Difficulties in Comprehending Causal Relations Among Children With ADHD: The Role of Cognitive Engagement

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The present study examined whether time spent in long looks (i.e., ≥15 s), an index of cognitive engagement, would account for differences between children with attention deficit hyperactivity disorder (ADHD) and comparison children in understanding causal relations. Children viewed two televised stories, once in the presence of toys and once in their absence. Dependent variables were visual attention and questions tapping factual information and causal relations. Comparison children answered significantly more causal relations questions than did the children with ADHD, but only in the toys-present condition. Four lines of evidence revealed that the difficulties children with ADHD had in answering causal relations questions in the toys-present condition could be linked specifically to this group’s decreased time spent in long looks.

Children with attention deficit hyperactivity disorder (ADHD) are at risk for significant academic difficulties (Barkley, 1990). Although academic problems are well documented for these children, there is little information about specific ways in which children with ADHD may differ from comparison children in their comprehension and memory for complex, interconnected information such as that represented in stories (Lorch, Milich, & Sanchez, 1998). The examination of children’s comprehension of televised stories permits systematic investigation of the impact of variations in visual attention on story comprehension (Lorch & Sanchez, 1997).

Several studies examining attention to and comprehension of televised stories in comparison children and children with ADHD have produced consistent results (Landau, Lorch, & Milich, 1992; Lorch et al., 2000; Milich & Lorch, 1994). To manipulate visual attention, the researchers in these studies asked children to view one program with toys present in the room and the other program with no toys present. When no toys are present during viewing, children with ADHD and comparison children do not differ in their visual attention to the television, with both groups averaging above 90%. Both groups also show similar performance on factual questions testing memory for discrete events as well as on questions testing their understanding of causal relations. In contrast, when toys are present during viewing, a different pattern of results is obtained. Visual attention for both groups decreases significantly, but the decrease is significantly greater for the children with ADHD than for the comparison children. Despite the decreased visual attention when toys are present, the recall of discrete factual information for both groups is unaffected. For questions testing causal relations, however, children with ADHD show a significant decrease in their understanding, whereas the comparison children show no decrement in performance. In Lorch et al.’s (2000) Study 2, controlling for visual attention decreased group differences in comprehension of causal relations. Thus, group differences in visual attention at least partially account for difficulties of children with ADHD in comprehending causal relations when attention is divided.

Why might children with ADHD maintain their understanding of factual events but not causal relations when the presence of toys reduces their visual attention? To answer this question one needs to look more closely at differences in the patterns of attention between the comparison children and children with ADHD. One possibility is that children with ADHD shift visual attention more frequently, thus disrupting the continuity of their story processing. However, studies consistently have failed to find group differences in the number of looks at the television in the toys-present condition (Landau et al., 1992; Lorch et al., 2000; Milich & Lorch, 1994). A second possibility is that children with ADHD engage in shorter looks at the television during the toys-present condition, thus impeding their construction of a coherent story representation. Indeed, these same studies consistently found that the average length of looks at the television is significantly shorter for children with ADHD than for comparison children. The question thus becomes how the group differences in look lengths might account for the problems children with ADHD have in understanding causal relations. One viable explanation stems from evidence that
long looks at the television reflect greater cognitive engagement (Anderson, Choi, & Lorch, 1987).

**Look Lengths and Cognitive Engagement**

A link between look length and cognitive engagement is suggested by studies of a phenomenon known as *attentional inertia*. Attentional inertia is defined as an increasing probability of a look continuing, the longer the look already has been in progress (Anderson, Alwitt, Lorch, & Levin, 1979). That is, a look at the television is most likely to be terminated early in the look (within the first 3 s) with an increasing probability of the look being maintained until around 15 s, when the probability begins to level off (Anderson & Lorch, 1983). Research also suggests that long looks are indicative of increased cognitive engagement and deeper processing.

