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The Use of Think-Aloud Protocols to Compare Inferencing Abilities in Average and Below-Average Readers

Sandra P. Laing and Alan G. Kamhi

Abstract

In this study, we examined whether think-aloud procedures would uncover differences in the kinds of inferences generated by average and below-average readers. Participants were 40 third-grade children who were divided into groups of average and below-average readers. All participants completed measures of nonverbal IQ, reading, language, and working memory, and a story comprehension task that consisted of two conditions: listen through and think aloud. The major findings in this study were that (a) average readers generated significantly more explanatory inferences than below-average readers, and (b) comprehension performance as measured by story recall was significantly better for both groups in the think-aloud condition than in the listen-through condition. The discussion addresses the implications of these findings.
objects, or events in the story. Associative inferences can also be specifications of procedures or responses to *why* questions. For example, consider the text sentence “He searched for the lake.” An associative inference would be, “He had to look around the world.” An explanatory inference provides causal connections between actions and events in the story. Explanatory inferences are usually responses to *why* questions that provide explanations for a state, event, or action. In one of the stories in the present study, one sentence in the text states, “He was very happy.” An example of an explanatory inference would be, “He was very happy because he had his own bike.”

The principal finding in the aforementioned studies is that the proportion of explanatory inferences generated is significantly related to comprehension performance (Magliano & Graesser, 1999; Suh, 1989). For example, Suh (1989) used a think-aloud task to examine inferences made by college students and found that 81% of utterances produced constituted some type of inference. The majority (58%) of inferences were explanations, suggesting that good comprehension performance by skilled readers is largely a function of their ability to make explanatory inferences.

To determine if the same pattern of inferences was used by less skilled readers, Trabasso and Magliano (1996b) analyzed think-aloud data produced by 24 third-grade students. The children were asked to read stories and tell the experimenter about their understanding of the stories after reading each sentence. The proportion of associative, predictive, and explanatory inferences was calculated. As in the study by Suh (1989), the majority of the students’ utterances (70%) constituted a type of inference. However, only one third of the inferences were explanations, which was considerably less than the proportion of explanatory inferences made by the more skilled college readers in Suh’s study. Explanatory inferences thus appeared to play an important role in comprehension performance. Trabasso and Magliano (1996b) suggested that explanatory inferences serve to unite propositions in a story, so that readers can construct a coherent mental representation of the story. Readers who are continually attempting to link story propositions are more likely to maintain causal information in working memory and to be able to use this information to answer comprehension questions and recall story propositions. In other words, a higher proportion of explanatory inferences would be expected to be associated with a greater number of comprehension questions answered and story propositions recalled correctly.

In a preliminary study, we tested this prediction by comparing third-grade children’s ability to answer comprehension questions after reading the entire passage (read-through condition) or commenting on propositions as they read the passage (think-aloud condition; Laing & Kamhi, 1998). We also questioned whether there would be any performance differences if instead of reading the passages, the children listened to them. Our interest here was to be able to use the think-aloud procedure with below-average readers to investigate their comprehension abilities independently of their decoding skills.

Participants were 20 third-grade African American children ranging in age from 8 years 8 months to 9 years 8 months, identified by classroom teachers as typical achievers who were not receiving special education services. The children were asked to read and listen to the same stories that were used by Trabasso and Magliano (1996b). There were four conditions:

Condition 1. Think aloud—read—similar to Trabasso and Magliano (1996b).
Condition 2. Think aloud—listen—children listened to two passages, one line at a time, and verbalized their understanding of the story after each line.
Condition 3. Read through—children read through the entire story.
Condition 4. Listen through—children listened to the entire story.

Two stories were read in each condition, and six questions—three literal and three inferential—were asked after the entire story was read. The passages were counterbalanced across conditions for each participant, so that each story was used in all four conditions.

As predicted, children answered significantly more comprehension questions in the think-aloud conditions than in the read/listen-through conditions. The relative proportion of inferences produced was similar to that found by Trabasso and Magliano (1996b). Explanatory inferences were produced more frequently than predictive or associative inferences. More important, no significant differences were found between the listening and reading conditions in the proportion of inferences generated or in the number of questions correctly answered.

