Subtypes of Aggression in Children with Attention Deficit Hyperactivity Disorder: Medication Effects and Comparison with Typical Children

Sara King \textsuperscript{a}, Daniel A. Waschbusch \textsuperscript{b}, William E. Pelham \textsuperscript{b}, Bradley W. Frankland \textsuperscript{c}, Penny V. Corkum \textsuperscript{c} & Sophie Jacques \textsuperscript{c}

\textsuperscript{a} Departments of Pediatrics and Psychology, Dalhousie University and IWK Health Centre,
\textsuperscript{b} Departments of Pediatrics and Psychology, University at Buffalo-SUNY and Center for Children and Families—SUNY,
\textsuperscript{c} Department of Psychology, Dalhousie University,

Published online: 04 Sep 2009.

To cite this article: Sara King, Daniel A. Waschbusch, William E. Pelham, Bradley W. Frankland, Penny V. Corkum & Sophie Jacques (2009) Subtypes of Aggression in Children with Attention Deficit Hyperactivity Disorder: Medication Effects and Comparison with Typical Children, Journal of Clinical Child & Adolescent Psychology, 38:5, 619-629, DOI: 10.1080/15374410903103619

To link to this article: http://dx.doi.org/10.1080/15374410903103619

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the “Content”) contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at http://www.tandfonline.com/page/terms-and-conditions
Subtypes of Aggression in Children with Attention Deficit Hyperactivity Disorder: Medication Effects and Comparison with Typical Children

Sara King
Departments of Pediatrics and Psychology, Dalhousie University and IWK Health Centre

Daniel A. Waschbusch and William E. Pelham
Departments of Pediatrics and Psychology, University at Buffalo—SUNY and Center for Children and Families—SUNY

Bradley W. Frankland, Penny V. Corkum, and Sophie Jacques
Department of Psychology, Dalhousie University

We examined aggressive behavior in 6- to 12-year-old children, including 20 children with attention deficit hyperactivity disorder (ADHD) on stimulant medication, 19 children with ADHD on placebo ($n = 19$), and 32 controls. Children completed a laboratory provocation task designed to measure hostile, instrumental, reactive, and proactive aggression. Children in the ADHD-placebo group exhibited increased proactive and reactive aggression following high levels of provocation compared to controls. On the last trials, instrumental aggression dissipated for controls and hostile aggression dissipated for children in the ADHD-placebo group. Both instrumental and hostile aggression dissipated for children in the ADHD-medication group.

Aggressive behavior has a significant impact on the social development of children and is associated with several negative long-term outcomes such as school difficulties (Brown, Atkins, Osborne, & Milnamow, 1996; Day, Bream, & Pal, 1992) and violent and antisocial behavior (Cornell et al., 1996; Tremblay et al., 2004). These and other negative outcomes have prompted much research as to the origins, nature, and treatment of aggressive behavior in children.

Given that the goal of aggression is not consistent across situations, researchers have developed taxonomic systems to reflect the heterogeneous nature of this construct. The distinction between reactive and proactive aggression is probably the most frequently used means of distinguishing subtypes of aggressive behavior. Reactive aggression has been defined as impulsive, angry, “hot” aggression that occurs in response to real or perceived provocation (Crick & Dodge, 1996; Dodge, 1991; Waschbusch et al., 2002). Conversely, proactive aggression has been defined as nonimpulsive, nonangry, “cool,” goal-oriented aggression that occurs without prior provocation (Crick & Dodge, 1996; Dodge, 1991; Waschbusch, Willoughby, & Pelham, 1998). One key
difference between reactive and proactive aggression is the antecedent to the aggression, that is, whether the aggression occurs in response to provocation. The validity of the distinction between reactive and proactive aggression has been shown in numerous studies (Polman, de Castro, Koops, van Boxtel, & Merk, 2007), including those using large groups (e.g., Waschbusch et al., 1998) and those using dyadic peer relationships (e.g., Dodge, Price, Coie, & Christophulos, 1990).

An alternative system for conceptualizing aggression has been to distinguish between instrumental and hostile aggression (e.g., Atkins, Stoff, Osborne, & Brown, 1993; Bushman & Anderson, 2001). Instrumental aggression has been defined as aggression that provides some reward or advantage to the aggressor and is unrelated to the victim’s discomfort. Conversely, hostile aggression can be defined as aggression that is intended solely to inflict injury or pain on the victim with little or no advantage to the aggressor (Atkins et al., 1993; Bushman & Anderson, 2001). Thus, the key distinction between instrumental and hostile aggression is the intended outcome, that is, whether the aggression is intended as a means to achieve a goal (instrumental aggression) or is intended for the sake of being aggressive (hostile aggression). The validity of the distinction between instrumental and hostile aggression has also been supported (e.g., Atkins & Stoff, 1993).

