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The Effects of Thematic Importance on Story Recall among Children with Attention Deficit Hyperactivity Disorder and Comparison Children

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Abstract

This study examined the recall of televised stories for younger (4-6 years) and older (7-9 years) children with and without attention deficit hyperactivity disorder (ADHD) under two different viewing conditions (toys present/toys absent). Each child watched two *Rugrats* television programs, once with toys present and once with toys absent. Immediately after viewing a program, the child completed a free recall of the observed story. Comparison children's recall increased more than ADHD children's as importance level increased, and comparison children recalled more information overall than children with ADHD. When toys were present, children with ADHD retold less coherent stories than comparison children, as indexed by smaller correlations between the story units recalled and the order of these units in the story. In summary, children with ADHD demonstrated multiple difficulties in story comprehension. These findings add to our understanding of the differences in higher-order cognitive processing abilities between children with ADHD and comparison children, and suggest important areas of focus in designing more effective academic interventions for children with ADHD.

The Effects of Thematic Importance on Story Recall among Children with Attention Deficit Hyperactivity Disorder and Comparison Children

Attention deficit hyperactivity disorder (ADHD) is one of the most common behavior disorders in children, with prevalence estimates between 2 and 9.5 percent (Barkley, 1998). ADHD is characterized by developmentally inappropriate levels of inattention, impulsivity, and hyperactivity (*Diagnostic and Statistical Manual of Mental Disorders-4th ed.*, American Psychiatric Association, 1994). These deficiencies increase the likelihood that children with ADHD will experience academic problems. Children with ADHD are more likely to have had histories of learning disabilities, repeated grades, placement in special classes, and academic tutoring than comparison children (Faraone et al., 1993). This is of particular concern because in addition to stifling future success and opportunities, academic problems can lead to both social and emotional difficulties. Until recently, much of the research on cognitive difficulties in children with ADHD has focused on attention. Few studies have looked at higher-order components of cognitive processing, and the studies that have looked at higher-order components have focused primarily on aspects of executive functioning (Nigg, 2006). However, in order to better understand the academic problems faced by children with ADHD, more needs to be known about the differences between children with ADHD and comparison children in specific academic functions, such as the processing of complex stories or story comprehension.

Story comprehension is important early on in school performance for children. Effective story comprehension requires the usage of a number of different cognitive functions. These include selecting and focusing attention on important story information, retrieving relevant background information and generating inferences to allow an interpretation of the presented information, encoding important story information, and monitoring comprehension (Lorch,

Milich, & Sanchez, 1998). Therefore, in assessing higher-order cognitive abilities, it is useful to study story comprehension because it is relevant to school performance for children and it allows us to gain insight into many different aspects of children's cognitive functioning.

Early research on story comprehension in children with ADHD found few reliable group differences (O'Neill & Douglas, 1991; Zentall, 1988). However, because only global measures of recall were used in these studies, other aspects of recall that may be more indicative of story comprehension abilities were not addressed. One aspect that was not addressed was the effect of variations in importance among story events on recall. Thus, these early studies may indicate that children with ADHD are able to recall the same number of story events as comparison children, but they do not provide information about the types of story events that children recall and whether children with ADHD differ from comparison children in how their recall is influenced by factors such as the importance of story events.

Previous research among children without ADHD that has looked more closely at which story events children recall has identified several particular changes as important in understanding how story comprehension abilities develop. One developmental change that has been identified involves children's sensitivity to the thematic importance of individual story events. As children mature, they become better at distinguishing between story events that are more important to the overall theme of the story and events that are less important or extraneous to the overall theme (Brown & Smiley, 1977; Brown, Day, & Jones, 1983). Because sensitivity to thematic importance is a skill that develops with age and enhances story comprehension, it would be useful to include this component when evaluating story comprehension in children with ADHD.

Tannock, Purvis, and Schachar (1993) offered one of the first investigations to address

this issue by examining the recall of story events by children with ADHD as a function of the level of thematic importance. In this study, thirty boys with ADHD and 30 comparison boys (ages 7 to 11 years) listened to two audiotaped stories and retold the stories in their own words. Both stories had been previously rated by adults for the thematic importance of each story unit. Results indicated that boys with ADHD recalled fewer story events than comparison boys; but the groups did not differ in their sensitivity to the level of importance of the events.

Additionally, when the boys with ADHD retold the stories, they included more ambiguous referents and semantically inappropriate word substitutions, and gave more incorrect or misinterpreted information than the comparison children. In a comparable study, Purvis and Tannock (1997) obtained similar findings; however, the statistical power of group comparisons was limited by a small sample size.