Taken together, these studies indicate that a think-aloud method is useful for identifying the frequency and types of inferences used by readers during listening and reading comprehension. Less skilled young readers were found to generate fewer explanatory inferences during comprehension than more skilled college-age readers. Below-average young readers would be expected to generate fewer explanatory inferences than young average readers. The primary purpose of the present study was to see if this prediction was true. A secondary purpose considered the factors that might be related to children’s ability to generate explanatory inferences. Because explanatory inferences require constructing causal connections between actions and events in the story, we hypothesized that a measure of working memory might be significantly related to the number of explanatory inferences generated. We also questioned whether more general measures of language and nonverbal intelligence were
related to children’s ability to make explanatory inferences.

Method

Participants

Participants were 40 third-grade children ranging in age from 8 years 1 month to 9 years 6 months. None of the children had been retained or were receiving special education or speech-language services at the time of this study. The children attended school in a rural, low-socioeconomic-status community in which 80% of the children participated in a free-lunch program. The children were divided into two groups based on their performance on the Woodcock Reading Mastery Test–Revised (WRMT-R; Woodcock, 1987) and the Gray Oral Reading Test–3 (GORT-3; Wiederholt & Bryant, 1992). Average readers were 20 children, 13 African American (4 boys and 9 girls) and 7 European American (4 boys and 3 girls), ranging in age from 8 years 1 month to 9 years 6 months, with a mean age of 8 years 8 months. These children performed within average age limits on the Word Identification, Word Attack, and Passage Comprehension subtests of the WRMT-R and the GORT-3, the Test of Nonverbal Intelligence (TONI-2; Brown, Sherbenou, & Johnsen, 1998), the Clinical Evaluation of Language Fundamentals–3 (CELF-3; Wiig, Semel, & Secord, 1995), and the Peabody Picture Vocabulary Test–III (PPVT-III; Dunn & Dunn, 1998). Below-average readers were 20 children, 17 African American (11 boys, 6 girls) and 3 European American (1 boy, 2 girls), ranging in age from 8 years 1 month to 9 years 6 months, with a mean age of 8 years 8 months. Below-average readers scored one or more standard deviations below the mean on the Passage Comprehension subtest of the WRMT-R. Only children who performed within one standard deviation of the mean (> 85) on the TONI-2 were included in the study. The range of cognitive abilities was restricted because we were interested in better understanding the inferencing abilities in below-average readers with average intelligence. The below-average readers performed significantly worse than the average readers on all the reading and language measures (see Table 1). There were no significant group differences on the TONI-2.

General Procedures

Testing was completed in three 45- to 60-minute sessions in a quiet, private setting in the child’s school by the first author. During the first session, the Word Identification, Word Attack, and Passage Comprehension subtests of the WRMT-R, the TONI-2, and the story comprehension measures (think-aloud and listen-through conditions) were completed. During the second session, the CELF-3 (Wiig et al., 1995) and the PPVT-III (Dunn & Dunn, 1998) were completed. During the third session, children completed the GORT-3 (Wiederholt & Bryant, 1992) and a verbal working memory task. The verbal memory and story comprehension tasks are described in detail hereafter.

Verbal Working Memory Task

The verbal working memory task was designed to measure the child’s ability to simultaneously store and process incoming verbal information and is shown in Appendix A (Gottardo, Stanovich, & Siegel, 1996). The task consisted of nine sentence groups—three sets of two statements, three sets of three statements, and three sets of four statements. All statements were presented on a tape recorder. The children were told that they were going to play a memory game. After listening to each sentence, they were asked to indicate whether the statement was true or false. A chime signaled the final statement in each set. After hearing the chime, children were asked to recall the last word of each statement in the set. Children were not penalized for word isolation ability. For example, with the stimulus statement, “The sun rises in the evening,” an acceptable response could be either “the evening” or “evening.”

Story Comprehension

The four stories used in the present study were adapted from the stories used by Trabasso and Magliano (1996b). The stories were estimated to be at a third-grade readability level based on the Rayggor readability estimate (Ragygor, 1977). The original stories were designed to elicit at least four inferences during reading. The number of inferences in each story was increased by using pronouns instead of character names; for example, the text “Once there was a blind man named Bill. Bill wanted to restore his eyesight” was changed to “Once there was a blind man named Bill. He wanted to restore his eyesight.”