Perhaps the most direct evidence indicating that length of look is related to cognitive engagement comes from a study by Burns and Anderson (1993). Using adult participants, the investigators demonstrated that recognition memory was the highest for parts of television segments occurring during the later parts of long looks (looks ≥15 s). Conversely, recognition memory declined the longer a look away from the television continued. Building on the notion that long looks represent increased cognitive engagement, Hawkins, Tapper, Bruce, and Pingree (1995) hypothesized that such engagement may reflect both the processing demands of a televised story and the degree to which the viewer actively integrates story events as the program continues. In a study of adult participants, Hawkins et al. found that the longer a look was in progress, the longer it continued beyond a content boundary. Further, this effect was stronger the more the information prior to the content boundary needed to be linked to information following the content boundary. Hawkins et al. concluded that these long looks were not merely an automatic process but that their continuation across boundaries also was due to deeper processing of thematically connected material.

Two studies with child participants also offer support for the hypothesized relations between look length and cognitive engagement. In a study of 3- to 5-year-olds, Anderson et al. (1987) found that during long looks at a *Sesame Street* program children were both less likely and slower to turn toward a distractor, indicating more involvement with the program during these long looks. Similarly, Lorch and Castle (1997) found that 5-year-old children were slower to respond to a secondary auditory probe the longer a look at a *Sesame Street* program was in progress. However, this was not true when children viewed segments of the program that were edited to be low in comprehensibility. Lorch and Castle concluded that if children were able to comprehend content, deeper processing occurred as longer looks were maintained.

Thus, several studies suggest a relation between long looks and cognitive engagement in both children and adults. No studies, however, have compared differences in look length and comprehension between children with ADHD and their nonreferred counterparts. Previous studies using a television viewing paradigm have found that if toys are present, children with ADHD do not suffer in their understanding of factual information from the story but show a decrement in their understanding of causal relations (Lorch et al., 2000). One possible explanation for the difficulties children with ADHD have in understanding causal relations when their attention is divided is that these children spend less time engaged in long looks at the television. If long looks are indicative of increased cognitive engagement, these children would be less engaged with the material and thereby less able to make connections among events.

**The Present Study**

In the present study we used the television viewing methodology to test the hypothesis that time spent in long looks, but not short looks, accounts for differences between children with ADHD and comparison children in understanding causal relations when toys are present during viewing. This prediction is based on the findings that long looks are indicative of greater cognitive engagement (Anderson et al., 1987; Burns & Anderson, 1993). Assuming replication of visual attention and comprehension results from Lorch et al. (2000), we examined the distribution of look lengths of the two groups of children in the toys-present condition. We hypothesized that when toys are present the children with ADHD will spend less time engaged in long looks (≥15 s) than will comparison children. When this hypothesis was confirmed, three analytic approaches were used to test whether time spent in long looks accounts for group differences in the understanding of causal relations. Converging results from these three approaches offers compelling evidence that the problems children with ADHD have in comprehending causal relations are rooted in difficulties in sustaining cognitive engagement when attention is divided.

**Method**

**Participants**

A total of 135 children ranging from 7 to 11 years of age participated in the study. None of these children had participated in prior studies of television viewing by this research group. Three children (1 ADHD and 2 comparison) were excluded from the study because of a refusal to complete all tasks. The final numbers for the sample were 70 children diagnosed with ADHD (47 boys and 23 girls) and 64 comparison children (40 boys and 24 girls). As shown in Table 1, there were no significant group differences in gender, age, or ethnicity. The study was reviewed and approved by the university Institutional Review Board, and informed consent was obtained from the parents of all children. The session lasted approximately 2 hr and included measures additional to those reported here. Children were paid $10 for their participation.

Children with ADHD were referred from a university psychiatry clinic. This clinic diagnosis was made independent of the research study and merely generated the pool of eligible participants. The clinicians varied in the data they used to make the ADHD diagnosis and included some combination of parent interviews, parent and teacher ratings, observation of the child, and psychological testing. Because of the variability in information used to make the initial clinic diagnosis, for this study an additional confirmation of diagnostic status was derived from a semistructured interview conducted with a parent, usually the mother. Advanced graduate students trained in this interview procedure conducted the interviews. The interview consisted of questions regarding the symptoms of ADHD taken verbatim from the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; DSM-IV; American Psychiatric Association, 1994). In the interview, parents indicated whether each diagnostic criterion was true of their child, and if so, they were asked to give behavioral examples. If a behavior was characteristic of the child, parents also indi-
cated if that behavior seemed inappropriate for the child’s age and whether it impaired the child’s functioning academically or socially. This interview procedure has been used successfully by this research group in previous studies, with interrater reliabilities for number of ADHD symptoms endorsed by the parent to be above 95% (e.g., Lorch et al., 1999). Any child referred as ADHD who did not meet criteria set forth in the DSM–IV was excluded. Children who exhibited only attentional problems were not included in the study because of mounting evidence of differences between the predominantly inattentive and combined groups along important classification dimensions (e.g., demographics, family history, symptom presentation, associated features, comorbid disorders) indicating that the inattentive group is a distinct disorder and not a subtype of ADHD (Barkley, 2001; Milich, Balentine, & Lynam, 2001).