The instrumental/hostile and reactive/proactive distinctions are sometimes used interchangeably, but the two classification systems do not define aggression in identical ways. Whereas reactive and proactive subtypes of aggression are primarily distinguished by the presence or absence of an antecedent provocation, hostile and instrumental aggression are primarily distinguished by the intended target or purpose of the aggressive act. This conceptualization suggests that reactive/proactive aggression and instrumental/hostile aggression are not mutually exclusive; hostile or instrumental aggression could occur regardless of whether or not an individual has experienced provocation. For example, a child who is teased (provoked) by a peer could react to this by hitting that child just to hurt him or her (reactive–hostile) or by trying to sabotage his or her performance during a competitive game (reactive–instrumental). These same behaviors could occur in the absence of provocation (proactive–hostile and proactive–instrumental). We are not aware of any research that has examined these two classification systems in a single sample of children.

One group for whom aggression is a particular concern is children with attention deficit hyperactivity disorder (ADHD). Numerous studies demonstrate that children with ADHD have high rates of aggression and antisocial behavior, even after controlling for co-occurring conduct problems (Hinshaw, Henker, Whalen, Erhardt, & Dunnington, 1989; Pelham et al., 1991; Waschbusch, 2002). Further, reducing aggression is often a primary goal when treating children with ADHD. For these reasons, several studies have examined rates and types of aggression within samples of children with ADHD (e.g., Amery, Minichello, & Brown, 1984; Casat, Pearson, Van Davelaar, & Cherek, 1995; Gadow, Nolan, Sverd, Sprafkin, & Paolicelli, 1990; Hinshaw, Henker, et al., 1989; Murphy, Pelham, & Lang, 1992; Pelham et al., 1991).

Stimulant medication, such as methylphenidate (MPH), is one of the most widely used and well-established treatments for ADHD (Centers for Disease Control, 2005; Swanson, McBurnett, Christian, & Wigal, 1995). In addition to significantly decreasing hyperactive, impulsive, and inattentive behaviors associated with ADHD (MTA Cooperative Group, 1999), research has also examined the effects of MPH on aggressive behavior. Most of this research suggests that MPH decreases the rate and intensity of aggression (Connor, Glatt, Lopez, Jackson, & Melloni, 2002; Hinshaw, 1991; Hinshaw & Lee, 2000). However, not all research is consistent. For instance, Murphy et al. (1992) used a laboratory provocation task to evaluate the effect of MPH on aggression in aggressive and nonaggressive boys with ADHD. Results indicated that MPH had no effect on the aggression displayed by high-aggressive boys with ADHD. Surprisingly, MPH significantly increased aggressive responding in low-aggressive boys with ADHD. In contrast, a later study using a similar paradigm found no effect of MPH on response to provocation in boys with ADHD (Pelham et al., 1991).

The reasons for these and other discrepant findings are not entirely clear. The majority of research used a nonspecific definition of aggression, typically measured using rating scales completed by parents or teachers. This leaves open the possibility that the effects of stimulant medication may depend on the subtype of aggression. In fact, it has been speculated that stimulant medications may be effective at reducing aggression that has impulsive components but it may not be effective (and may even be detrimental) at reducing nonimpulsive aggression (Hinshaw & Lee, 2000; Vitiello & Stoff, 1997). Unfortunately, research has not systematically examined the effects of MPH on subtypes of aggression within a single sample of children.

The present study examined the effects of stimulant medication on reactive, proactive, instrumental, and hostile aggression in children with ADHD. Subtypes of aggression were induced and measured using an established experimental procedure that allowed for the control of antecedent and consequent variables. It was hypothesized that children with ADHD who received placebo would exhibit higher rates of each type
of aggression relative to children without ADHD and relative to children with ADHD who received MPH. It was also hypothesized that children with ADHD who received MPH would not differ from controls.

METHOD

Participants

Participants were 71 children (52 boys, 19 girls) between the ages of 6 and 12 years \( (M = 9.20, SD = 2.02) \), including 39 children with ADHD and 32 typically developing children who participated in the study as controls. Children with ADHD were randomly assigned to participate after receiving MPH \( (n = 20) \) or a placebo \( (n = 19) \). Thirty-four \( (87\%) \) of the children in the ADHD group had previous experience with medication (e.g., Ritalin, Adderall, Concerta) prior to participating in this study.

The children with ADHD were enrolled in an 8-week comprehensive summer treatment program (STP) for children with ADHD (see Pelham, Gnagy, & Greiner, 1998, for a description). ADHD was evaluated using criteria from the Diagnostic and Statistical Manual of Mental Disorders (4th ed., text rev.; American Psychiatric Association, 2000) as determined by parent and teacher ratings on the Disruptive Disorders Rating Scale (Pelham et al., 1992) and a structured diagnostic interview with parent(s) on the computerized, parent-report version of the Diagnostic Interview Schedule for Children (DISC; NIMH-DISC Editorial Board, 1999; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000). Diagnoses were made by doctoral-level clinicians based on both rating scale and interview information. A majority of the children with ADHD also met criteria for oppositional defiant disorder or conduct disorder \( (n = 36; 92.3\%) \).

