Prose Memory Strategies of Children Treated for Leukemia: A Story Grammar Analysis of the Anna Thompson Passage

Sandra N. Kleinman and Deborah P. Waber

Prose memory was examined in long-term survivors of acute lymphoblastic leukemia (ALL) between the ages of 10 and 16 (n = 34) and in age- and sex-matched controls (n = 33). By the standard scoring procedure, children in the ALL group scored lower on the Anna Thompson passage from the Wechsler Memory Scale—Revised. A story grammar analysis indicated that children in the ALL group produced fewer structures and committed more errors; error types differed for the 2 groups. There was no difference between the groups in order of elements or completeness of episodes. The findings suggest that the ALL group did not effectively access the story schema as a metacognitive strategy and thus implicates the relational processing by which connections are made between what is known and what is to be known.

Memory disturbance is a common complaint among children who have suffered a neurologic insult that has cognitive sequelae. Effective treatment of such complaints rests in part on accurate description of the memory disturbance phenomenon. Moreover, better definition of the processes involved in memory can provide a broader appreciation of cognition in affected and unaffected individuals.

In the present article, we focus on a group of children who are reported to have memory deficits as a consequence of a suspected neurobehavioral insult—namely, children who have undergone treatment for acute lymphoblastic leukemia (ALL). This treatment typically includes a number of drugs, some of which have known neurotoxicity, and in some cases cranial irradiation. An increased prevalence of learning problems is well documented in these children and is generally thought to be attributable to neurotoxicity associated with the treatment (Fletcher & Copeland, 1988).

A number of investigators have reported poor performance on standardized tests of memory among these children. Typically, the relevant tasks require that the child repeat or identify short bits of information. These include verbate recall of sentences (Rodgers, Britton, Morris, Kernahan, & Craft, 1992; Wilson et al., 1991), list learning (Brouwers & Poplack, 1990; O’Hare, Aitken, & Eden, 1988; Rodgers et al., 1992), recall or recognition of figures (Rodgers et al., 1992; Wilson et al., 1991), and aggregate scores on subtest clusters that discriminate short- from long-term memory abilities (Rubenstein, Varni, & Katz, 1990). Rodgers et al. (1992) argued that deficits on such tasks are not necessarily due to memory per se, but rather to failure in the application of strategies, such as rehearsal.

Children who have undergone these treatments also perform poorly on tasks that measure memory for prose (Brouwers & Poplack, 1990; Jannoun & Chessels, 1987). Brouwers and Poplack theorized that an underlying attentional disorder disrupts the encoding stage of processing so that information is not available for later recall. Those children who performed poorly on a vigilance task also achieved lower scores on the Logical Memory subtest of the Wechsler Memory Scale. The present study focuses on other cognitive factors that may also contribute to the consistent finding of poor memory for prose in these children.

The extension of studies of memory beyond discrete bits of information has greater ecological validity, with implications for discourse and text comprehension as well as the pragmatics of communication. Remembering prose is associated with linguistic and cognitive demands that are different from those associated with remembering word lists or even sentences. Standardized tests that measure memory for prose, however, typically fail to acknowledge that distinction. The number of bits of information recalled is summed, and these summary scores are then compared with preestablished norms.

Cognitive psychologists have argued that bit scoring does not accurately reflect memory for prose (Bransford & Franks, 1971; Sachs, 1967; Webster, Godlewski, Hanley, & Sowa, 1992). Prose memory is a complex cognitive process by which elements are woven together by relational processing—the confluence of content, structure, and prior knowledge (Bransford & Johnson, 1973; Webster et al., 1992). The narrative is understood because of the specification and integration of the relationships among the elements; it is neither coded nor recalled as isolated bits of

Sandra N. Kleinman and Deborah P. Waber, Department of Psychiatry, Children’s Hospital, Boston, Massachusetts.

This research was supported by Grant NS22108 from the National Institute of Neurological Disorders and Stroke and in part by Mental Retardation Center Grant P30-HD18655 and Grants CA19789, CA22719, CA34183, and CA06516 from the National Cancer Institute.