Comparison children were recruited through an ad in the local newspaper and flyers distributed in the community. During a recruitment phone call for comparison children, parents were asked if the child had ever been referred for any behavioral or learning problems. Thus, comparison children were not required to be symptom free, but as Table 1 indicates, as a group they averaged less than one symptom in each of the three symptom categories.

Both groups of children were assessed further by having a parent complete the Child Behavior Checklist (Achenbach, 1991), from which summary scores reflecting internalizing and externalizing problems were created. In addition, all children completed the Block Design and Vocabulary subtests of the Wechsler Intelligence Scale for Children—III (WISC–III; Wechsler, 1991), from which a prorated IQ score was computed. Children in both groups were required to have a prorated IQ of at least 80.

Table 1
Demographic Information for Children With ADHD and Comparison Children

<table>
<thead>
<tr>
<th>Factor</th>
<th>ADHD (n = 70)</th>
<th>Comparison (n = 64)</th>
<th>t  (130)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>47 (67%)</td>
<td>40 (63%)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>23 (33%)</td>
<td>24 (37%)</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>64 (92%)</td>
<td>52 (81%)</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>6 (8%)</td>
<td>10 (16%)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0 (0%)</td>
<td>2 (3%)</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>9.44</td>
<td>9.53</td>
<td>1.52</td>
</tr>
<tr>
<td>Mother’s education (years)</td>
<td>14.70</td>
<td>16.00</td>
<td>2.70</td>
</tr>
<tr>
<td>Father’s education (years)</td>
<td>14.90</td>
<td>16.70</td>
<td>3.10</td>
</tr>
<tr>
<td>WISC–III prorated IQ</td>
<td>103.30</td>
<td>110.00</td>
<td>15.90</td>
</tr>
<tr>
<td>Woodcock–Johnson–R</td>
<td>103.20</td>
<td>113.90</td>
<td>15.30</td>
</tr>
<tr>
<td>DSM–IV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inattention</td>
<td>6.60</td>
<td>0.50</td>
<td>0.70</td>
</tr>
<tr>
<td>Impulsivity/hyperactivity</td>
<td>5.80</td>
<td>0.80</td>
<td>1.10</td>
</tr>
<tr>
<td>Oppositional</td>
<td>3.50</td>
<td>0.40</td>
<td>0.70</td>
</tr>
<tr>
<td>Child Behavior Checklist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internalizing</td>
<td>59.20</td>
<td>48.80</td>
<td>9.20</td>
</tr>
<tr>
<td>Externalizing</td>
<td>64.00</td>
<td>45.40</td>
<td>8.30</td>
</tr>
</tbody>
</table>

Note. WISC–III = Wechsler Intelligence Scale for Children—III.
*p < .05.  ** p < .01.  *** p < .001.

Consistent with the assignments to diagnostic groups, Table 1 shows that children with ADHD scored significantly higher than did the comparison children on scores of inattention, impulsivity/hyperactivity, and oppositional defiant symptomatology from the DSM–IV (1994) interview and scored higher on internalization and externalization scores on the Child Behavior Checklist. Of the children with ADHD, 38 (54%) met formal criteria for a diagnosis of oppositional defiant disorder. The parents of the children with ADHD had significantly fewer years of education than did the parents of the comparison children. In addition, children with ADHD scored significantly lower on the prorated IQ and reading achievement scores.