Children in the control group were recruited from two sources, one in Buffalo, New York, and one in Halifax, Nova Scotia, Canada. Seven children were enrolled as control children in the STP (for research purposes only), 2 children had been enrolled as controls in a previous STP, and the remaining control children were recruited from the community using radio and television advertising as well as flyers posted in public places (i.e., grocery stores, libraries, health centers). Control children were screened for behavior and other adjustment difficulties using parent ratings on the Disruptive Disorders Rating Scale (Pelham et al., 1992), Aggression Scales (Dodge & Coie, 1987), the DISC (NIMH-DISC Editorial Board, 1999; Shaffer et al., 2000) and the Impairment Rating Scale (Fabiano et al., 2006). Control children with evidence of clinically significant behavior problems, defined as having a score above the published norms on one or more of the measures, were excluded from participation. Groups recruited at the two sites did not differ on age, \( F(1, 69) = 2.58, p = .113 \), or sex, \( \chi^2(1) = 1.68, (n = 71), p = .195 \). With respect to ethnicity, 65 \( (91.5\%) \) of participants were identified as Caucasian, whereas 6 \( (8.5\%) \) were identified as African American. Group differences in ethnicity showed a trend toward significance, \( \chi^2(1) = 3.46, p = .06 \), as all African American children were part of the Buffalo sample.

Table 1 summarizes demographic and rating scale measures for the ADHD group on placebo (ADHD-placebo), the ADHD group on medication (ADHD-med), and the control group. As can be seen, groups did not differ on age or sex but differed in expected ways on measures of ADHD, oppositional defiant disorder, and conduct disorder.

<table>
<thead>
<tr>
<th>No Diagnosis</th>
<th>ADHD-Placebo</th>
<th>ADHD-Medication</th>
<th>Test Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. (%) Boys</td>
<td>20 (62.5%)</td>
<td>14 (73.70%)</td>
<td>18 (90.0%)</td>
</tr>
<tr>
<td>Age in Years</td>
<td>8.88 (1.98)</td>
<td>9.88 (2.50)</td>
<td>9.06 (2.00)</td>
</tr>
<tr>
<td>No. of Symptoms Endorsed by Parent on the DBD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADHD-Inattentive</td>
<td>0.31s (0.78)</td>
<td>7.26s (2.16)</td>
<td>7.05s (1.88)</td>
</tr>
<tr>
<td>ADHD-Hyp/Imp</td>
<td>0.22s (0.61)</td>
<td>5.89s (2.11)</td>
<td>6.35s (1.95)</td>
</tr>
<tr>
<td>ODD</td>
<td>0.16s (0.37)</td>
<td>4.79s (2.46)</td>
<td>4.60s (2.37)</td>
</tr>
<tr>
<td>CD</td>
<td>0s (0%)</td>
<td>1.37s (1.34)</td>
<td>1.10s (1.17)</td>
</tr>
<tr>
<td>Clinical Diagnoses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADHD</td>
<td>0s (0%)</td>
<td>19s (100%)</td>
<td>20s (100%)</td>
</tr>
<tr>
<td>ODD</td>
<td>0s (0%)</td>
<td>10s (52.6%)</td>
<td>10s (50.0%)</td>
</tr>
<tr>
<td>CD</td>
<td>0s (0%)</td>
<td>5s (26.3%)</td>
<td>4s (20.0%)</td>
</tr>
</tbody>
</table>

Note. Values are means with standard deviations in parentheses unless otherwise indicated. Means or frequency counts within same row with different subscripts differ significantly on Tukey test at \( p < .05 \). ADHD = attention deficit hyperactivity disorder; DBD = Disruptive Behavior Disorders Rating Scale (Pelham et al., 1992); Hyp/Imp = hyperactive/impulsive; ODD = oppositional defiant disorder; CD = conduct disorder.

\( ^*n = 32 \), \( ^*n = 19 \), \( ^*n = 20 \).
Parents of all children gave informed consent in writing for their children to participate in the study and children gave verbal assent to participate. All participants were treated in accordance with the requirements of the local ethics review boards. As part of this process, parents were informed about the deception used in the experimental task and asked not to inform their children of the deception until the end of the STP. Parents were given the choice to have their children debriefed by the experimenters following completion of the STP, but all declined this offer.

Procedure

**Medication procedure.** As part of a larger study, all children who met the diagnostic criteria for ADHD participated in a placebo-controlled, randomized medication assessment where medication condition varied on a day-to-day basis (see Pelham, 1993; Pelham et al., 2002, for a detailed description of the procedure). Children who were randomly assigned to be tested on medication received a dose of MPH equivalent to 0.3 mg/kg of body weight, rounded to the nearest 1.25 mg dose. Children assigned to the placebo condition received an inactive capsule. Medication and placebo were identically encapsulated in opaque pills so that neither staff members nor children were aware of the medication condition. A member of the research staff administered medication to ensure that children received the correct pill at the correct time each day. Testing took place between 30 min and 3 1/2 hr after administration of the pill.

