the three-way interactions, which are the most important effects.

The Starter–Initial Comment–Response Comment (SIR) effect is illustrated in Tables IIa and IIb and Figs. 1a and 1b. Table IIa and Fig. 1a correspond to the instances where the first, initial comment was a mother's and the second, responding comment was the teen's, whereas Table IIb and Fig. 1b correspond to instances where the initial comment was the teen's and the response was the mother's. It appears from these tables and figures, first, that mothers were less likely (14.65%) to make negative comments than were teens (23.96%). Second, regardless of the teen's initial comment, a mother was most likely to respond with a positive comment, whereas, the teen's response tended to parallel the mother's comment, negative following negative, neutral following neutral, and positive following positive. Furthermore, only when the teen's first comment was negative was the mother's second most likely response to be negative; otherwise her second most likely response was neutral.

It will be noticed from Table I that the parameter estimates for the DSI and DSR effects are essentially the same. This is because both effects are counts of the type of comments made by each member of the dyad in the neutral and in the conflict discussions, and therefore discussion of one of these effects will account for both effects. In Tables IIIa and IIIb and Figs. 2a and 2b, the DSI effect is illustrated. From Table IIIa and Fig. 2a, it can be seen that in the neutral Discussion mother and teen were most

Table II. SIR (Starter × Initial Comment × Response) Effect

a. Proportions of teen's response to each type of comment by mothers

Mother's comment	Teen's response			
	Negative	Neutral	Positive	Total
Negative	65.73%	15.17%	19.10%	14.65%
Neutral	15.90%	54.55%	29.54%	27.49%
Positive	17.32%	23.98%	58.70%	57.86%
Total	24.02%	31.09%	44.88%	

b. Proportions of mothers responses to each type of comment by teens

Teen's comment	Mother's response			
	Negative	Neutral	Positive	Total
Negative	39.30%	17.63%	43.07%	23.96%
Neutral	7.71%	45.52%	46.77%	31.13%
Positive	6.48%	20.46%	73.06%	44.91%
Total	14.72%	27.58%	57.69%	

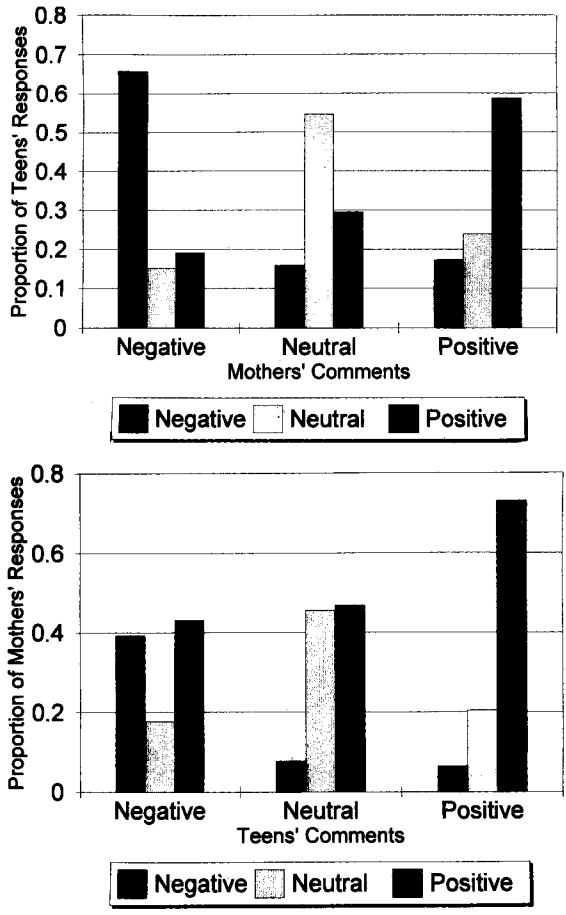


Fig. 1. (a) SIR (Starter × Initial Comment × Response) effect: proportions of teen responses to mother comments; (b) SIR effect: proportions of mother responses to teen comments.

likely to make positive comments and least likely to make negative comments. On the other hand, during the conflict Discussion (Table IIIb), both speakers were less likely to make positive comments and more likely to make negative comments than during the neutral conversation. However, whereas mothers were still most likely to make positive comments, teens were most likely to make negative comments.