The four stories were presented in one of two conditions: listen-through or think-aloud. The order of presentation was counterbalanced across these conditions. In the listen-through condition, the children listened to two stories in their entirety. In the think-aloud condition, the children also listened to the stories, but after each sentence, they were asked to tell what they understood about the story. Children were also told that they would be asked to recall the first story in each condition. After recalling or listening to each story, three literal and three inferential questions were presented. Responses were judged as correct or incorrect. The stories and questions used for each condition appear in Appendix B.

The questions that followed each story were designed to assess either literal or inferential information. The literal questions focused on factual information that was explicitly stated in the passage (e.g., “How often did Jane play racquetball?”) Inferential questions required the listener to make bridging or causal inferences using world knowledge and information from the text. For example, the question “What cured Bill’s blindness?” is an inferential question, because the answer was not in the
The number of propositions/idea units that was determined by counting the total utterances for each think-aloud story (Trabasso & Magliano, 1996b). The number of utterances was scored another 20% of the data. Interjudge reliability averaged 98%. A second examiner independently transcribed and scored another 20% of the data. Intergroup reliability averaged 90.2% across these tasks.

**Scoring Reliability.** The first author transcribed and scored all of the audiotapes from the think-aloud protocols. The data were scored for inference types, error types, and story recall. The first author then retranscribed and scored 20% of the data. Intrajudge reliability averaged 98%. A second examiner independently transcribed and scored another 20% of the data. Interjudge reliability averaged 90.2% across these tasks.

**Results**

The primary purpose of this study was to compare the number and types of inferences produced by average and below-average readers. Table 2 presents the total number of inferences and inference errors produced by the two groups. The average readers produced significantly more inferences and had fewer errors than the below-average readers (p < .05). Average readers averaged about 10 correct inferences and one error for each think-aloud protocol. The below-average
readers averaged about 7 correct inferences and three errors for each think-aloud protocol.

The next analysis examined the types of inferences produced by the two groups (see Table 3). A 2 (Group) × 3 (Inference type) repeated-measures analysis of variance found a significant main effect for type of inference, $F(1, 38) = 20.6, p < .001, ES = .351$, and a significant Group × Type of inference interaction, $F(1, 38) = 6.63, p < .001, ES = .20$. Follow-up analyses indicated that the average readers produced significantly more explanatory inferences than the below-average readers, $t(38) = 2.53, p < .001$. The average readers also produced significantly more explanatory inferences than predictive and associative inferences, Tukey $p < .05$, whereas below-average readers produced significantly more predictive inferences than associative inferences, $p < .05$.

Table 4 presents the number of literal (as opposed to inferential) statements made by participants in the course of the think-aloud condition. Average readers did not differ from below-average readers in the number of statements they repeated verbatim from the stories, but they paraphrased data from the stories somewhat more frequently than below-average readers did ($p < .05$).

### Comprehension Questions

A 2 (Group) × 2 (Condition) repeated-measures analysis of variance found that the average readers answered significantly more questions correctly than the below-average readers, $F(1, 38) = 5.8, p < .05, ES = .131$, and that more questions were answered correctly in the think-aloud condition than in the listen-through condition, $F(1, 38) = 20.5, p < .001, ES = .35$. The Group × Condition interaction approached significance, $F(1, 38) = 3.32, p = .076$. Looking at the data in Table 5, one can see that the average readers’ comprehension performance showed a relatively greater improvement in the think-aloud condition than the improvement shown by the below-average readers.