Children in the ADHD group were medication free on the day of the study. Parents were reminded in a phone call the day before testing to discontinue medication for the following day. A reconfirmation of the suspension of the drug was obtained on test day. If parents indicated that the child took medication the morning of testing, the child did not participate in the study that day but instead was rescheduled.

Materials
Two episodes of the situation comedy Growing Pains were used in the current study. A detailed script was made for each of the episodes. The scripts were used to parse the stories into individual idea units. Using the procedures defined by Trabasso and van den Broek (1985) for causal network analysis, we coded each individual unit as on or off the causal chain and identified the causal connections for each unit. The units also were rated by undergraduates for importance to the story on a scale ranging from 1 (very unimportant) to 7 (very important). Mean importance ratings were then computed for each idea unit.

On the basis of the causal network analyses and the importance ratings, 30 cued-recall questions were written for each episode. Three types of questions were generated: factual questions testing information of high importance (five questions), factual questions testing information of low correlations with overall IQ and reading achievement scores (Sattler, 2001).
importance (five questions), and questions testing for understanding of causal relations (20 questions).

Procedure

The study was divided into two sessions approximately 2 to 7 days apart. In Session 1 the child participated in the television and recall tasks, whereas in Session 2 the child completed the tests of achievement and intelligence. In Session 1 the child was shown the two episodes of Growing Pains, once with toys present and once with toys absent. The order of presentation of the episodes and the viewing conditions was counterbalanced.

Before each program, each child was seated at a table. For the toys-absent condition, there was nothing on the table. For the toys-present condition, the toys were placed on the table in a standard arrangement. The toys on the table included a hand-held video game, a radio-controlled car, some action figures, a spaceship, and a small basketball. In addition, a child-sized basketball goal was against the wall to the child’s left. The TV/VCR was placed on a cart at a height of 48 in. (121.92 cm), and the cart was located at a 45° angle from the table. The camera was mounted in a corner on the opposite side of the room from the television. This arrangement ensured that children had to make a distinct head movement to view the program and that the direction of their gaze was apparent on the videotaped record.

Each child was given the following instructions: “There will be a TV program coming on in a minute for you to watch.” (For the toys-present condition: “There are some toys here, too, and you can play with them if you want while the TV program is on.”) “When I come back into the room, I’ll ask you some questions about what you saw on TV.” The examiner then turned on the TV/VCR and, before leaving the room, said, “Remember, I’ll ask you some questions about what you saw when the program is over.”

While the television program was shown, each child was videotaped. An observer viewing a monitor in a control room coded visual attention to the television. The observer began the computer program simultaneously with a signal preceding the program. This served to synchronize the computer program with the television program. The observer then pressed one key each time the child looked at the television and another key each time he or she looked away. This method produced a continuous record of onsets and offsets of visual attention relative to the television program.

Following each program, the examiner entered the room, removed the toys from the table (in the toys-present condition), presented a still picture of the characters, and reminded the child of the characters’ names. Cued recall testing followed, in which questions followed the order of presentation of information in the TV program. All testing sessions were videotaped and audietape for later scoring.

The dependent variables included measures of visual attention and comprehension. The measures of attention consisted of percent visual attention to the program, number of looks at the program, as well as the time spent engaged in long looks (≥15 s) and short looks (<15 s). The two measures of comprehension were percentage correct on questions testing for understanding of causal relations (why questions) and percentage correct on questions testing comprehension of causal relations (what questions).

Results

Visual Attention

Percentage of visual attention for the participants was analyzed using an analysis of covariance (ANCOVA), with percentage of attention as the dependent variable, IQ as the covariate, group and sex as between-participants factors, and viewing condition (toys present or toys absent) as the within-participants factor. The ANCOVA yielded main effects for group, \( F(1, 129) = 9.74, p < .01 \), effect size \( r = .26 \), as well as a Group \( \times \) Viewing Condition interaction, \( F(1, 129) = 4.5, p < .05, r = .18 \). In the toys-absent condition, groups did not differ in percentage of visual attention, \( r(132) = 1.02, p > .10 \), but in the presence of toys, percentage of visual attention declined more for children with ADHD than for the comparison children, \( r(132) = 3.2, p < .01, r = .28 \) (see Figure 1). There were no other significant effects or interactions involving group.