The significant DIR effect suggests that the type of discussion influenced the type of interchanges that occurred between mothers and teens

Table III. DSI/DSR (Discussion × Starter × Initial/Comment/Discussion × Starter × Response Comment Effect)

a. Proportions of speaker's comments during the neutral discussion

	Comments		
Speaker	Negative	Neutral	Positive
Mother	5.62%	31.28%	63.10%
Teen	9.55%	34.76%	55.69%

b. Proportions of speaker's comments during the conflict discussion

	Comments		
Speaker	Negative	Neutral	Positive
Mother	24.35%	23.42%	52.23%
Teen	39.47%	27.22%	33.31%

regardless of who started the chain and regardless of their group membership. Results showed that during the neutral conversation negative comments were infrequent (7.58%). Moreover, regardless of whether the initial comment was negative or positive, the response was most likely to be positive during the neutral conversation (42.96% for negative initial comments and 71.72% for positive initial comments). On the other hand, negative comments became more prevalent (31.35%) during the conflict conversation. If a negative comment were made during this conversation, a negative response was likely (53.06%). Negative responses were also more likely when other comments were made than they were during the neutral period (18.84% after neutral comments during conflict discussions vs. 5.43% during neutral discussions; and 23.30% after positive comments during conflict vs. 5.41% during neutral discussions). In fact, negative responses to positive comments were just as likely during the conflict period (23.20%) as were neutral ones (21.81%).

The significant DGI and DGR effects signify important Discussion × Group × Comment effects. The ADHD/ODD dyads were the most likely of three groups to make negative comments during both types of conversations. Members of the ADHD-only and normal dyads were very unlikely to make any negative comments during the neutral conversation (5.47% and 3.51%, respectively), whereas the members of ADHD/ODD dyads made negative comments 13.41% of the time. All dyads became more likely to make negative comments during the conflict conversation (41.99% for

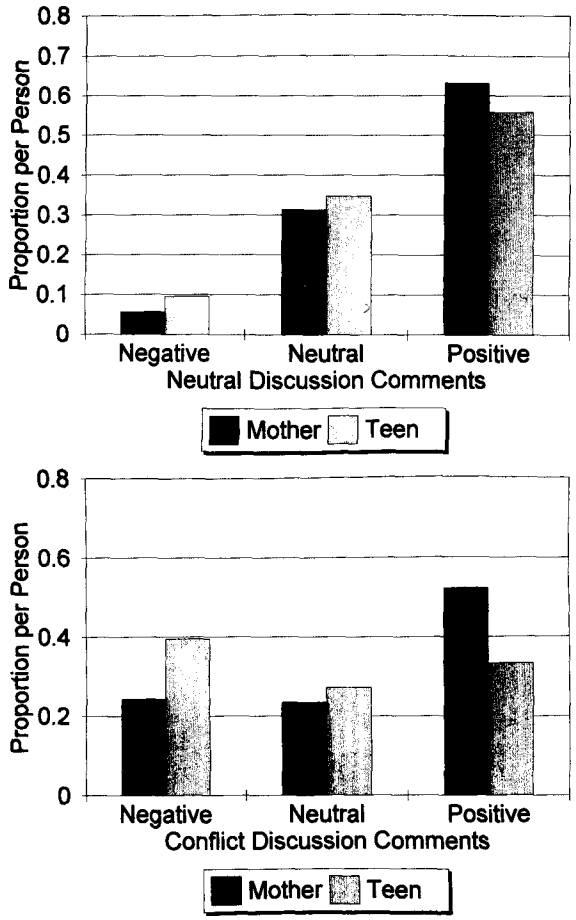


Fig. 2. (a) DSI/DSR (Discussion × Starter × Initial Comment/Discussion × Starter × Response Comment) effect: proportion of comments during neutral discussion; (b) DSI/DSR effect: proportion of comments during conflict discussion.

ADHD/ODD dyads vs. 30.31% for ADHD-only dyads and 23.53% for normal dyads), but the ADHD/ODD dyads were the only ones to make more negative comments than positive (38.25%) or neutral ones (19.76%). The ADHD-only dyads were still most likely to make positive comments (46.31%), but their next most likely response was to make negative comments. The normal dyads, on the other hand, were least likely to make negative comments even in the conflict situation.