### Story Recall

Table 6 presents the story recall data as a function of condition and group. A 2 (Group) × 2 (Condition) repeated-measures analysis of variance revealed main effects for group and condition. Average readers recalled significantly more propositions in both conditions than below-average readers, $F(1, 38) = 12.32, p < .01, ES size = .245$. Children in both groups recalled more story propositions accurately in the think-aloud condition than in the listen-through condition, $F(1, 38) = 6.77, p < .05, ES = .151$. The interaction between

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**TABLE 2**
Correct and Incorrect Inferences and Total Verbal Output by Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>AR</th>
<th>M</th>
<th>SD</th>
<th>BA</th>
<th>M</th>
<th>SD</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inferences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct</td>
<td>10.4</td>
<td>5.7</td>
<td></td>
<td>7.3</td>
<td>3.3</td>
<td></td>
<td>2.13*</td>
</tr>
<tr>
<td>Incorrect</td>
<td>1.0</td>
<td>1.6</td>
<td></td>
<td>3.1</td>
<td>4.2</td>
<td></td>
<td>–2.00*</td>
</tr>
<tr>
<td>Verbal output</td>
<td>19.7</td>
<td>6.4</td>
<td></td>
<td>14.6</td>
<td>5.0</td>
<td></td>
<td>2.80**</td>
</tr>
</tbody>
</table>

Note. AR = average reader group; BA = below-average reader group.

*a n = 20.

*p < .05. **p < .01.

**TABLE 3**
Number and Type of Inferential Statements in the Think-Aloud Condition by Group

<table>
<thead>
<tr>
<th>Statement type</th>
<th>AR</th>
<th>M</th>
<th>SD</th>
<th>BA</th>
<th>M</th>
<th>SD</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanation</td>
<td>9.3</td>
<td>1.7</td>
<td></td>
<td>7.8</td>
<td>2.2</td>
<td></td>
<td>2.53*</td>
</tr>
<tr>
<td>Prediction</td>
<td>3.6</td>
<td>2.4</td>
<td></td>
<td>3.9</td>
<td>2.4</td>
<td></td>
<td>–0.39</td>
</tr>
<tr>
<td>Association</td>
<td>2.4</td>
<td>1.8</td>
<td></td>
<td>2.0</td>
<td>1.4</td>
<td></td>
<td>0.70</td>
</tr>
</tbody>
</table>

Note. AR = average reader group; BA = below-average reader group.

*a n = 20.

*p < .05.

**TABLE 4**
Number and Type of Literal Statements in the Think-Aloud Condition by Group

<table>
<thead>
<tr>
<th>Statement type</th>
<th>AR</th>
<th>M</th>
<th>SD</th>
<th>BA</th>
<th>M</th>
<th>SD</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exact repetition</td>
<td>4.1</td>
<td>2.8</td>
<td></td>
<td>3.3</td>
<td>2.4</td>
<td></td>
<td>1.0</td>
</tr>
<tr>
<td>Paraphrase</td>
<td>4.7</td>
<td>2.2</td>
<td></td>
<td>3.1</td>
<td>2.0</td>
<td></td>
<td>2.7*</td>
</tr>
</tbody>
</table>

Note. AR = average reader group; BA = below-average reader group.

*a n = 20.

*p < .05.
Correlational Analyses

The Pearson product-moment correlation coefficients for the measures of language, explanatory inferences, verbal working memory, comprehension questions, and story recall for the combined groups are shown in Table 7. As can be seen in this table, 12 of the 14 correlations were significant. Of interest was that the number of explanatory inferences produced was significantly related to the number of comprehension questions answered and not to performance on the recall task. In contrast, the measure of working memory was significantly related to performance on the recall task but not to the number of comprehension questions answered.

Discussion

There were two major findings in the present study. Average readers produced significantly more explanatory inferences than below-average readers. Almost half (46%) of the inferences generated by average readers consisted of explanatory inferences, compared with only 36% for below-average readers. The increased number of explanatory inferences produced by the average readers may account for their better performance on the comprehension measures (comprehension questions and story recall) relative to below-average readers. As Trabasso and Magliano (1996b) have noted, explanatory inferences serve to unite propositions in a story, so that the readers can construct a coherent mental representation of the story. When readers engage in consistent retrieval and maintenance of causal information linking story propositions, this information is available in working memory to answer comprehension questions and to recall propositions from the story. Thus, readers who make more explanatory inferences should do better on measures of comprehension than readers who make fewer explanatory inferences. The findings in the present study are consistent with this claim.