We are grateful to the staff and students of the public schools in Needham and Weymouth, Massachusetts, for their participation; to Cynthia Kahn and Deirdre Calderone for data collection; and to Stephen Sallan and Nancy Tarbell for their continuing support in these efforts. A preliminary version of these results was presented at the 22nd annual meeting of the International Neuropsychology Society, Cincinnati, Ohio, February 1994.

Correspondence concerning this article should be addressed to Deborah P. Waber, Department of Psychiatry, Children’s Hospital, 300 Longwood Avenue, Boston, Massachusetts 02115.
information. Although counting bits of information can identify a generic problem in memory for prose, it cannot specify the cognitive and linguistic processes by which the relational aspects of prose memory break down.

In an effort to look beyond bits recalled to assess prose memory, cognitive psychologists have approached the assessment of story recall by examining the subjects' use of specific cognitive and linguistic structures. The story schema, or macrostructure, is a network of background knowledge activated as the story is heard or read (Anderson, 1977; Mandler & Johnson, 1977; Rumsfeld & Ortony, 1977; Stein & Glen, 1979). It is a cognitive processing mechanism guiding both comprehension and production of narrative (Mandler & Johnson, 1977; Montague, Maddux & Dereshiwsky, 1990; Stein & Glenn, 1979) and includes memories of similar or related events. As such, it provides a familiar context to frame a new story. In essence, the story schema is what the story is about, its theme.

For example, the story schema of the well-known Anna Thompson story from the Wechsler Memory Scale—Revised (Wechsler, 1987) is robbery and murder, the experience of being robbed of one's last pennies. Use of a story schema instantiates new information into an already existing conceptual framework. When the story contains a familiar theme, background knowledge is accessed as a metacognitive strategy. It may also elicit inferences and additional information that can interfere with the accurate recounting of the exact details of the story (Bartlett, 1932; Webster et al., 1992).

Concurrently, a story grammar is used as a structural template. As a grammar, it provides structural cohesion to the narrative, facilitating the organization and encoding of information in the story. It includes rules specifying the causal, temporal, and spatial relationships among bits of information within the narrative (Merritt & Liles, 1987, 1989). Understanding and use of the story grammar are guided by the story schema.

The story grammar includes six structures: a setting containing one structure and an episode containing five structures (Stein & Glenn, 1979; see Table 1). Analyses of prose memory have used the six grammatical structures as the basis for determining whether story schemata are activated. To analyze prose memory, one must categorize the information within the story as one of the six story grammar structures. Conclusions are drawn about the use of a story schema on the basis of the integrity of the story grammar. This presupposes that in using grammatical structures one concurrently activates a more thematic cognitive structure—a story schema.

Use of story grammar to understand and encode stories is generally stable by 9 years of age (Merritt & Liles, 1987). In fact, children as young as 6 can already use episodic structures to guide them on story recall and storytelling tasks (Rumsfeld, 1975; Stein & Glenn, 1979). Developmental data indicate that elementary-school-aged children focus primarily on setting, initiating event, and consequence, with less well established use of the other three structures (Mandler & Johnson, 1977; Stein & Glenn, 1979). Language-impaired students can use story grammar structures to organize their listening to stories but are less skilled than nonimpaired peers in using those structures to retell the same stories (Merritt & Liles, 1987, 1989).

We undertook the present study to examine specific cognitive and linguistic processes used by children who are long-term survivors of ALL to perform a standard prose memory task. Prose memory was chosen as the focus not only because these children consistently perform poorly but also because it can serve as a window into relational processing in these children. Moreover, analysis of this task among a relatively homogenously defined group of patients may reveal regularities that might not emerge so clearly in a more heterogenous sample of learning-disabled children.

Specifically, we examined the activation of story schema and story grammar as memory strategies on the Anna Thompson story among ALL patients and a control group matched for age and sex. We applied traditional methods of counting bits of information recalled to derive a summary score, and we then categorized the information according to six story grammar structures. This allowed us to determine how many structures were present, which structures were present, and in what order they were recalled. Analysis of errors allowed us to draw inferences about the activation of a story schema.