In contrast to the results from Tannock et al. (1993) and Purvis and Tannock (1997), two more recent studies, using the same stimulus materials, did find group differences in the impact of thematic importance on recall. Lorch, Diener et al. (1999) examined recall as a function of both perceived importance and two story structure variables (the number of causal connections a story event has to other events and whether an event is on the causal chain linking events from the beginning to the end of the story) not included in the two previous studies. Seventy-four children with ADHD and 62 comparison children, ages 7 to 11 years, participated in this study. Comparison children showed significantly more sensitivity to the importance level and the number of causal connections in their recall than did children with ADHD, and they remembered more story units than children with ADHD. Lorch, O'Neil et al. (2004) replicated the results of Lorch, Diener et al. In this study, after the children completed a free recall of the audio taped story, they were allowed to study a written version of the story for up to ten minutes and then

completed a second free recall of the story. Group differences in sensitivity to the number of causal connections increased for story events newly added to recall after the studying period had been allowed.

The four studies discussed thus far differ in their findings with respect to group differences in children's sensitivity to thematic importance. Given that the four studies all used the same stimulus materials, it is not possible to reconcile these differences, except perhaps to attribute them to the greater statistical power in Lorch, Diener et al. (1999) or the inclusion of other potentially sensitive story structure variables in Lorch, O'Neil et al. (2004). One limitation common to all four studies is that they all share a single methodology. In fact, most research on story comprehension has used methods in which stories are presented either orally or through pictures/writing. These methods are useful, but they make it difficult to study story comprehension in preschool age children due to the requirement of reading skills or the difficulties involved in processing linguistic information. Lorch and Sanchez (1997) discuss several advantages of using a television viewing methodology to study story comprehension. Most germane to the present study is that this methodology does not require reading skills and so is appropriate for children who are younger or have poor reading skills. In addition, the television methodology allows for attention to be linked with story comprehension, which is beneficial when studying children with ADHD.

A study by Lorch, Sanchez et al. (1999) demonstrates the usefulness of the television viewing methodology. In this study, four- to six-year-old children with and without ADHD watched a televised program (*Sesame Street*). For half of the children toys were present during the program, and for the other half toys were absent. This study examined whether children's free recall of story events was predicted by several story structure properties (number of causal

connections, whether an event is on or off the story's causal chain, story-grammar category, and position in the story's hierarchical structure). Both groups of children attended significantly less to the program when toys were present than in their absence, but this effect was larger for children with ADHD. Additionally, both groups of children were sensitive to the causal structure of stories; however, when attention was reduced by the presence of distracter stimuli, the children with ADHD were less sensitive to the causal properties of stories. Although this study investigated sensitivity to causal properties and not thematic importance, these two variables are conceptually and empirically related (Trabasso & Sperry, 1985; Trabasso & van den Broek, 1985). Thus, if group differences are found in sensitivity to causal properties, then it is likely that group differences would also be found in sensitivity to thematic importance.

Lorch, Sanchez et al. (1999), Lorch, Diener et al. (1999), and Lorch, O'Neil et al. (2004) suggest that both younger and older children with ADHD may be less sensitive than comparison children to the thematic importance of story events. However, conclusions about developmental changes cannot be made because these studies examined two different age groups of children using two different methodologies and two different sets of stimulus materials. Further, only one of the studies examined the role that attention may play in accounting for the impact of thematic importance on recall, a significant issue when studying the story recall of children with ADHD. Thus, one purpose of the present research is to build on previous findings by examining the story recall of two different age groups of children (4-6 and 7-9 years of age) with and without ADHD by analyzing the amount of information recalled as a function of the level of thematic importance. This study expands on previous research by looking at the story recall of two different age groups of children in the same study using the same stimulus material and methodology (i.e., television viewing). In addition, the current study used more demanding and

complex stories to examine the degree to which previous findings generalize across a wider range of story representations. Another purpose of this study was to assess differences in story recall of children with and without ADHD under two different viewing conditions (toys present/toys absent) to manipulate the visual attention of the children. This methodology has been shown to be an effective way to manipulate attention in previous studies (see for example Lorch, Eastham et al., 2004).

A third purpose of this study, unique to the present investigation, was to examine the coherence of the children's recalled stories. Adopting the procedure used by Lorch, Lorch, and Inman (1993), the sequence of each child's recall of the story events was correlated with the actual sequence of the events as they occurred in the story. Differences in the coherence of the stories recalled by children with and without ADHD have not been evaluated in the past, and thus determining whether discrepancies exist in this area would further add to our understanding of the story recall difficulties of children with ADHD. If children with ADHD produce less coherent recall protocols than comparison children, then this may indicate that they are not creating an accurate representation of the story in memory and are not consistently linking early story events with future outcomes in the story in a meaningful fashion. Thus, they may in fact be able to remember as many events as their peers, but not be able to remember the actual sequence of story events because they do not understand or remember the cause/effect relations between events, and instead recall the story as a collection of relatively isolated events.