What would cause below-average readers to produce fewer explanatory inferences? To answer this question, it is necessary to consider the knowledge and processes involved in constructing explanatory inferences. An explanatory inference requires the construction of a situation model of the relevant causal propositions in the story. A situation model is a mental representation of a story in the form of sequenced events, actions, and states (Just & Carpenter, 1992). To construct a situation model, it is necessary to retrieve and maintain causal information that links story propositions together (Graesser et al., 1994; Trabasso & Magliano, 1996b). Children who have difficulty maintaining causal links across story propositions would be expected to have problems with generating explanatory inferences. Sufficient working memory is thus crucial to maintaining causal links as the story progresses. Con-

TABLE 5
Number of Comprehension Questions Answered Correctly by Question Type, Group, and Condition

<table>
<thead>
<tr>
<th>Question type/Condition</th>
<th>AR&lt;sup&gt;a&lt;/sup&gt;</th>
<th>BA&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td><strong>Think-Aloud</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literal</td>
<td>5.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Inference</td>
<td>5.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Total</td>
<td>10.5</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>Listen-Through</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literal</td>
<td>4.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Inference</td>
<td>4.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>8.1</td>
<td>2.2</td>
</tr>
<tr>
<td><strong>Total across conditions</strong></td>
<td>19.0</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Note. AR = average reader group; BA = below-average reader group.
<sup>a</sup><i>n</i> = 20.
<sup>*</sup><i>p</i> < .05. **<i>p</i> < .01.

TABLE 6
Number of Story Propositions Recalled by Group and Condition

<table>
<thead>
<tr>
<th>Condition</th>
<th>AR&lt;sup&gt;a&lt;/sup&gt;</th>
<th>BA&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td><strong>Think-Aloud</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literal</td>
<td>8.8</td>
<td>1.9</td>
</tr>
<tr>
<td>Listen-Through</td>
<td>7.9</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Note. AR = average reader group; BA = below-average reader group.
<sup>a</sup><i>n</i> = 20.
<sup>*</sup><i>p</i> < .05. **<i>p</i> < .01.
structing a situation model also requires an understanding of the specific propositions in the story. Thus, receptive language abilities must be sufficient for a child to construct an accurate situation model of the causally linked propositions.

Given the importance of language abilities and working memory for generating explanatory inferences, it should not be surprising that measures of these abilities are significantly correlated. The strengths of this relationship explain why younger children generate fewer explanatory inferences than older children and adults and why below-average readers generate fewer explanatory inferences than average readers. Younger children have less developed language and memory abilities than older children, and below-average readers typically have less developed language and memory abilities than average readers.

The Think-Aloud Procedure

Although traditional measures of comprehension are useful for examining inferences that occur after reading or listening, these measures may not capture inferences that are made during reading (Graesser et al., 1994; Laing & Kamhi, 1998; Trabasso & Magliano, 1996a). We showed in the present study that think-aloud procedures can be used as a diagnostic tool for below-average readers by administering passages as listening tasks and that think-aloud procedures provide the same information about inferences and comprehension processes that previous studies have found using reading tasks. The think-aloud procedure also provided a way to identify where specific comprehension breakdowns occurred and what caused these breakdowns. Below-average readers made significantly more inferencing errors than average readers, and these errors were often the result of a failure to make an explanatory or predictive inference earlier in the passage.

Consistent with previous research (e.g., Trabasso & Magliano, 1996a), comprehension performance was better in the think-aloud condition than in the listen-through condition. As noted previously, the think-aloud procedure facilitates comprehension by encouraging the generation of explanatory inferences. Although both groups benefited from the think-aloud procedure, the two comprehension tasks showed somewhat different patterns of performance. The average readers benefited more from the think-aloud procedure than the below-average readers in answering comprehension questions, whereas the below-average readers benefited more than the average readers on the story recall task. These differences did not reach significance, but they may suggest a trend that future research could further explore.

Theoretical and Educational Implications

The success of the think-aloud procedure in providing an on-line measure of inferencing abilities and in facilitating comprehension performance has important educational implications. The think-aloud procedure can be used routinely to assess children’s ability to construct inferences. It also provides an excellent way to facilitate comprehension and to identify where comprehension breakdowns occur as children read a text. The think-aloud procedure could also be used as a listening task, as we did in the present study, to identify those below-average readers who may have a high risk for comprehension problems independent of their decoding skills. These children could be targeted for language intervention or some additional instruction that attempts to improve their ability to understand narrative and expository texts.