**Aggression task.** Custom software was written for this experiment to run on a computer compatible with the Microsoft Windows operating system. The study used a modified version of the Taylor aggression task as in previous studies of aggression in children and adults (e.g., Atkins & Stoff, 1993; Cherek, Steinberg, Kelly, & Robinson, 1986; Taylor & Gammon, 1975; Waschbusch et al., 2002; Zeichner & Pihl, 1979). The task consisted of a reaction-time game in which participants thought they were competing over the Internet against another child their age to win points to exchange for prizes. However, there was no other child and all win and loss trials were determined a priori. In addition, all messages from the opponent were preprogrammed and consistent across all children.

The aggression task included two conditions that all children completed, one designed to measure instrumental aggression and the second designed to measure hostile aggression. Instrumental aggression was operationalized as aggression used for the purpose of attaining a goal. In the instrumental condition, participants were seated at a computer and told that they would be playing a game against another child over the Internet and that they were to press a red button on a joystick as fast as possible when a bull’s-eye target appeared on the screen. Children were told that if they pressed the button faster than the other child, they would win 10 points and would be given the opportunity to (a) take between 0 and 10 points away from their opponent, (b) send their opponent a message over an instant messenger program, (c) do both, or (d) do nothing. They were told to inform the other child of their action(s) using an instant messenger program built into the game. They were also told that if the other child won, he or she would have the same opportunities to take points and/or send a message and that their “opponent” would also communicate using instant messenger. Hostile aggression was operationalized as aggression used to hurt or penalize the opponent. The methodology for the hostile condition was identical to that of the instrumental condition with the exception that, instead of having the opportunity to take points from their opponents, participants were given the opportunity to (a) send a “buzz” (white noise) lasting from 0 to 10 sec to their opponent, (b) send a message to their opponent, (c) do both, or (d) do nothing.

Immediately after informing the child of a win, he or she was allowed to take points/send a buzz and write a message to the opponent, as just described. At the end of each trial, both wins and losses, participants were asked to provide a 5-point Likert rating to indicate how they were feeling at that moment. Possible responses ranged from 0 (very happy) to 4 (very angry) and were anchored by cartoon drawings of happy, neutral, and angry faces. During task administration, the investigator or a research assistant was present at all times. All loss messages from the “opponent” were read in a neutral voice to the participant by a research assistant, and all win messages participants wished to convey to the “opponent” were typed by a research assistant. Messages sent from each participant were saved as text files so that they could be analyzed at a later time.

In reality, the game was rigged so that participants lost on the same 8 of 28 trials in each condition. Immediately after a loss, an instant message from the opponent appeared on the computer screen informing the participant how many points would be taken or the length of the buzz that would be sent. Four of these loss trials were high-provocation trials in which the “opponent” took 8, 9, or 10 points from the participant (or received a buzz of 8, 9, or 10 sec) and sent a highly aversive message (e.g., “Nice try, speedo! What’s the matter—is your hand stuck in cement? You lose another 10!”). The other 4 loss trials were low-provocation trials in which the “opponent” took 0, 1, or 2 points from the participant (or received a buzz of 0, 1, or 2 sec) and sent a nonprovocative message (e.g., “You lost, but you’re getting better. I’ll take 2 points.”). The remaining 20
trials of each condition were win trials, including 4 consecutive win trials at the beginning of the game and 6 consecutive win trials at the end of the game.

The trial immediately following a loss was always a win trial; that is, two loss trials never occurred in succession. Reactive aggression was operationalized as aggressive behavior that occurred on trials immediately following provocation, that is, the number of points taken away or the length of buzz sent immediately following a high- or low-provocation loss trial. Proactive aggression was operationalized as aggressive behavior that occurred in the absence of provocation, that is, aggressive behavior that occurred in the first four trials of the task, each of which the participant won. Dissipation of aggression was operationalized as reduction in aggressive responding in the last six win trials of the task immediately following a high-provocation loss. Dissipation of aggression in the current study is analogous to “holding a grudge” as described in Waschbusch (2002). The entire duration of the task was between 20 and 40 min, depending on the child.

Data Analyses

Behavioral and affective measures were examined on proactive aggression trials, reactive aggression trials, and dissipation of aggression trials. Data were analyzed two ways. First, a series of analyses of variance (ANOVAs) were computed to evaluate the effects of group (ADHD-placebo vs. ADHD-med vs. control), provocation (low vs. high), and aggression (instrumental vs. hostile). Significant main effects and interactions were followed up using simple effects tests and Bonferroni-adjusted pairwise comparisons and by examining means and standard deviations. Second, to evaluate the most extreme responses, participants were dichotomized based on whether they showed highly aggressive behavior on every relevant trial, and these were examined using a series of 3 (group: control vs. ADHD-placebo vs. ADHD-med) × 2 (high aggressive: no vs. yes) chi-square analyses, with separate analyses computed for each type of aggression. Consistent with our definition of high provocation, a highly aggressive trial was defined as taking at least 8 points from the “opponent” or sending an average buzz of at least 8 sec to the opponent. Likewise, affect measures were dichotomized into angry versus not on every relevant trial and these were compared using 3 (group) × 2 (affect: none vs. anger) chi-square analyses, with separate analyses computed for each type of aggression.