Table IV. GSI/GSR (Group × Starter × Initial Comment/Group × Starter × Response Comment) Effect

a. Proportions of comments by ADHD/ODD group speaker			
	Comments		
Speaker	Negative	Neutral	Positive
Mother	22.54%	23.65%	53.80%
Teen	32.08%	26.04%	41.88%
b. Proportions of comments by ADHD-only group speaker			
	Comments		
Speaker	Negative	Neutral	Positive
Mother	12.78%	27.32%	59.90%
Teen	22.72%	30.54%	46.74%
c. Proportions of comments by normal group speaker			
	Comments		
Speaker	Negative	Neutral	Positive
Mother	8.55%	30.95%	60.50%
Teen	17.38%	35.88%	46.74%

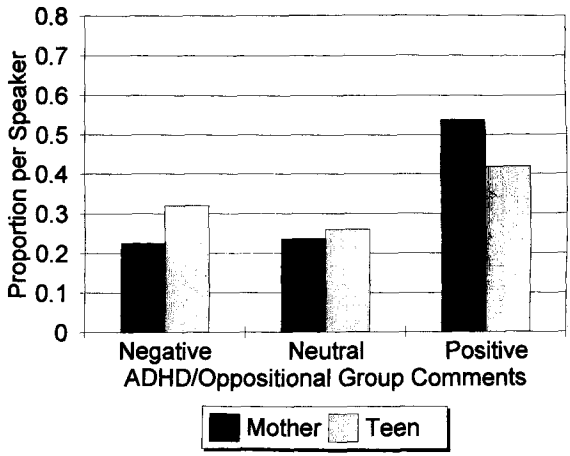
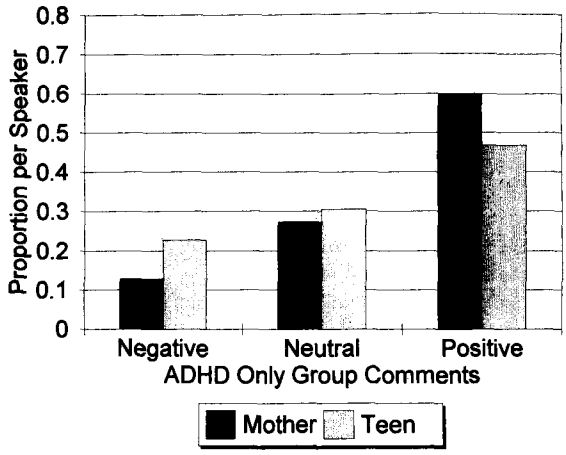


Fig. 3a.



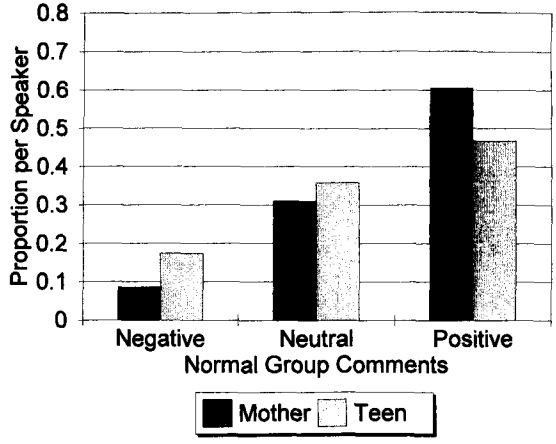


Fig. 3c.

Fig. 3. GSI/GSR (Group × Starter × Initial Comment/ Group × Starter × Response Comment) effect: proportion of comments by each ADHD/ODD speaker; (b) GSI/GSR effect: proportion of comments by each ADHD-only speaker; (c) GSI/GSR effect: proportion of comments by each normal speaker. ADHD = attention deficit hyperactivity disorder; ODD = oppositional defiant disorder.