The more general focus of this study was on comprehension. The complexity of comprehension has made it an elusive target for researchers and educators to develop reliable and valid assessment measures. As indicated earlier, reading comprehension is dependent first and foremost on the accuracy and efficiency of decoding processes. Most studies that examine comprehension processes in below-average readers fail to control for decoding abilities when they attempt to examine other factors that affect comprehension. Most below-average readers have learning problems that are not limited to decoding single words, so it has been of interest to identify the language, cognitive, and reasoning processes that contribute to comprehension difficulties.

In this study, we found that below-average readers performed more poorly on the two comprehension measures than average readers. Although this is

### TABLE 7

Correlations Between Language, Explanatory Inferences, Working Memory, Comprehension Questions, and Story Recall for Both Groups Combined (n = 40)

<table>
<thead>
<tr>
<th>Variable</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CELF-3</td>
<td>–</td>
<td>.63**</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>2. PPVT-III</td>
<td></td>
<td>.32* .41**</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>3. Explanatory inferences</td>
<td>.39*</td>
<td>.55**</td>
<td>.52**</td>
<td>–</td>
</tr>
<tr>
<td>4. Verbal working memory</td>
<td>.61**</td>
<td>.51**</td>
<td>.41*</td>
<td>.26</td>
</tr>
<tr>
<td>5. Comprehension questions</td>
<td>.46*</td>
<td>.54**</td>
<td>.27</td>
<td>.35*</td>
</tr>
<tr>
<td>6. Story recall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. CELF-3 = Clinical Evaluation of Language Fundamentals, 3rd edition; PPVT-III = Peabody Picture Vocabulary Test, 3rd edition.

*p < .05. **p < .01.
not an unexpected finding, all below-average readers do not necessarily have deficient listening comprehension abilities. Children with dyslexia, as defined by the International Dyslexia Association (see Lyon, 1995), have a specific language-based disorder characterized by difficulties in single-word decoding. One way to differentiate these children from other below-average readers is to administer a listening comprehension task. The children with dyslexia will perform within average age limits on such a task, whereas below-average readers without dyslexia will perform below age norms. The below-average readers in the present study were obviously not children with dyslexia. These children performed significantly lower than the average readers on the two listening comprehension measures and below age level on the two norm-referenced measures of language.

Because most below-average readers are like the children in the present study, it seems imperative to routinely assess language abilities in young elementary school children who are at risk for reading failure or are already experiencing reading difficulties. The assessment of language abilities is not meant to replace in any way the assessment of phonological processing (e.g., phoneme awareness) and other early literacy skills. Language problems can be identified using standardized measures of language proficiency, such as the ones used in the present study, or criterion-referenced measures that a language specialist can administer. Children with language learning problems could then be targeted for intervention to improve their vocabulary, inferencing abilities, comprehension monitoring, and other abilities that contribute to reading comprehension.

ABOUT THE AUTHORS

Sandra P. Laing, PhD, is an assistant professor in the Department of Communicative Disorders at The University of Alabama. She is currently teaching graduate-level courses in diagnostics, intervention, language development, and phonology, and one undergraduate course in speech disorders. Her primary research interests include child language development and disorders, reading development and disorders, behavior disorders, and multicultural issues. Alan G. Kamhi, PhD, is a professor and chair of the Program in Communication Disorders and Sciences at the University of Oregon. His early research focused on linguistic and cognitive abilities of children with specific language impairments (SLI) and mental handicaps. His later research focused on language-learning disabilities. His recent research has focused on language abilities in children with mild–moderate hearing loss, phonological awareness and early reading abilities, and differentiating children with SLI from children with nonspecific language impairments. Address: Sandra P. Laing, University of Alabama, Department of Communicative Disorders, Box 870242, Tuscaloosa, AL 35487-0242.