RESULTS

Proactive Aggression

Behavior. Proactive aggression was evaluated using a 2 (aggression: instrumental vs. hostile) × 3 (group: control vs. ADHD-placebo vs. ADHD-med) ANOVA on proactive aggression. There was a marginally significant main effect of group, $F(2, 68) = 2.62, p = .072$, partial $\eta^2 = .072$. Bonferroni-adjusted pairwise comparisons and examination of means indicated that the ADHD-placebo group was marginally more aggressive than controls ($p = .075$), with ADHD-med between but not different than the other two groups (control: $M = 6.02$, $SD = 2.76$; ADHD-placebo: $M = 7.84$, $SD = 2.44$; ADHD-med: $M = 6.71$, $SD = 3.33$). The 3 (group) × 2 (high aggression: no vs. yes) chi-square analysis was marginally significant for hostile aggression, $\chi^2(2) = 5.76, p = .056$, but not for instrumental aggression. As can be seen in Table 2, the two ADHD groups were more than twice as likely as controls to show high proactive aggression on all four proactive trials at the beginning of the task.

| TABLE 2 |
| Number and Percentage of Participants With Highly Aggressive Responses as a Function of Group |

<table>
<thead>
<tr>
<th></th>
<th>Control (%)</th>
<th>ADHD Placebo (%)</th>
<th>ADHD Medicated (%)</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proactive Aggression</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hostile</td>
<td>5 (15.6)</td>
<td>7 (36.8)</td>
<td>9 (45.0)</td>
<td>$\chi^2(2) = 5.75^*$</td>
</tr>
<tr>
<td>Instrumental</td>
<td>12 (37.5)</td>
<td>8 (42.1)</td>
<td>9 (45.0)</td>
<td>$\chi^2(2) = 0.30$</td>
</tr>
<tr>
<td><strong>Reactive Aggression</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hostile-Low Prov</td>
<td>4 (12.5)</td>
<td>4 (21.1)</td>
<td>4 (20.0)</td>
<td>$\chi^2(2) = 0.81$</td>
</tr>
<tr>
<td>Hostile-High Prov</td>
<td>17 (53.1)</td>
<td>15 (78.9)</td>
<td>7 (35.0)</td>
<td>$\chi^2(2) = 7.68^*$</td>
</tr>
<tr>
<td>Instrumental-Low Prov</td>
<td>4 (12.5)</td>
<td>5 (26.3)</td>
<td>4 (20.0)</td>
<td>$\chi^2(2) = 1.58$</td>
</tr>
<tr>
<td>Instrumental-High Prov</td>
<td>16 (50.0)</td>
<td>14 (73.7)</td>
<td>15 (75.0)</td>
<td>$\chi^2(2) = 4.50$</td>
</tr>
<tr>
<td><strong>Dissipation of Aggression</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hostile</td>
<td>8 (25.0)</td>
<td>10 (52.6)</td>
<td>8 (40.0)</td>
<td>$\chi^2(2) = 4.06$</td>
</tr>
<tr>
<td>Instrumental</td>
<td>16 (50.0)</td>
<td>11 (57.9)</td>
<td>9 (45.0)</td>
<td>$\chi^2(2) = 0.66$</td>
</tr>
</tbody>
</table>

*Note.* Values in the tables are frequency counts with percentages in parentheses. ADHD = attention deficit hyperactivity disorder; Prov = provocation.

* $\chi^2(2)$ marginally significant at $p < .10$. ** $\chi^2(2)$ significant at $p < .05$. 
**Affect.** The 2 × 3 ANOVA examining affect during the proactive aggression trials was not significant. Results of the chi-square analyses also showed no group differences; none of the participants reported being angry on any four trials that occurred at the start of either condition.