Method

Participants

An initial sample of 99 children with ADHD and 132 comparison children participated in this study. The data for 31 children were excluded because of the following reasons: a low IQ (5

ADHD and 1 comparison); having a number of ADHD symptoms (6 ADHD and 13 comparison) or Oppositional Defiant Disorder (ODD) symptoms (1 comparison) that were inconsistent with group placement; having a diagnosis of a speech problem or epilepsy (2 ADHD and 1 comparison); or taking a prescription medication that could not be discontinued for the testing session (1 ADHD and 1 comparison). Two comparison children and two children with ADHD were dropped from the study because of missing parent interviews, and two comparison children refused to complete the experimental procedure. Additionally, data for three children with ADHD could not be included due to experimental malfunctions. The final sample consisted of 80 children with ADHD (19 females and 61 males) and 111 comparison children (43 females and 68 males). Approximately half of the children in each diagnostic group were 4 to 6 years of age ($n = 78$; $M = 5.72$ years; $SD = .79$ years), and half were 7 to 9 years of age ($n = 113$; $M = 8.46$ years; $SD = .94$ years). Approximately 85% of the children were Caucasian, 10% were African American, and 5% were from other groups. Demographic characteristics for each group of children can be found in Table 1. The groups did not differ in terms of age, but did differ in mean education level of mothers.

The children with ADHD were recruited from the Hyperactive Children's Clinic in the School of Medicine at the University of Kentucky. To ensure that children in the ADHD group had appropriate symptomatology for a diagnosis of ADHD and were relatively free of confounding factors, a three-step diagnostic process was implemented in this study. First, children only were considered as potential participants in the study if they had received a diagnosis of ADHD based on the *DSM-IV* criteria after a thorough assessment at the psychiatric clinic. This diagnosis was made by a team, including a child psychiatrist and another mental health professional. It was based on child and parent interviews, child observations, and other

measures (e.g. Conners' Parent and Teacher Rating Scales). Also, additional information was obtained when feasible from teachers, referring physicians, and/or psychological test results. Although children with ADHD were diagnosed by a convergence of evidence from multiple informants and multiple measures, the clinic did not employ a standardized set of assessment measures consistent with the systematic criteria necessary for research purposes. Therefore, the clinic diagnosis did not determine inclusion in the study but identified children with a clinic diagnosis of ADHD/Combined type.

In the second step of the diagnostic process, parents of identified children were contacted to request permission for the research team to review the children's files. If parents consented, the clinic files were examined in detail by one of the authors to determine if the child met eligibility criteria for the study. In doing this, additional information was obtained on factors like children's scores on ADHD rating scales, IQ, medications, additional diagnoses, or reasons for clinical referral. Children were not contacted for participation in this study (or their data were excluded from analysis as described earlier) if it was found that they had a low IQ (IQ score below 80); had a hearing impairment or other significant sensory impairment, epilepsy, or were diagnosed with a psychotic disorder; or were prescribed medication that could not be discontinued temporarily for the testing session (thus, psychostimulant medication was allowed). Children were not excluded from participation in this study based on the presence of comorbid psychological disorders. However, children with ADHD who had predominately inattentive symptoms and few impulsive/hyperactive symptoms were not contacted for participation in this study. This was due to increasing evidence of differences between the predominantly inattentive and combined / predominantly hyperactive subtypes along important classification dimensions (e.g., demographics, family history, symptom presentation, associated features, comorbid

disorders), indicating that children who have problems solely in inattention may have a distinct disorder and not a subtype of ADHD (Barkley, 2001; Milich, Balentine, & Lynam, 2001).

If the above criteria were met, then the parent of the child with ADHD was contacted and invited to participate in this study. The third step of the diagnostic process was to collect standardized interview and behavior rating scale information to confirm the ADHD diagnosis. A semi-structured interview, similar to the Children's Interview for Psychiatric Syndromes - Parent Version (P-ChIPS; Weller, Weller, Rooney, & Fristad, 1999), but only consisting of verbatim *DSM-IV* criteria for ADHD and ODD, was conducted with the parent. In the interview, the parent was asked whether each diagnostic criterion was true of his/her child, and, if so, the parent was asked to give behavioral examples. If a behavioral symptom was deemed to be characteristic of the child, the parent was additionally asked whether that behavior seemed inappropriate for the child's age and whether it impaired the child's functioning academically and socially. A diagnostic criterion was only considered to be endorsed, if the parent indicated the behavior was age inappropriate and impairing. This interview procedure has been used successfully by this research group in previous studies, with interrater reliabilities for the number of ADHD symptoms endorsed by the parent to be above 95% (e.g., Lorch, Sanchez et al., 1999). The data for children whose parental interviews supported an ADHD diagnosis were retained for analysis in this study.