AUTHORS' NOTES

1. A portion of these results was presented at the American Speech Hearing and Language Convention in San Francisco, California, 1999.
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We are going to play a memory game. It has two parts. You are going to hear some statements and I want you to answer true or false (yes or no for Grades 1 and 2 or for children who cannot tell you what true and false mean). Then you will hear a chime, and I want you to give me the last word of each of the sentences in the group just given. It does not matter if you give the words in the same order as the sentences.

For example, Set 1: You are a man/woman/boy/girl. (Ask so that answer is true)
I am sitting/standing. (Ask so that answer is false) OK. Now recall.
Set 2: This room is purple. It is raining.

**Task Items**
1. The sun rises in the evening.
2. Trees lose their leaves in spring.
   *(evening, spring)*
3. Cars have four wheels.
5. A red traffic light means “go.”
   *(wheels, meat, go)*
6. We get milk from cows.
7. Plants need water and light to grow.
8. In winter, it is warm.
9. The pyramid is in Memphis.
   *(cows, grow, warm, Memphis)*
10. We read from right to left.
11. Lettuce and peas are vegetables.
   *(left, vegetables)*

12. Centimeters are used for measuring.
13. Elephants have gray spots.
14. Some birds have fur.
   *(measuring, spots, fur)*
15. Arkansas is close to Tennessee.
16. A motorcycle can move faster than a bicycle.
17. An apple is a fruit.
18. Fish swim in the sky.
   *(Tennessee, bicycle, fruit, sky)*
19. People can buy groceries in stores.
20. Little Rock is the capital of Arkansas.
   *(stores, Arkansas)*
21. We use a thermometer to tell time.
22. Boiling water is hot.
23. Memphis is on the shore of the Mississippi.
   *(time, hot, Mississippi)*
24. A football is round.
25. We sleep at night.
26. Insects have eight legs.
27. A feather is heavier than a rock.
   *(round, night, legs, rock)*

Give items with asterisks only to children who get one of the four-item sets correct.

*28. Some birds fly north in winter.
29. The earth travels around the sun.
30. Purple, red, and big are colors.
31. The United States is the smallest country in the world.
32. Tadpoles become frogs.
   *(winter, sun, colors, world, frogs)*

**APPENDIX A**

*Verbal Working Memory Task*

APPENDIX B
Test Stories

Jane
There was a teenage girl named Jane. She was very heavy. Jane wanted to lose weight. She jogged for a while. Jane did not become thinner. She was frustrated. One day, Jane saw a racquetball game. She decided to learn racquetball. She took lessons. Jane learned quickly. She played racquetball with her friends. She played very hard every day. Jane became very thin.

1. What game did Jane learn to play? Racquetball. (literal)
2. How often did Jane play racquetball? Every day. (literal)
3. How old was Jane? Teenager/13–19. (literal)
4. How did Jane become thin? She played racquetball. (inferential)
5. Why did Jane run? To get thin. (inferential)
6. Why was Jane frustrated? Because she couldn't lose weight. (inferential)

John
John was the second son of a king in a country. He wanted to become the king. John served his father with all his heart. But his father gave his throne to the first son, William, instead of him. John could not accept his father’s decision. He did not like William. John decided to poison William. He invited William to his place. John gave William a poisoned drink. He died several days later. John attracted his father’s attention. He demonstrated his talents. He was crowned the king.

1. Who did the king give his throne to at first? William/the first son. (literal)
2. How did John feel about William? He disliked him/didn't like him/jealous. (literal)
3. What happened to William? He died. (literal)
4. How did William die? He was poisoned/John killed him. (inferential)
5. Why did John kill William? Because John wanted to be king/so he could be king. (inferential)
6. Who crowned John as the king? His father. (inferential)

Jimmy
Once there was a boy named Jimmy. One day, he saw his friend Tom riding a new bike. Jimmy wanted to buy a bike. He spoke to his mother. Jimmy’s mother got a bike for him. He was very happy. Next day, Jimmy’s mother told him that he should have his own savings. He wanted to earn some money. Jimmy asked for a job at a nearby grocery store. He made deliveries for the grocery store. Jimmy earned a lot of money. He and his mom went to the department store. Jimmy walked to the second floor. He bought a new basketball.