Tables IVa through IVc and Figs. 3a through 3c illustrate differences among the groups in the frequency of types of comments made by adoles-

Table V. GIR (Group × Initial Comment × Response Comment) Effect[a]

a. Proportions of ADHD/ODD Initial Comments by response

Initial Comment	Response			
	Negative	Neutral	Positive	Total
Negative	54.71%	14.89%	30.40%	27.30%
Neutral	17.36%	46.15%	36.49%	24.84%
Positive	17.05%	19.54%	63.41%	47.85%
Total	27.41%	24.88%	47.71%	

b. Proportions of ADHD-only Initial Comments by response

Initial Comment	Response			
	Negative	Neutral	Positive	Total
Negative	46.84%	16.61%	36.55%	17.75%
Neutral	11.19%	50.97%	37.84%	28.93%
Positive	11.66%	21.13%	67.22%	53.32%
Total	17.77%	28.96%	53.27%	

c. Proportions of normal Initial Comments by response

Initial Comment	Response			
	Negative	Neutral	Positive	Total
Negative	40.94%	20.11%	38.95%	12.96%
Neutral	7.90%	51,64%	40.46%	33.41%
Positive	9.50%	25.32%	65.18%	53.62%
Total	13.04%	33.44%	53.52%	

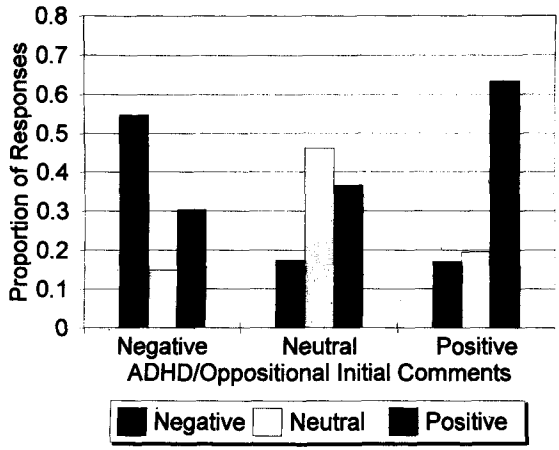


Fig. 4a.

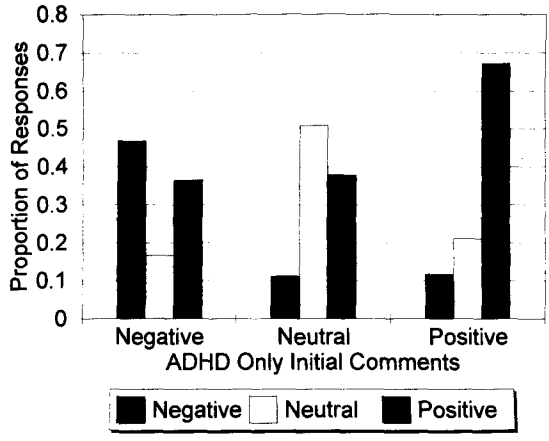


Fig. 4b.

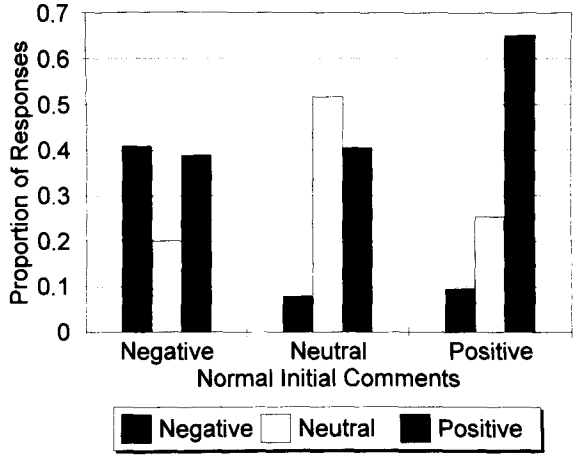


Fig. 4c.