The comparison group of children without ADHD was recruited through an advertisement in a local newspaper. They were screened before participation, during a recruitment phone call, by asking parents if their child had ever been referred for any behavioral or learning problems, ensuring that comparison children had no history of referrals for behavioral or learning problems. Data for comparison children who met criteria for three or more

symptoms of inattention, hyperactivity/impulsivity, or oppositional defiant disorder on the parent interview of *DSM-IV* symptomatology were excluded from the study. Thus, the comparison children were not required to be symptom free, but were significantly less symptomatic (see Table 1) than children with ADHD in terms of the *DSM-IV* criteria for inattentive symptoms ($M = .14$, $SD = .44$, and $M = 5.99$, $SD = 2.26$, respectively); hyperactive-impulsive symptoms ($M = .18$, $SD = .47$, and $M = 6.01$, $SD = 1.98$, respectively); and oppositional defiant disorder symptoms ($M = .28$, $SD = .73$, and $M = 3.48$, $SD = 2.35$, respectively). Both groups of children were further assessed by having a parent complete the Child Behavior Checklist (Achenbach, 1991), and comparison children scored significantly lower than children with ADHD on the Attention Problems scale of this measure. Additionally, because this study was part of a larger longitudinal study, children's scores from the Conners' Parent Rating Scales (CPRS-R:S) (Conners, 1997) were available from a session conducted on average 18 months later. Due to drop out between the two time periods, Conners' scores were only available for 57 of the children with ADHD and 92 of the comparison children. Comparison children scored significantly lower than children with ADHD on all of the scales in this measure, confirming the stability of the diagnostic categories.

In addition to the above measures, all children completed the Vocabulary subtest of the *Wechsler Preschool and Primary Scale of Intelligence-III* (*WPPSI-III*; Wechsler, 2002) or *Wechsler Intelligence Scale for Children-III* (*WISC-III*; Wechsler, 1991), as appropriate for their age, to provide an estimate of intelligence. Comparison children had significantly greater scaled scores on the Vocabulary subtest than children with ADHD.

For those children with ADHD who were prescribed psychostimulant medication ($n = 60$), they did not receive any psychostimulant medication on the day of the study. This provided

an acceptable period of time (around 24 hours) to occur for the drug to be passed out of the children's system (length of drug effect between 3-7 hours; see for example Greenhill, 2001 or Pelham et al., 1999). All children received two small toys and \$15.00 for their participation in this phase of the study.

Materials

The principal materials in this study consisted of two *Rugrats* cartoons from a pool of six possible episodes. All of the cartoons had conventional story structures. In each cartoon, a problem arose, and then the story centered on the protagonist's attempts to solve the problem. The stories for these cartoons were parsed into idea units, where each unit expressed a single event. Importance ratings were collected for each story unit by having college students ($n = 193$) rate the units (1 = not important to the overall meaning of the story; 7 = extremely important to the overall meaning of the story) after viewing the televised program. These importance ratings were collected so that the children's recall protocols could be examined to determine if they were recalling information that adult raters, or those skilled at story comprehension, had indicated was central to the overall meaning of the story. College students watched two televised programs each and received class credit for their participation.

Procedure

Upon arrival to the testing session, which took place in a home-like university laboratory, the child first spent about five minutes getting to know the experimenter. A graduate student explained the study to the parent during this time and obtained consent. After this, the child was taken to the testing room by the experimenter. The child sat at a small table facing a television. Toys were either present or absent, depending on the appropriate toy condition. In the toys-present condition, several age-appropriate toys were positioned on a table in front of the child.

The child was told that a television program was coming on for them to watch, and that he/she would be asked about what he/she saw when the program was over. Additionally, if toys were present, the child was told that he/she could play with the toys during the program. The experimenter reminded the child that he/she would be asked questions when the program was over before leaving the room. The experimenter started the television program (one of the six *Rugrats* videos) and then left the room. While the child watched the television program, the experimenter observed the child, who was being videotaped, in a separate room. When the television program finished, the experimenter re-entered the testing room and had the child complete a free recall of the observed story. The free recall was audiotaped and cued by a picture of the story characters. After this, the child completed a cued recall, which consisted of answering 35-38 factual and causal relations questions about what they saw. The cued recall data do not directly measure the child's construction of a coherent story representation, and thus are reported in a separate paper that examines developmental changes in relations between attention and cued recall (Bailey, 2006). Following the free and cued recall, the child was given a short break. During the break, the appropriate toy condition for viewing the next television program was set up, and then the procedure described above was repeated. The order of the television programs and the toy conditions was counterbalanced, where each child watched a program once with toys present and a different program with toys absent. While the child completed the testing session, the parent filled out several forms and completed the *DSM-IV* interview with a graduate student.