A second analysis was conducted with number of looks at the program as the dependent variable. There was not a significant main effect for group, \( F(1, 129) = 3.2, p > .05 \), and no significant interactions involving group.

Because the relation between look length and the children’s understanding of the story is a major focus of the present article, separate \( t \) tests were conducted to compare the time spent by ADHD and comparison children in looks greater than or equal to 15 s and in looks less than 15 s in the toys-present condition only. This analysis was restricted to the toys-present condition because both groups showed ceiling effects for visual attention in the toys-absent condition. The analysis revealed that comparison children spent more time in longer looks (≥15 s; \( M = 715.3 \) s, \( SD = 452.9 \) s) than did children with ADHD (\( M = 442.4 \) s, \( SD = 378.8 \) s), \( t(127) = 3.8, p < .01, r = .32 \), whereas the reverse was true for shorter looks. Children with ADHD spent more time in shorter looks (<15 s; \( M = 188.1 \) s, \( SD = 108.1 \) s) than did comparison children (\( M = 135.8 \) s, \( SD = 117.1 \) s), \( t(129) = 2.6, p < .01, r = .22 \).  

Cued Recall Performance

An ANCOVA was conducted with percentage correct on the factual questions as the dependent variable, IQ as the covariate, group and sex as between-participants factors, and viewing condition and question importance (high or low) as within-participants factors. The analysis revealed no significant main effect for group, \( F(1, 128) = 3.1, p > .05 \), nor any interactions involving group.

A second ANCOVA was conducted with percentage correct on causal relations questions as the dependent variable, IQ as the covariate, group and sex as between-participants factors, and viewing condition as the within-participants factor. This analysis yielded no main effect for group but did reveal a significant Viewing Condition \( \times \) Group interaction, \( F(1, 128) = 7.2, p < .01, r = .23 \). There was no significant group difference in performance for the toys-absent condition, \( t(131) = 1.8, p > .10 \), but the comparison children performed significantly better on the causal relations questions in the toys-present condition, \( t(131) = 3.2, p < .01, r = .27 \) (see Figure 2).

These causal relations questions consisted of two types of questions; for the first type, the answers were stated explicitly in the story (10 questions). The second type of questions designed to test the child’s understanding of causality were inferential (10 questions). The answers to these questions were not stated explicitly in the story, and therefore the child had to use background knowledge as well as information in the story to infer the correct answer. Because the type of causal relations questions never interacted with group status for any of the analyses, we do not report the results regarding the type of causal relations questions.
Having replicated the pattern of results for comprehension of causal relations questions from Lorch et al. (2000), in the next set of analyses we focused on the primary purpose of the present study, which was to test the hypothesis that differences in cognitive engagement accounted for group differences in comprehension in the toys-present condition. This set of analyses included three different analytic strategies that focused on how patterns of attention in the toys-present condition relate to comprehension. First, we tested whether time spent in long looks, but not time spent in short looks, significantly mediated group differences in comprehension. The second set of analyses compared the groups in their distributions of long looks, short looks, and looks away during presentation of information necessary to answer causal relations questions. The third set of analyses compared the groups’ performance on the causal relations questions for long looks, short looks, and looks away during the relevant information. Converging findings from all three analyses offer compelling support for the hypothesis that greater cognitive engagement enables the comparison children to form a more coherent representation of the relations among story events, thereby accounting for group differences when toys are present.

The first set of analyses tested whether time spent in long looks, but not time spent in short looks, significantly mediated group differences in comprehension of causal relations. Adopting procedures recommended by MacKinnon, Lockwood, Hoffman, West, and Sheets (2002), we converted the regression coefficients into Z scores representing (a) the link between the independent variable and the mediator (Za) and (b) the link between the mediator and the dependent variable (Zb). The product of the two Z scores is computed and compared against the distribution of the product of two normal random variables, with the critical value of the distribution for p < .05 being ZaZb = 2.18. MacKinnon et al. presented data demonstrating that this approach is the most powerful method of testing for mediation. In testing the time spent in long looks as a mediator, Za = 3.70, Zb = 2.59, and ZaZb = 9.58, p < .05. In testing the time spent in short looks as a mediator, Za = −2.81, Zb = 0.27, and ZaZb = −0.76; ns. Thus, consistent with the cognitive engagement hypothesis, time spent in long looks significantly mediates the group difference in performance on causal relations questions, whereas time spent in short looks does not.