### Table 1

<table>
<thead>
<tr>
<th>Structure</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Setting</td>
<td>Main character(s), protagonist, spatiotemporal context</td>
</tr>
<tr>
<td>2. Initiating event</td>
<td>Occurrence influencing the main character to action</td>
</tr>
<tr>
<td>3. Internal response</td>
<td>Thought and feelings of the protagonist in response to the initiating event that triggers some action, or goal formulation</td>
</tr>
<tr>
<td>4. Attempt</td>
<td>Action to solve the problem or pursue the goal</td>
</tr>
<tr>
<td>5. Direct consequence</td>
<td>Attainment of the goal or solution of the problem; other events resulting from the attempt</td>
</tr>
<tr>
<td>6. Reaction</td>
<td>An emotional response to what has occurred</td>
</tr>
</tbody>
</table>

Note. See Griffith, Ripich, & Dastoli, 1986; Merritt & Liles, 1987; Stein & Glenn, 1979.

### Subjects

The participants were 34 children (15 girls and 19 boys) who had been treated for ALL on Dana-Farber Cancer Institute Protocol 81–01 and 33 children recruited from a local public school system.

The control group was matched for age and sex to the patient group. In order to identify controls, we recruited children from several public school systems in communities with a range of socioeconomic backgrounds. At least 10 children at each age level from 10 to 16 years were recruited, with the sexes approximately equally represented (total N = 77).

### Method
Each patient protocol was then matched to that of the child of the same sex and closest age from the control group. Because an appropriate match could not be found for 1 child, analyses are based on 34 children from the patient group and 33 from the control group. Table 2 shows age and sex characteristics of the two groups.

The leukemia patients were seen as part of a comprehensive study evaluating late effects of treatment among children on Protocol 81–01 (Waber, Tarbell, Kahn, Gelber, & Sallan, 1992). Median time elapsed between diagnosis and testing was 84 months (range = 60–112 months). The leukemia treatment protocol, described in detail elsewhere (Clavell et al., 1986; Niemeyer et al., 1991), included cranial radiation therapy for all patients as well as intensive chemotherapy (methotrexate, doxorubicin, vincristine, mercaptopurine, asparaginase, and prednisone). Children included in the present study were a subsample of that group who were between 10 and 16 years of age. Children younger than 10 had been given a different logical memory task. Four other children who were within the age range had been excluded from the sample reported by Waber et al. (1992) because they had not received induction methotrexate, evaluation of which was a focus of that study. These 4 children were included in the present sample because induction methotrexate dose effects were not a subject of this study and because all other aspects of their treatment, including methotrexate, were comparable.

### Procedure

All children were tested individually. The Anna Thompson passage from the Logical Memory subtest of the Wechsler Memory Scale—Revised was read to them, and they were asked to repeat it according to the test instructions (Wechsler, 1987). Children in the patient group were given the test in the context of a comprehensive neuropsychological evaluation; those in the control group were given the test twice, with several other nonlanguage tasks for which normative data were being collected. Those in the patient group provided an immediate and a delayed recall; those in the control group were asked for immediate recall only. The present study, therefore, is based on the immediate recall condition. All protocols were tape-recorded and transcribed for analysis.

### Data Reduction

Protocols were initially scored according to the instructions in the test manual (Wechsler, 1987). In order to carry out the story grammar analysis, we broke the passage down into six structures as per Stein and Glenn (1979), with component substructures as indicated in Table 3. The analysis procedure was as follows:

1. The narrative was initially broken up into constituent T-units. A T-unit is “one main clause plus any subordinate clause or non-clausal structure that is attached to or embedded in it” (Hunt, 1970, p. 4).

2. Each T-unit was coded according to the story structures and substructures it represented. These substructures served as the unit of analysis.