1. How did Jimmy get his bike? His mother bought it. (literal)
2. Where did Jimmy buy a basketball? At the department store. (literal)
3. How did Jimmy earn money? By working at the grocery store/making deliveries at the grocery store. (literal)
4. What made Jimmy want a bike? His friend had one. (inferential)
5. Why did Jimmy ask for a job at the grocery store? So he could earn his own savings/money. (inferential)
6. Who paid for the basketball? Jimmy did. (inferential)

Billy
Once there was a blind man named Bill. He wanted to restore his eyesight. He tried every medicine available. At last, Bill could see. He was happy. One day, Bill heard that there was a mysterious lake. The water of the lake was known to have powers to grant any wish. He wanted to find the lake. Bill went on a journey. He searched for the lake. Bill brought home water from the lake. He washed his face with the water. He found the water made him younger.

1. What did Bill bring back from the journey? Water. (literal)
2. What did Bill do with the water from the lake? He brought it home/washed his face with it. (literal)
3. What problem did Bill have at the beginning of the story? He was blind. (literal)
5. Why did Bill go on a journey? To find the mysterious lake. (inferential)
6. What did Bill wish for at the lake? To look younger. (inferential)

APPENDIX C
Story Recall Propositions

Jane (15 propositions)

- teenage
- girl/Jane
- heavy
- wanted to lose weight
- jogged
- still heavy/didn’t lose weight/jogging didn’t help
- frustrated/mad
- saw game/racquetball
- wanted to learn game/racquetball
- lessons/to learn
- learned quickly/fast
- played with friends/racquetball
- played hard
- played daily
- became thin/skinny

Jimmy (15 propositions)

- boy/Jimmy
- friend/Tom
- friend rode bike
- Jimmy wanted a bike
- Jimmy talked/spoke to mom
- mom got Jimmy bike
- Jimmy happy about bike
- mom told Jimmy to save own money
- Jimmy wanted to earn/savings/wanted job
- made deliveries/grocery store to department store
- on second floor of department store
- to buy basketball with savings/earned money

John (15 propositions)

- John
- second son
- father was king
- wanted to be king
- served father/good son
- first son/William/got throne
- John couldn’t accept decision
- John disliked William/jealous
- decided to poison/kill William
- invited William to his place
- gave William poison
- William died
- John attracted/gained father’s attention
- John showed his talents to father
- John crowned king

Bill (15 propositions)

- man/Bill
- blind
- wanted to see
- tried medications
- regained sight
- happy to see again
- heard of mysterious lake
- lake had powers
- lake granted wishes
- wanted to find lake
- went on journey to find lake
- searched/looked for lake
- brought water home from lake
- washed face with lake water
- water made him younger

APPENDIX D
Verbal Protocol Analysis

Clause was defined as an utterance containing a unified predicate that expressed an event, activity, or state. Each predicate was a main verb. Infinitives and complements were included with the main verb as single clauses. Utterances that had two verbs and one or more agents were treated as having two separate clauses. Clauses were examined with respect to their relationship to the focal (spoken) sentence. The function or inference type was determined (to paraphrase, explain, associate, or predict) as follows:

1. A paraphrase was assigned if the clause represented a transformation of the focal sentence that preserved its meaning. Paraphrases were not assigned if the utterance occurred in isolation or was judged to be a rote rehearsal of focal sentences.

2. An explanation was assigned if the clause was determined to provide an answer to a why question. According to Trabasso and Magliano (1996a), explanations may be causally chained so that they comprise a series of explanations for a state, event, or action.

3. A prediction was assigned if the clause was found to provide answers to causal consequence questions. The as-
Assignment of a prediction did not depend on whether it was accurately substantiated by future text or not. Moreover, like explanatory inferences, predictive inferences may also be produced in chains. In this respect, one prediction is necessary for and enables another one to occur.

4. An association was assigned for clauses in which the content occurred concurrently with the event, state, or activity depicted in the focal sentence or clause. Statements that might be labeled associations include generalizations; specifications of procedures; expressions of manner, features, and properties of characters or objects; and specifications of temporal or spatial information. Associations may provide answers to what, how, where, when, and who questions. As with explanations and predictions, associations may be produced in chains. Thus, one association may become the basis for another.