Reactive Aggression

**Behavior.** Reactive aggressive behavior was examined using a 3 (group) × 2 (aggression: instrumental vs. hostile) × 2 (provocation: low vs. high) ANOVA. There were significant main effects of provocation, $F(1, 68) = 103.28, p < .001$, partial $\eta^2 = .603$, and group, $F(2, 68) = 3.19, p = .047$, partial $\eta^2 = .086$, but no other significant effects. Examination of means for the provocation main effect showed that participants were more aggressive following high provocation than following low provocation (low provocation: $M = 5.28$, $SD = 2.99$; high provocation: $M = 8.73$, $SD = 1.43$). Bonferroni-adjusted pairwise comparisons and examination of means for the group main effect showed that the ADHD-placebo group was marginally more aggressive than the control group ($p = .052$), with the ADHD-med group between but not different than the other two groups (control: $M = 6.52$, $SD = 1.80$; ADHD-placebo: $M = 7.81$, $SD = 1.78$; ADHD-med: $M = 6.69$, $SD = 1.78$). Chi-square analyses examining rates of highly aggressive responses showed that groups differed in hostile aggression following high provocation, $\chi^2(2) = 7.68, p = .022$, but not in other conditions. As shown in Table 2, children in the ADHD-placebo group were highly aggressive on every trial that followed high provocation in the hostile task, whereas rates were lower for other groups.

**Dissipation of Aggression**

**Behavior.** Dissipation of aggression over time was examined using a 3 (group) × 2 (aggression) × 6 (dissipation trial: 1 vs. 2 vs. 3 vs. 4 vs. 5 vs. 6) ANOVA. There was a significant main effect of dissipation trial, $F(5, 335) = 11.54, p < .001$, partial $\eta^2 = .147$; a marginal main effect of group, $F(2, 67) = 2.74, p = .072$, partial $\eta^2 = .076$; and a significant Group × Aggression interaction, $F(2, 67) = 4.74, p = .012$, partial $\eta^2 = .123$, but these were qualified by a marginal Group × Aggression × Dissipation interaction, $F(10, 335) = 1.78, p = .064$ partial $\eta^2 = .050$. Means and standard errors for the three-way interaction are shown in Figure 2. The differences; none of the participants reported being angry on any four trials that occurred at the start of either condition.

Chi-square analyses examining rates of high anger showed that groups differed following high instrumental provocation, $\chi^2(2) = 7.82, p = .020$, and were marginally different following high hostile provocation, $\chi^2(2) = 5.49, p = .064$. As shown in Table 3, the number of children who were angry on every trial that followed high instrumental provocation was three times higher in the ADHD-placebo group than in the ADHD-med and control groups. In contrast, the number of children angry on every trial that followed high hostile provocation was much lower in the ADHD-med group than in the ADHD-placebo or control groups.

Chi-square analyses examining rates of high anger showed that groups differed following high instrumental provocation, $\chi^2(2) = 7.82, p = .020$, and were marginally different following high hostile provocation, $\chi^2(2) = 5.49, p = .064$. As shown in Table 3, the number of children who were angry on every trial that followed high instrumental provocation was three times higher in the ADHD-placebo group than in the ADHD-med and control groups. In contrast, the number of children angry on every trial that followed high hostile provocation was much lower in the ADHD-med group than in the ADHD-placebo or control groups.

Chi-square analyses examining rates of high anger showed that groups differed following high instrumental provocation, $\chi^2(2) = 7.82, p = .020$, and were marginally different following high hostile provocation, $\chi^2(2) = 5.49, p = .064$. As shown in Table 3, the number of children who were angry on every trial that followed high instrumental provocation was three times higher in the ADHD-placebo group than in the ADHD-med and control groups. In contrast, the number of children angry on every trial that followed high hostile provocation was much lower in the ADHD-med group than in the ADHD-placebo or control groups.
three-way interaction was followed up by computing simple effects tests to examine dissipation trial for each combination of group and aggression condition; that is, dissipation of aggression over time was examined separately for each group and for each type of aggression. As shown in Figure 2, results showed that the control group significantly decreased their aggression following high hostile provocation, $F(5, 63) = 3.18$, $p = .013$, partial $\eta^2 = .202$, but not following high instrumental provocation, $F(5, 63) = 1.17$, $p = .335$, partial $\eta^2 = .085$. In contrast, the ADHD-placebo group significantly decreased aggression following high instrumental provocation, $F(5, 63) = 3.16$, $p = .013$, partial $\eta^2 = .200$, but only marginally decreased aggression following high hostile provocation, $F(5, 63) = 1.98$, $p = .093$, partial $\eta^2 = .136$. Finally, the ADHD-med group significantly decreased their aggression following both high instrumental provocation, $F(5, 63) = 3.40$, $p = .009$, partial $\eta^2 = .213$, and following high hostile provocation, $F(5, 63) = 3.56$, $p = .007$, partial $\eta^2 = .220$. Chi-square analyses examining highly aggressive behavior across the dissipation trials were not significant.