Fig. 4. (a) GIR effect: (Group × Initial Response × Response Comment) effect: proportion of ADHD/ODD group initial comments by response; (b) GIR effect: proportion of ADHD-only group initial comments by response; (c) GIR effect: proportion of normal group initial comments by response. ADHD = attention deficit hyperactivity disorder; ODD = oppositional defiant disorder.

cents and their mothers. Mothers in all groups made more positive comments than did adolescents. Both parties were equally likely to make neu-

tral comments, and adolescents were more likely to make negative comments. Both mothers and adolescents in the ADHD/ODD group were the most likely of the three groups to make negative comments, the least likely to make neutral comments, and the least likely to make positive comments. Adolescents in this group were the only ones more likely to make negative comments than neutral, and mothers were equally likely to make negative and neutral comments. Both parties in the normal group were least likely of the groups to make negative comments and the most likely to make neutral comments. The discussants in both the ADHD-only and normal groups were equally likely to make positive comments.

The final significant lag 1 three-way GIR, Group × Initial Comment × Response, effects are illustrated in Tables Va through Vc and Figs. 4a through 4c. There it can be seen that a positive comment was equally likely to be followed by a positive response in all three groups and unlikely to be followed by a negative response, with it being least likely in the normal group. An initial neutral comment was most likely to lead to positive comments in all groups, and negative responses were the least likely responses. However, negative responses to neutral comments were most likely in the ADHD/ODD group and least likely in the normal group. The greatest differences among groups, however, occurred when the initial comment was negative. In the normal group, the most frequent response tended to be a positive comment, but in the other two groups the most frequent response was negative, and this likelihood was greatest in the ADHD/ODD group.

DISCUSSION

The present paper represents the first attempt, of which we are aware, to analyze the sequential interactions of adolescents with their mothers as a function of psychiatric diagnoses; in this case the dyadic interactions of ADHD teens with or without comorbid ODD were compared to each other and to the interactions of normal mother–teen dyads. The interpretation of results must be tempered, however, by several methodological limitations. One was the relatively small sample sizes, which may have limited the statistical power of the group comparisons such that only moderate to large effect sizes could be detected. Another was the fact that the coder was not entirely blind to group membership, being aware of which subjects were previously identified as hyperactive and normal, though not who was ADHD or ADHD with ODD at outcome. A third was that a large minority of the original hyperactive subjects (over 30%) were not available for this portion of the follow-up evaluation. Those subjects lost to follow-up were found to have lower IQs at study entry but otherwise did not differ on

initial levels of hyperactivity or other demographic measures (Barkley et al., 1991). Since IQ was found in these samples to be correlated with the parent–teen interaction categories, it is possible that, had the lost subjects been included here, greater differences among these groups might have been obtained. A further limitation was the screening of the normal group at study entry to eliminate those with any psychiatric disorders. While this might suggest that the control group was supernormal, this may not be the case given that they were of average IQ at follow-up, that up to 12% had some disruptive behavior disorder (ODD) at follow-up, and that only a rating scale, not a full psychiatric evaluation, was used to eliminate high-scoring subjects from this group at study entry. In any case, these limitations should be kept in mind in considering the issues discussed below.

At a general level, regardless of group membership, the parent–teen verbal interactions appeared as a tightly linked dance of contingent relationships between the immediate behaviors of each participant. This is hardly surprising. More interesting is the finding that the significant effects were to be found within the single chained (lag 1) antecedent–consequent exchanges in the sequence. The behavior of one member at any point in the sequence was significantly related only to the immediately preceding behavior of the other (lag 1). Hence, these parent–teen interactions seemed highly flexible in the course they took over the longer sequence of exchanges, yet they revealed a closely linked contingent relationship at each exchange in the sequence.

More important, it seems, was that the mothers' behavior compared to that of the teens, while contingent, was different in its overall rates of initiating and responding with positive, neutral, or negative behaviors. Mothers were more likely than teens to both initiate positive behaviors and respond to all three categories of teen response with subsequent positive behaviors. In contrast, teens, while initiating mostly positive behaviors, were likely to respond with the same category of behavior as that just previously initiated by their mothers. In this sense, the mothers of these adolescents seemed to behave in a manner that could be typified as "be nice and forgive." This approach may well be most adaptive for constraining conflict to a minimum while engendering cooperation that maximizes the positive outcomes for both parties (Axelrod, 1984; Rapoport & Chammah, 1965). Teens, in contrast, behaved in a manner suggesting "tit for tat" or "do unto others as they do unto you." This difference in interaction styles between the teens and their mothers might reflect developmental changes in the acquisition of social interaction skills with age. However, it could also be that the sex of the parent was a factor that confounded these results given that most of the teens were male and all the parents observed here were females.