Each child was also videotaped during the entire session, so that the experimenter could later code visual attention to the television by recording looks toward and away from the television. The following measures of attention were used as covariates in this study: the

percentage of time spent attending to the *Rugrats* program for both viewing conditions and the total amount of time (in seconds) spent in looks at the *Rugrats* program that were longer than 15 seconds for both viewing conditions (see Table 2). The measure of the amount of time spent in looks longer than 15 seconds was included, because previous research suggests that long looks are an indicator of greater cognitive engagement (see Lorch, Eastham et al., 2004).

Each child's free recall protocol was transcribed verbatim. The protocols were then analyzed into units of information corresponding to main clauses. These units were compared with the idea units from the original scripts, and a score of 0/1 (not recalled/recalled) was assigned for each unit. The child was not required to recall the unit verbatim, just to capture the gist of the unit. To estimate interrater reliability for coding, a subset of the protocols was scored twice, producing a kappa value of .76.

Results

Effects of importance on recall

The initial focus of data analysis concerned the degree to which importance ratings predicted recall as a function of group status. General linear model regression analyses were conducted following the procedures recommended by Lorch and Myers (1990) for unbiased tests of repeated measures variables in regression analyses. As stipulated by Lorch and Myers, appropriate error terms for these analyses consist of the respective Participant x Linear Factor effects, rather than the often used pooled residual error term. In the first analysis, the between-participant variables consisted of age group (younger vs. older) and referral status (ADHD vs. comparison), and the within-participant variables consisted of viewing condition (toys vs. no toys) and importance level. "Importance level" was determined by first calculating the mean importance rating for each story event (from college students' ratings), and then constructing

four levels of importance based on the quartiles of the ratings for each *Rugrats* program. This ensured that the importance level variable was standardized for the different *Rugrats* programs.

Comparison children ($M = 19\%$) and older children ($M = 21\%$) recalled a significantly greater percentage of story units than children with ADHD ($M = 11\%$), $F(1, 187) = 44.63, p < .01, d$ (effect size) = .98, and younger children ($M = 8\%$), $F(1, 187) = 125.12, p < .01, d = 1.62$, respectively. These findings were qualified by a significant age group x referral status interaction, $F(1, 187) = 13.40, p < .01, d = .54$. Differences between the comparison children and the children with ADHD were more pronounced for older children ($M_s = 25\%$ and 14% respectively; $F(1, 110) = 43.11, p < .01, d = .1.25$) than for younger children ($M_s = 9\%$ and 6% respectively; $F(1, 77) = 3.90, p < .10, d = .45$).

Although all children's recall increased as the importance level increased ($M_s = 9\%$, 12% , 15% , and 26% , respectively), $F(1, 187) = 479.31, p < .01, d = 3.23$, this finding was qualified by a significant importance level x referral status interaction, $F(1, 187) = 13.80, p < .01, d = .54$. Comparison children's recall increased more than the recall of children with ADHD as importance level increased (see Figure 1), as shown by the significant interaction of group and the linear component of importance level, $F(1, 187) = 11.50, p < .01, d = .49$. Thus, children with ADHD show some sensitivity to the importance of the information they recall, but they do not show the same degree of sensitivity as do comparison children. This finding was further supported by analyses of paired comparisons of importance levels across groups. Comparison children showed a significantly larger importance effect than children with ADHD in each paired comparison, F 's ranging from 5.08 to 11.89, with the exception of the difference between levels 1 and 2 and levels 2 and 3, $F(1, 189) = 2.74$ and 1.22 , respectively, p 's $> .10$. A significant importance level x age group interaction, $F(1, 187) = 38.44, p < .01, d = .90$, indicated that older

children's recall increased more than younger children's recall as importance level increased (see Figure 2), $F(1,187) = 33.99, p < .01, d = .85$. Although children recalled slightly more information in the toys-absent condition ($M = 16\%$) than in the toys-present condition ($M = 14\%$), $F(1, 187) = 8.87, p < .01, d = .43$, no significant group or age interactions with viewing condition were obtained.¹

The analyses conducted thus far were repeated with the scores dropped for the children who did not recall any information (23 ADHD, 12 comparison dropped; $n_s = 57$ ADHD and 99 comparison retained) to determine if including these children in the analyses altered the above results. Findings did not differ from the above results indicating that the analyses were not affected by including these children. Additionally, follow-up analyses considered the following variables as covariates: intelligence, gender, ethnicity, years of completed education for the mother, the percentage of time spent attending to the *Rugrats* program for both viewing conditions, and the total amount of time spent in looks at the *Rugrats* program that are greater than fifteen seconds for both of the viewing conditions. The only variables that were found to be significant covariates were intelligence, percentage of time attending for both viewing conditions, and the total amount of time spent in long looks for the toys condition. Findings did not differ when these variables were included in the analyses, indicating that the importance level x referral status interaction results cannot be attributed to these covariates.