**Affect.** The 3 (group) $\times$ 2 (aggression condition) $\times$ 6 (dissipation trial) ANOVA resulted in a significant main effect of dissipation trial, $F(5, 335) = 75.80$, $p < .001$, partial $\eta^2 = .531$, and marginal Group $\times$ Aggression interaction, $F(2, 67) = 2.75$, $p = .071$, partial $\eta^2 = .076$. Examination of means for dissipation trial showed that anger generally decreased as the provocation became more distal and that participants generally rated themselves as nonangry. Simple effects tests to follow up the Group $\times$ Aggression interaction showed a significant effect of aggression for the ADHD-placebo group, $F(1, 67) = 4.39$, $p = .040$, partial $\eta^2 = .061$, but not for the other groups. Examination of means showed that the ADHD-placebo group was significantly less angry/more happy following high hostile provocation than following high instrumental provocation (Instrumental: $M = 1.07$, $SD = 0.64$; Hostile: $M = 0.75$, $SD = 0.58$), but the ADHD-med group did not differ between aggressive conditions (Instrumental: $M = 0.87$, $SD = 0.58$; Hostile: $M = 0.87$, $SD = 0.64$), and neither did the control group (Instrumental: $M = 0.90$, $SD = 0.60$; Hostile: $M = 1.04$, $SD = 0.65$). However, affect did not differ between the

![FIGURE 2](https://example.com/figure2.png)
groups in either the instrumental condition or in the hostile condition. Chi-square analyses to examine rates of anger across trials were not significant; none of the groups maintained anger across all of the dissipation trials.

**DISCUSSION**

The goals of the current study were to examine subtypes of aggressive behavior in children with and without ADHD and to examine the effects of MPH on aggression. It was hypothesized that children with ADHD who received a placebo would show higher levels of aggression than children without ADHD, whereas children with ADHD who received MPH would not. Results showed partial support for this hypothesis, as discussed next.

**Proactive Aggression**

Proactive aggression was measured by examining the child’s behavior and affect during the first five trials of the task (i.e., before they had received either high or low provocation from their “opponent”). Consistent with our hypothesis, results indicated that the ADHD-placebo group had marginally higher levels of proactive aggression than the control group, whereas the ADHD-med group did not. Results also showed that children with ADHD (regardless of medication status) were twice as likely as controls to begin the hostile aggression task with persistently high rates of proactive aggression. Of interest, these differences seem to result from the fact that the control group changed their behavior between the hostile and instrumental aggression conditions, whereas the children with ADHD did not (see Table 2). At the outset of the hostile aggression task, children in the control group were not as likely to be persistently highly aggressive as were children in the two ADHD groups. However, at the outset of the instrumental aggression task, all groups were equally likely to be aggressive. Because, by definition, aggression during the instrumental task helped the child win, these findings suggest that control children were aggressive when it helped them to achieve a goal even in the absence of provocation, whereas children with ADHD were aggressive regardless of whether it helped them achieve a goal (i.e., winning the game). It is also interesting to note that these differences emerged despite the fact that children did not differ on self-reported affect; all groups rated themselves as nonangry. This is consistent with the conceptualization of proactive aggression as nonangry and nonimpulsive. Overall, these results generally support the hypothesis that children in the ADHD-placebo group would show higher rates of proactive aggression than controls but show mixed support for the hypothesis that ADHD-med would not differ from controls.

**Reactive Aggression**

Reactive aggression was measured by examining children’s affect and behavior immediately following low and high levels of provocation. Results indicated that all children, regardless of diagnosis and medication condition, exhibited more reactive aggressive behavior and more anger in response to high provocation than to low provocation. This finding suggests that the manipulation was effective and consistent with previous research suggesting that it is developmentally appropriate for children to react in angry, aggressive ways when they are the target of high levels of provocation (Coie & Benenson, as cited in Coie, Dodge, & Kupersmidt, 1990; Waschbusch et al., 2002).

More central to the study was the finding that children with ADHD on placebo had higher levels of reactive aggression than did controls, whereas the children with ADHD on medication did not differ from controls. In addition, children with ADHD on placebo rated themselves as somewhat angrier than children with ADHD on medication following high provocation in the instrumental condition. These results are consistent with our hypothesis that children with ADHD would be more aggressive than controls but that this would be ameliorated by medication. MPH is known to increase inhibition and decrease many behavioral symptoms of ADHD (Greenhill & Ford, 2002; Swanson et al., 1995; Wigal et al., 1999). Therefore, it is possible that children in the medication group were able to inhibit their impulses to react aggressively to provocation.

Whereas overall rates of reactive aggression did not differ as a function of subtype of aggression, rates of persistently high levels of reactive aggression did, as did rates of persistent anger in response to provocation. Specifically, results showed that children with ADHD in the placebo group had higher rates of persistently high reactive aggression on the hostile aggressive task but not on the instrumental aggressive task and had significantly higher persistent anger following high provocation on the instrumental aggressive task (see Table 3). In contrast, the ADHD-med group had significantly lower rates of persistent anger following high provocation on the hostile aggression trials (see Table 3). Taken together, these findings suggest a number of interesting patterns. First, children with ADHD appear to be more likely to use high levels of aggression indiscriminately (in both instrumental and hostile conditions), whereas control children used aggression only when there was a specific instrumental reason to do so (i.e., to win the game). However, administration of MPH seemed to improve the ability of children with ADHD to use aggression...
selectively rather than indiscriminately. Second, reducing anger may be one key impact of MPH. Following high provocation, children in the ADHD-placebo group exhibited higher levels and more persistent anger in the instrumental task than did controls. In contrast, children in the ADHD-medication group had lower rates of persistently high anger than controls following high provocation in the hostile task. Thus, self-reported anger in response to provocation seems to be a key difference between children with ADHD on and off medication. These results are consistent with other research indicating differences in anger between children with ADHD and controls in response to provocation (Hinshaw, Buhrmester, & Heller, 1989; Hinshaw, Henker, & Whalen, 1984a, 1984b; Waschbusch et al., 2002).