Diagnostic group membership was also a major determinant of the nature of the parent–teen exchange, whether during the neutral or conflict discussion. The majority of interpersonal conflict noted here, and likely in previous research using children with ADHD, appears to be accounted for by that subgroup having comorbid ODD. This conclusion must be tempered by our use of a laboratory observation measure which may not fully have represented the nature of these interactions in the natural settings of these families. Moreover, mothers may be more likely than the teens to suppress their negative behavior under such observational conditions, further reducing the representativeness of these results. Group differences in levels of conflict at home, however, were also reported by these families on self-report measures (Barkley et al., 1991). And the results of our observations agree with other studies (Barkley et al., 1992) of parent–teen interactions in ADHD adolescents using this same methodology. This implies that, if anything, our findings may be underestimates of the magnitude of group differences that might emerge from measures taken in natural family settings.

Parent–teen dyads in which the teen had both ADHD and ODD were the most likely to make negative comments during either discussion period relative to those with ADHD-only or the normal parent–teen dyads. They were also the least likely to employ the positive or neutral behaviors compared to dyads in the other two groups. Moreover, only in the ADHD/ODD parent–teen dyads did the use of negative comments become their predominant category of behavior during the conflict discussion. Particularly indicative of this pattern of social irritability and hostility in the ADHD/ODD dyads was the finding that neutral comments were most likely to be responded to by neutral or positive responses in the ADHD-only and normal dyads, whereas they were most likely to be met with negative comments in the ADHD/ODD dyads. Even more striking was the pattern of responses when the initial comment was negative. The normal dyads still responded with positive comments most often, whereas the ADHD-only dyads were somewhat more likely to respond negatively and the ADHD/ODD dyads most likely of all to do so.

These findings underscore the point made by others (Patterson, 1982; Patterson, Reid, & Dishion, 1992; Wahler, 1980) and ourselves (Barkley et al., 1992) that ODD, or socially hostile–defiant behavior, may not simply be a diagnosis or feature of an individual (the teen in this case) but a characteristic of a family's interaction pattern. The pattern seems to be one typified by interpersonal hostility and irritability that occurs at a higher base rate than in normal or ADHD-only families and increases dramatically in probability as a response when a negative behavior is initiated by either party. This pattern may be apparent even during neutral discussions but

becomes predominant in social exchanges where past conflicts must be discussed.

This is not to say that the negative behaviors of mothers in ADHD/ODD dyads are necessarily the cause of the greater negativity in the dyads or the teens' ODD. Our results cannot speak directly to the direction of effects in their exchanges. Teens in this group certainly made more negative comments than their mothers or the teens and mothers in the other groups. Such frequent comments may act as "social sparks" that increase negative reactions from the mothers of such teens far more often during daily family life than is the case for teens with ADHD alone or normal teens. The results do suggest, however, that the manner in which such mothers attempt to cope with such social sparks can readily kindle the exchange into an escalating negative sequence or, in contrast, reduce the continuance of negative teen behaviors. By responding tit for tat, mothers of ADHD/ODD teens may be employing the same less-mature response style as that employed by the teens in all groups. Mothers of ADHD-only and normal teens were much less likely to do so, staying the cooperative course by using positive behaviors most often regardless of their teens' antecedent behavior.

Why are mothers of the ODD teens more likely to respond to their teens' irritable behavior with their own negativity or hostility when mothers of the other teen groups are less likely to do so? Models developed by others (Dumas, 1986; Hops et al., 1987; Patterson, 1982) show that both maternal perceptions of childhood conduct problems as well as actual maternal negative behavior toward children are not only a function of the child's actual misconduct, but also of maternal maladjustment, especially marital discord, depression, interpersonal hostility, and more specific psychiatric disorders. These models suggest that it is the maternal maladjustment in the context of temperamentally difficult children (i.e., oppositional) which results in increased maternal controlling and coercive behavior toward the children. Our findings are quite consistent with these models although they cannot directly reveal the direction of effects between these mother and child characteristics.

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