Story Coherence

The second focus of data analysis concerned group differences in the coherence of the stories children recalled. First, the order of units as stated in each child's recall was correlated with the correct order sequence, with the individual child's correlation serving as the dependent variable in the analyses of variance (Myers & Well, 1991). This measure is similar to indices of

concordance used in previous studies of the coherence of children's story recall (Oakhill & Cain, in press; Stein & Glenn, 1982). Data were dropped for these analyses for children whose total recall was less than three story units. Separate analyses of variance were then conducted for each viewing condition because there were different numbers of children left in the two viewing conditions. For each analysis, there were two between-participant factors, referral status and age group.

For the toys-present viewing condition, results showed that children with ADHD ($M = .69$) had significantly smaller correlations between the story units they recalled and the correct sequence than comparison children ($M = .79$), $F(1, 159) = 4.72, p < .05, d = .35$. Additionally, younger children ($M = .63$) had significantly smaller correlations than older children ($M = .85$), $F(1, 159) = 20.84, p < .01, d = .72$. There was no significant referral status x age group interaction, $F(1, 159) = 1.55, p > .10$.

For the toys-absent viewing condition, results showed that older children ($M = .83$) had significantly greater correlations than younger children ($M = .51$), $F(1, 170) = 22.34, p < .01, d = .72$. There was no main effect of referral status ($M = .65$ for children with ADHD and $M = .69$ for comparison children), $F(1, 170) = .36, p > .10$, or referral status x age group interaction, $F(1, 170) = .00, p > .10$, for the toys-absent viewing condition.

Discussion

The first purpose of this study was to assess group differences in story comprehension between two different age groups of children with and without ADHD by analyzing the free recall of televised stories as a function of thematic importance. Comparison children recalled more information from the stories than children with ADHD. More importantly, in addition to recalling less information than comparison children, children with ADHD were found to be less

sensitive to the importance of the information they recalled. Although their recall did increase as the importance of the material to the overall meaning of the story increased, the rate of increase was not as steep for the children with ADHD. These group differences were found regardless of the viewing condition (toys present or toys absent), which was used to manipulate the visual attention of the children. Furthermore, the group differences in story recall cannot be attributed to group differences in sustained attention (i.e. the total percentage of time spent attending to the televised program) or in cognitive engagement (i.e. the total amount of time spent in long looks at the televised program), because the results did not change when these variables were included as covariates in the analysis. This indicates that reduced attention does not explain why the children with ADHD were less sensitive to the importance of the information they recalled from televised stories.

The finding of group differences in recall as a function of importance is consistent with the findings of Lorch, Diener et al. (1999), Lorch, O'Neil et al. (2004), and Lorch, Sanchez et al. (1999), which collectively indicate that children with ADHD are less sensitive to the causal properties of stories than comparison children.² The reliability of these findings is noteworthy because the four studies span a wide age range (i.e., ages 4 to 12), different modalities of presentation (audio tape or video tape), and stories varying in content (i.e., folktales, *Sesame Street*, and *Rugrats*), length (ranging from 41 to 241 story units) and complexity (stories arranged around single or multiple goals). As discussed previously, decreased sensitivity to the causal properties of stories is linked with decreased sensitivity to thematic importance because story events that are judged more important also have more causal connections and are more likely to be on the causal chain.

There are several possible reasons why children with ADHD may be less sensitive to

thematic importance, and thus show poorer story recall, than comparison children. First, children with ADHD may have difficulty distinguishing between events that are unimportant and those that are important to the overall meaning of the story. When trying to comprehend and remember a story, it is useful to focus one's attention on encoding the more important story events, because everything cannot be remembered and these events account for the main points or gist of the story. Additionally, these events may be easier and less time consuming to encode than unimportant events, because they have a greater number of links or ties to other important story events. Thus, the connections among these events, which allow for a cohesive story representation to be constructed in memory, have already been provided by the story, and so additional cognitive resources do not have to be allocated to this task. Developmental research has documented links between increases in the ability to identify the information that is more important to the overall meaning of a story and the development of sensitivity to thematic importance in story recall (Brown & Smiley, 1977; Brown, Day, & Jones, 1983). Thus, if children with ADHD have difficulty identifying important story events, then they will be less able to direct their attention to encoding and then retrieving this information.