3. Substructures were coded sequentially, using the numeric codes indicated in Table 3, so that order of elements could be evaluated.

4. Errors were identified. If an error was present, it was categorized according to the following error types: (a) incomplete thought (e.g., “Anna somebody” or “a woman”) or ambiguous statement (details not clearly stated); (b) additional information (extra information not in original story but somehow related) or assumed information (e.g., “subway on State Street”); (c) alteration (e.g., reversal of agent and action, recombination of detail as in “South Station”).

In addition, we analyzed the narrative as a whole to determine whether it constituted a complete episode, an incomplete episode, or a nonepisode. According to Stein and Glenn (1979), a narrative can be analyzed for episodic structure as follows: A complete episode includes the attempt, initiating event or internal response, and the direct consequence; an incomplete episode includes two of the three requisite story grammar structures; and a nonepisode includes one or fewer of the requisite story structures. Many of the structures in the Anna Thompson Story were lengthy and detailed. Therefore, following Stein and Glenn (1979), one investigator, on an ad hoc basis, designated key substructures for the requisite structures as follows: attempt, 2.1 and 2.2; initiating event, 3.4; internal response, 4.2 and 4.3; and direct consequence, 6.1.

We quantified the order of structures by assigning a value of 1 to each substructure whose identification number was higher than that of the preceding substructure or 0 if the identification number was lower. The total was then summed across substructures, with a higher number indicating more elements correctly ordered. An order quotient, the total order score divided by the total number of structures, was used for analysis purposes.

We quantified the total number of errors by summing the number of errors coded for each protocol. An error quotient, the total number of errors divided by the number of substructures, was created.

### Table 3

<table>
<thead>
<tr>
<th>Structure</th>
<th>Component substructures</th>
<th>Numeric code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting</td>
<td>Anna Thompson</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>of South Boston</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>employed as a cook</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>in a school cafeteria</td>
<td>1.4</td>
</tr>
<tr>
<td>Attempt</td>
<td>reported</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>at the City Hall station</td>
<td>2.2</td>
</tr>
<tr>
<td>Initiating event</td>
<td>that she had been held up</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>on State Street</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>the night before</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>and robbed of $56</td>
<td>3.4</td>
</tr>
<tr>
<td>Internal response</td>
<td>She had four small children</td>
<td>4.1</td>
</tr>
<tr>
<td></td>
<td>the rent was due</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>and they had not eaten for two days</td>
<td>4.3</td>
</tr>
<tr>
<td>Reaction</td>
<td>The police, touched by the woman’s story</td>
<td>5</td>
</tr>
<tr>
<td>Direct consequence</td>
<td>took up a collection for her</td>
<td>6</td>
</tr>
</tbody>
</table>

### Table 2

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>ALL (n = 34)</th>
<th>Control (n = 33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age in years</td>
<td>12.00</td>
<td>11.89</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>2.00</td>
<td>1.98</td>
</tr>
<tr>
<td>Range of ages</td>
<td>10–16</td>
<td>10–16</td>
</tr>
<tr>
<td>% male</td>
<td>56</td>
<td>54</td>
</tr>
</tbody>
</table>

Note. ALL = acute lymphoblastic leukemia.
Types of errors were also evaluated. Because the frequency of errors was low for each individual, the total number of errors of each type committed by the entire group was pooled so that distributions could be compared.

Interrater reliability was evaluated for two raters (S.N.K. and D.P.W.) on a set of 15 protocols not included in the study. Reliability coefficients for number of substructures, the order variable, and number of errors were .96, .95 and .64, respectively. For those structures that were scored as errors by both raters, agreement as to type of error was 86%.

Results

Because in preliminary analyses we detected no relationship between outcomes and sex, we did not include sex in subsequent analyses. The matching procedure resulted in equivalent age and sex distributions, and so age was not included as a variable in the analyses either.

Standard Scoring Method

Scores derived by the standard method were submitted to an analysis of variance with group as the between-subjects factor. Children from the control group achieved higher scores than did those from the patient group, $F(1, 65) = 7.44, p = .008$ (see Table 4).