Dissipation of Aggression

Dissipation of aggression (i.e., reduction in aggression over time) was measured by examining behavior and affect on the last six consecutive win trials following a high-provocation loss. All children showed higher aggression and anger immediately following high provocation (as compared to subsequent trials) in both the instrumental and hostile tasks, but behavior and affect after that differed by group (see Figure 2). On behavioral measures, children with ADHD who were administered MPH significantly decreased both hostile and instrumental aggression use as the high-provocation trial became more distal, whereas children with ADHD who were administered a placebo significantly decreased instrumental aggression but showed marginal change in hostile aggression. In contrast, children in the control group significantly decreased hostile aggression but showed no change in the instrumental condition as the high-provocation trial became more distal. These findings are consistent with previous studies showing that hostile aggression may be more pronounced in aggressive children with ADHD (Atkins & Stoff, 1993). Examination of affect during these same trials showed that children in the ADHD-placebo group were slightly more angry/less happy following high instrumental aggression than follow high hostile aggression, whereas anger/happiness did not differ between the instrumental and hostile conditions for the ADHD-med or control groups. This difference should be interpreted in light of the fact that participants generally endorsed low levels of anger; the average scores for the groups were about 1, indicating that groups tended to chose happy faces to describe their mood. Overall, these findings again suggest that control children were more discriminating in their aggression use than were children in the placebo group. Specifically, controls decreased their aggression in the hostile condition (when aggression would not help them win) but not the instrumental condition (when aggression would help them win), whereas the reverse was true for ADHD children on placebo. Of interest, the fact that both ADHD groups exhibited decreased instrumental aggression over the last six trials of the game suggests that, unlike children in the control group, they may have been unable to develop an optimal strategy for playing and winning the game. In contrast, aggression use by children in the placebo group showed less decrease over time in the hostile condition, suggesting that these children may have continued to use aggressive behavior because they wanted to annoy the opponent as much as possible.

Limitations

Whereas the current study provides some promising results regarding the use of aggression subtypes in children with and without ADHD, some limitations should be noted. First, a between-subjects design was used rather than a more powerful within-subjects design because of potential carryover effects and the length of the task. Second, comorbid conduct problems were not taken into account when conducting this study, even though past research has shown that ADHD children with and without comorbid conduct problems may differ in important ways in response to provocation (Waschbusch et al., 2002). We elected to divide children based on presence of ADHD (rather than presence of conduct problems) because stimulant medication was the central focus of this study, and this form of treatment is typically used to treat ADHD rather than conduct problems. Ideally, we would have subdivided the ADHD-placebo and ADHD-medication groups into those with and without comorbid conduct problems, but the sample sizes precluded this approach and it was not possible to collect data on additional participants because of various time and financial constraints. Examining whether comorbid conduct problems play a role in determining response to MPH in children with ADHD is an important topic for future research, as is a more systematic investigation of sex differences in aggression use in children with ADHD.

Finally, treatment may have had an effect on the outcome of the current study. As noted previously, children with ADHD were part of a summer treatment program designed to deliver intensive behavioral treatment in the areas of peer relationships, social skills, and academic difficulties. Therefore, it is possible that this ongoing treatment impacted children’s responses to the aggression task. Indeed, research has shown that interventions using social skills training and social problem-solving skills may be effective in increasing social competence and decreasing antisocial behavior in aggressive and “hard-to-manage” children (e.g., Fraser et al., 2005; Nangle, Erdley, Carpenter, & Newman, 2002; van
Implications for Research, Policy, and Practice

Although the predictive and construct validity of aggression as measured by our task must be further investigated to determine whether it relates to aggression in naturalistic settings such as the playground or other peer interactions, the current study raises important questions about the nature of aggression in children with ADHD. The results make it clear that aggressive behavior in this group depends on many factors but also highlight the benefits of using MPH as part of a treatment program for children with ADHD. The results of the current study indicate that, in addition to providing benefits in classroom settings, MPH may also be useful in decreasing both aggression and anger in children with ADHD. However, further research is needed to investigate not only the types of aggression used by children with ADHD on and off medication but also their reasons for engaging in aggression. Separating antecedents and consequences in using aggression is an important step toward achieving this goal. Such research may lead to more targeted and effective interventions for children with ADHD, thus ensuring the most positive outcome possible for these children.

REFERENCES