The ability to identify important information was not tested directly in this study. Although importance ratings were not collected from children for the *Rugrats* programs, the impact of importance on recall of other stories was assessed during another testing session of the larger project represented by the current study (see Lorch, Milich, Astrin, & Berthiaume, in press). After viewing a *Growing Pains* program, children divided story events into three groups (low, medium, and high) according to their importance to the overall meaning of the story. Children with ADHD made more gross errors (classifying events of high importance as low or events of low importance as high) than comparison children, indicating that children with ADHD

have difficulty identifying important information. Additionally, a group difference in recall of the *Growing Pains* program was eliminated when the number of gross errors was entered as a covariate. This finding provides some support for the idea that children with ADHD have poorer story recall due to difficulties with identifying and encoding important information.

A second reason why children with ADHD may be less sensitive to thematic importance is that they have difficulty encoding information from stories due to a limited working memory capacity. Several studies have found that children with ADHD have deficits in multiple components of working memory (e.g. Martinussen, Hayden, Hogg-Johnson, & Tannock, 2005). These deficits may be linked with difficulties encoding information from stories because they limit the amount of available cognitive resources that can be allocated to this task. Additionally, deficits in working memory limit the ability to encode a coherent story representation in memory, because they cause one to be less able to maintain activation of antecedents as new information is processed (Just & Carpenter, 1992). Thus, difficulties may occur for children with ADHD because they have fewer cognitive resources to devote to encoding information and linking this information to previously encoded information.

An additional purpose of this study was to evaluate group differences in the coherence of the recalled stories. Children with ADHD were able to recall equally coherent stories as comparison children when no distracter stimuli (i.e. toys) were present; however, when distracters were present, children with ADHD recalled stories that were significantly less coherent than those of their peers. Thus, unlike encoding and recalling important story material, reproducing a story in the sequence in which it was originally presented is a task that children with ADHD are able to perform as well as comparison children, but only under optimal conditions (when distractions are minimized). This finding suggests that some of the difficulties

in story comprehension of children with ADHD occur during encoding, because when a distracter is present and attention is reduced, these children are less able to produce stories that are as coherent as those of their peers. Difficulties in story coherence only occur for children with ADHD when they are distracted from observing the televised story and are not able to devote as many cognitive resources to encoding story information in its correct sequence.

Limitations

First, certain features of the diagnostic process may limit the generalizability of the findings. Although parents were asked about children's behavior at school and home in the parent interview and behavior rating scales they completed, information was not obtained directly from teachers to further substantiate the parents' reports. Additionally, data for children in the comparison group were excluded from analysis if three or more symptoms of inattention, hyperactivity/impulsivity, or oppositional defiant disorder were endorsed in the parent interview. This was done to ensure that children with subthreshold levels of ADHD symptoms were not included in the comparison. However, the cost of this procedure is to exclude a portion of the undiagnosed population.

A second limitation was that the stimulus materials used may not have been equally appropriate for both age groups. As noted earlier, although age did not interact significantly with diagnostic group and importance, very low levels of recall were obtained for both groups of younger children, suggesting that the task may have been too difficult and possibly obscuring group differences for the four- to six-year-olds. In future studies, it would be useful to include children in this younger age range, but have them complete a task that is more age-appropriate (i.e., with shorter or simplified stories).

Another limitation of this study, and a possible direction for future studies to address, was

that it did not test directly whether children with ADHD differed from comparison children in the ability to identify important story information. As discussed previously, the results of Lorch et al. (in press) provide some evidence that differences in the ability to identify important information may be linked with story recall abilities; however, it would be useful to directly test the children's abilities by having them rate the importance of the story events from the *Rugrats* programs.

One final limitation of the current study was that our index of coherence depended on the assumption that agreement between story order and recall order reflects coherence of the child's recall. It is possible to operationalize recall coherence in alternative ways. For example, Cain (2003) defines coherence more globally, with greater coherence associated with more frequent inclusion of explicit causal and temporal relations among events. Further, another way to operationalize recall coherence, which is conceptually similar to the measure used in the current study, is to compute the absolute deviation between the position of each event in the story and in the child's recall (McDaniel, Waddill, Finstad, & Bourg, 2000). Thus, it may be useful in future studies to develop or examine additional measures of story coherence to further our understanding of the story comprehension difficulties of children with ADHD.