The second set of analyses was undertaken to examine further the relation between look lengths and comprehension of causal relations. To accomplish this, we analyzed detailed scripts of the two programs to determine during which story units information necessary to answer each causal relation question was presented. For each causal relation question, each participant was coded as engaged in a long look, a short look, or a look away during viewing of no toys or toys.
presentation of the relevant information. These analyses compared the groups in their distributions of the three types of looks when the information necessary to answer the causal relations questions was presented. Comparison children were engaged in long looks during information relevant to causal relations questions for significantly more questions ($M = 11, SD = 7.1$) than were children with ADHD ($M = 7.2, SD = 6.3$), $t(130) = 3.3, p < .01, r = .28$. In contrast, children with ADHD were looking away during information relevant to causal relations questions for significantly more questions ($M = 7.2, SD = 4.8$) than were comparison children ($M = 4.6, SD = 4.9$), $t(130) = 3.1, p < .01, r = .26$. For short looks, the difference between the comparison children ($M = 4.4, SD = 3.7$) and the children with ADHD ($M = 5.6, SD = 3.4$) did not reach significance, $t(130) = 1.9, p > .05$.

The third set of analyses compared the groups’ performance on the causal relations questions for long looks, short looks, and looks away when information needed to answer causal relations questions was presented. First, we compared the two groups’ performance on the causal relations questions when the participants were looking away during the relevant information. The children with ADHD ($M = 42\%, SD = 26.7$) and the comparison children ($M = 48\%, SD = 35.1$) performed comparably on these questions, $t(90) = 1.16, p > .10$. Next, we compared the groups’ performance on the causal relations questions in which the relevant information occurred when participants were engaged in short looks. The comparison group ($M = 64\%, SD = 35.6$) significantly outperformed the children with ADHD ($M = 48\%, SD = 29.7$), $t(92) = 2.7, p < .01, r = .27$ on these questions. Finally, we compared the groups when the participants were engaged in long looks during the information necessary to answer the causal relations questions. The children with ADHD ($M = 56\%, SD = 33.6$) and the comparison children ($M = 62\%, SD = 25.4$) did not differ significantly in performance on these questions, $t(93) = 1.22, p > .10$.

Discussion

The major goal of the present study was to examine whether group differences in cognitive engagement would account for the difficulties understanding causal relations observed in children with ADHD when attention to the television is decreased by a competing activity. Four pieces of evidence converge to support the conclusion that the difficulties the children with ADHD have in

\[ \text{Figure 2. Percent causal relations questions correct as a function of group status and viewing condition.} \]

ADHD = attention deficit hyperactivity disorder.
understanding causal relations in the toys-present condition are due to less sustained cognitive engagement. First, comparison children spent significantly more time engaged in long looks (≥15 s) than did children with ADHD, whereas children with ADHD spent more time in short looks (<15 s) at the television than did comparison children. Second, time spent in long looks significantly mediated the group difference in performance on causal relations questions. In contrast, time spent in short looks was not a significant mediator of this difference. Third, during the times when information needed to answer the causal relations questions was presented, comparison children were more likely to be engaged in long looks than were children with ADHD. Finally, when children with ADHD were engaged in long looks, their performance on causal relations questions was comparable to that of the comparison children.

Taken together, these four findings are consistent with the literature on attentional inertia and provide further support for the interpretation that long looks lead to deeper cognitive processing (Burns & Anderson, 1993; Hawkins et al., 1995). Of greater significance, these findings constitute the first evidence that the amount of time spent in deeper cognitive processing during long looks helps explain the differential patterns of comprehension in children with ADHD and comparison children reported here and by Lorch et al. (2000). That is, the similar performance on causal relations questions by the two groups of children when toys were absent can be explained by the fact that in this condition both groups engaged primarily in long looks. In contrast, the deficiency in understanding causal relations shown by children with ADHD in the toys-present condition is attributable to the fact that they spent significantly less time engaged in long looks than did comparison children. The most compelling support for this interpretation is that when toys were present, children with ADHD processed information more deeply during long looks, as shown by their impressive performance on causal relations questions testing information presented while they were engaged in long looks.