The findings from this study have important implications for children with ADHD. Research has shown that children with ADHD have more academic difficulties than comparison children. One of the factors that may be contributing to these academic problems is the difficulties children with ADHD have in identifying important story information, and then using this information to guide their story recall. The ability to identify and focus on important information is crucial in the school setting, where children must sift through information regularly, while completing reading or other assignments, preparing for an exam, or just taking

notes in class. Time limits them from being able to process and thus recall all of the information that is presented, so in order to succeed in school and retain useful material for the future, they need to be able to identify and focus on the information that is the most important.

Currently, the empirically-validated treatments recommended for children with ADHD are stimulant medication and behavior modification, but such interventions may be insufficient in helping children with ADHD understand and construct coherent representations of information presented in lectures or texts. Instead, appropriate interventions may need to target ways to assist these children in identifying the most important information so that children can make connections among events to build a complete and coherent understanding of the presented material.

In summary, the findings from this study provide further support that children with ADHD have difficulties in multiple aspects of story comprehension in contrast to comparison children of the same age. Specifically, children with ADHD show less sensitivity to the thematic importance of the information they recall from stories, and they are able to recall less information overall. Additionally, children with ADHD produce less coherent stories than comparison children, but only when distracter stimuli are present while the televised story is viewed. This suggests that children with ADHD have consistent weaknesses in certain aspects of story comprehension, such as sensitivity to thematic importance; however, they are able to perform as well as their peers in recalling a coherent story, unless their attention to the story is reduced by distracter stimuli. These findings add to our knowledge on differences in higher-order cognitive processing abilities of children with ADHD and comparison children, and they suggest implications for more effective academic interventions.

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Footnotes

¹Although there was no significant age group x referral status x importance level interaction, the analyses were repeated separately for each age group due to low levels of recall for the younger children. In these analyses, the importance level x referral status interaction was only significant for the older group of children, $F(1, 110) = 12.71, p < .01, r = .32$, for the older group and $F(1, 77) = 1.93, p > .05$, for the younger group.

²The finding of group differences in recall as a function of importance differs from previous findings by Tannock et al. (1993) and Purvis and Tannock (1997), where children with ADHD recalled less than did comparison children, but this difference did not vary as a function of thematic importance. It is not possible to determine what factors (e.g., sample size, sample characteristics) may account for the absence of a significant interaction in these two studies in contrast to the four studies that have obtained such an interaction.

Table 1.

Comparison of Two Diagnostic Groups on Relevant Demographic Variables

Factor	ADHD (n = 80)		Comparison (n = 111)		<i>t</i>	<i>p</i>
	<i>M</i>	(<i>SD</i>)	<i>M</i>	(<i>SD</i>)		
Age (years)						
Younger group	5.79	(.87)	5.67	(.73)	.67	.507
Older group	8.53	(.86)	8.41	(.99)	.70	.486
<i>CBCL</i> Attention Problems	70.38	(9.36)	51.16	(2.90)	20.28	<.001
<i>DSM-IV</i>						
Inattention	5.99	(2.26)	.14	(.44)	26.58	<.001
Hyp/Imp	6.01	(1.98)	.18	(.47)	29.94	<.001
Oppositionality	3.48	(2.35)	.28	(.73)	13.47	<.001
Mother's education	13.99	(2.27)	15.65	(2.18)	5.07	<.001
Vocabulary scaled score	9.89	(3.65)	12.65	(3.32)	5.23	<.001
<i>Conners' Parent Ratings</i>	(n = 57)		(n = 92)			
Oppositional	66.63	(12.06)	48.36	(6.88)	11.78	<.001
Inattention	69.75	(10.95)	47.70	(5.76)	16.08	<.001
Hyperactivity	77.07	(10.45)	49.55	(6.08)	20.32	<.001
ADHD Index	72.51	(8.84)	47.88	(5.81)	20.52	<.001

ADHD = attention deficit hyperactivity disorder; Hyp/Imp = hyperactivity/impulsivity; *DSM-IV* = *Diagnostic and statistical manual of mental disorders* (4th edition).

Table 2.

Comparison of Two Diagnostic Groups on Measures of Attention

Factor	ADHD (n = 80)		Comparison (n = 111)		<i>t</i>	<i>p</i>
	<i>M</i>	(<i>SD</i>)	<i>M</i>	(<i>SD</i>)		
Percent Attention – toys	24.22	(21.25)	42.86	(30.75)	4.56	<.001
Percent Attention – no toys	91.84	(13.43)	94.11	(15.76)	1.02	.310
Sum long looks (s) – toys	80.98	(121.23)	211.63	(214.25)	4.80	<.001
Sum long looks (s) – no toys	584.46	(118.05)	635.66	(47.62)	4.02	<.001

Figure Captions

Figure 1. Percentage of information recalled at four different importance levels for children with and without ADHD across both viewing conditions.

Figure 2. Percentage of information recalled at four different importance levels for younger and older children across both viewing conditions.