What is it about long looks that leads to a better understanding of causal relations? One possible explanation is that long looks are more likely than short looks to continue across content boundaries (Anderson & Lorch, 1983; Hawkins et al., 1995), thereby enabling the viewer to establish causal links among events relatively distant in time. Children with ADHD showed they are capable of enhancing their comprehension by engaging in deeper processing during long looks, as evidenced by their comparable understanding of causal relation information presented during long looks. However, because comparison children spent more time in long looks, they have the opportunity to link more distant events than do children with ADHD, thereby leading to a more complete understanding of the causal connections among story events.

A second explanation of the role of long looks in the comprehension of causal relations is that comparison children’s greater time in long looks means that these children engage in deeper processing of more story content, in turn enabling construction of more coherent story representations. Comparison children can then use these more coherent representations to guide further processing and thereby make causal connections even during short looks. In contrast, children with ADHD had difficulty making such connections during short looks. There are several possible mechanisms for how extended time in long looks could enhance comprehension of causal relation information presented during short looks. First, by developing a more coherent story representation, comparison children may more systematically monitor their ongoing understanding of the story than do children with ADHD, which enables the comparison children to use short looks to fill in missing information. Second, more coherent story representations among comparison children may provide a structure for connecting incoming information, even that obtained during short looks. Finally, more coherent story representations may allow comparison children to make inferences about the connections among events during cued recall testing, even if short looks did not allow for deeper processing at the time of viewing.

The present study provides intriguing evidence that children with ADHD are able to comprehend story information similarly to comparison children when the environment is free of external distractors, but their understanding of causal relations is impaired in the presence of salient distractors. However, the concept of a generalized distraction effect cannot entirely account for the performance of children with ADHD during the toys-present condition. First, they show no significant decrement in their performance on questions testing factual information. Second, even though distracted by the toys, children with ADHD do spend approximately one third of their time in long looks, and when these children are engaged in such looks, they do as well as comparison children in answering questions testing causal relations. Thus, although decreased comprehension may in part result from distraction, variations in cognitive engagement seem to provide a more complete explanation for the pattern of results presented here.

Limitations and Future Directions

The present results suggest that variations in cognitive engagement may account for the problems that children with ADHD have in understanding causal relations. However, cognitive engagement is an internal construct that cannot be measured directly. In the current study, we inferred the degree of cognitive engagement from time spent in long looks. There are other ways to operationalize cognitive engagement, and a better understanding of this construct can be gained from combining methodologies in a converging operations approach. For example, one method for measuring moment-to-moment variations in cognitive engagement is the secondary task procedure (Britton, Westbrook, & Holdredge, 1978). In this procedure, children’s reaction times to a secondary probe (e.g., an auditory tone) are measured while they are watching a television program. The assumption underlying this procedure is that slower reaction times reflect greater cognitive engagement with the televised material. Research with nonreferred children has indicated that levels of cognitive engagement, as measured by the secondary task procedure, vary with the comprehensibility of the material and the centrality of story content (Lemberger et al., 2004; Lorch & Castle, 1997; Meadowcroft & Reeves, 1989).

The results of the present study appear to have implications for understanding the academic problems experienced by children with ADHD. However, future research needs to test the generalizability of these findings to the classroom. The most direct connection between the present study and what is required in the classroom is our use of televised stories that contain a strong narrative structure. However, academic success in the classroom...
involves a number of additional skills, including reading, attending to and comprehending lectures, and working with texts that do not have narrative structure. Future research needs to use different presentation formats and variations in distractors to reflect more closely what children experience in school.

In closing, it is well established that children with ADHD are likely to have significant academic difficulties. Further, a great deal of research has identified the core deficits that underlie this disorder. However, little is known about the mechanisms by which these core deficits may contribute to the academic problems experienced by children with ADHD. The present study begins to address this problem by providing converging evidence that variations in cognitive engagement that accompany group differences in attention patterns lead to differences in story representation thereby contributing to the difficulties that children with ADHD have in understanding causal relations.

References

Received June 7, 2002
Revision received April 18, 2003
Accepted April 30, 2003