Story Grammar Analysis

The number of structures produced, the order quotient, and the error quotient were submitted to a multivariate analysis of variance with group as the between-subjects factor. Means and standard deviations of the relevant variables appear in Table 4. Because this analysis revealed between-group differences, $F(3, 63) = 5.36, p = .0024$, separate univariate analyses were performed for each dependent variable.

Number of substructures. Children in the control group produced more substructures than did those in the patient group, $F(1, 65) = 9.98, p < .003$. This difference was then examined for each of the six structures separately. The control group tended to produce more substructures for the setting, $F(1, 65) = 3.67, p < .06$, and differences emerged clearly for the attempt, $F(1, 65) = 5.36, p < .03$, initiating event, $F(1, 65) = 9.47, p < .003$, and internal response, $F(1, 65) = 5.12, p < .03$, structures. No differences could be documented for the reaction or direct consequence structures. Thus, group differences in number of substructures produced were attributable primarily to the three structures that occurred in the middle of the story. There was no difference between groups in terms of the order in which the elements of the story were produced, $F(1, 65) = .39, p > .1$.

Errors. Children from the patient group had a higher error quotient score, $F(1, 65) = 6.81, p < .02$. Distributions of pooled error types were evaluated by chi-square analysis. This analysis was based on a total of 113 errors for the ALL group and 70 errors for the control group. Figure 1 illustrates group differences, $\chi^2(2, N = 67) = 8.88, p < .025$. For the patients, the most common types of errors were incomplete or ambiguous (53%), with far fewer that were additions or assumed information (19%). For the control group, the reverse was observed: The most common errors were additions or assumed information (41%) followed by incomplete and ambiguous (36%). Both groups produced approximately 25% alteration errors.

Completeness of episodes. Even though the patient group produced fewer elements and committed more errors, there was no group difference in completeness of the episodes, $\chi^2(2, N = 67) = .842, ns$. Twelve percent of patients and 22% of controls produced complete episodes; 33% of patients and 34% of controls produced incomplete episodes.

Discussion

Consistent with prior studies of prose memory, leukemia survivors in this study produced sparser stories than did their age-matched controls. Organization was, nevertheless, grossly equivalent in terms of the story grammar and sequence of elements. Thus, both groups were apparently using the same rules to structure their stories.

The group difference in number of elements arose primarily from the structures in the middle of the story. This pattern could reflect either the fact that these structures contained more information or an impact of primacy and recency.

The ALL group also committed more errors, indicating that even when they recalled a structure, it was more likely to be distorted or degraded. Of potentially greater explanatory significance were the qualitative differences in types of errors. Children in the control group were more likely to produce additions and assumed information: “The police were touched by her story and her life style”; “She did not have a husband.” Those in the patient group were more likely to produce incomplete or ambiguous information: “The police did something”; “She hadn’t for two days.”

The error profile suggests that the children in the patient group were less effective at using story schemata in encoding the story. Children in the control group were more likely to make errors such as assumptions and additions, which imply access to prior knowledge; those in the ALL group were more likely to produce degraded information, which raises the question of whether they used prior knowledge as a metacognitive strategy. Errors on narrative recall tasks,
particularly intrusions, have often been dismissed or viewed as interfering with the accurate recall of the material. In this case, however, error patterns proved to be discriminating. Moreover, intrusion errors may constitute circumstantial evidence for the more effective encoding strategy.

Story grammar has been represented as the internal linguistic structures of a story schema. The story schema emerges from the integration or relationship among the story grammar units. The presence of information reflecting story grammar structures is generally treated as evidence for the use of a story schema as a metacognitive strategy. The present data, specifically the error data, suggest that they may be dissociable: Evidence of a story grammar does not presuppose simultaneous access of a story schema. Even though the control group and the ALL group apparently coded information using specific story grammar structures in a similar fashion, the ALL group did not appear to integrate the relationships among structures into a unified story schema. Alternatively, their prior knowledge may have been relatively more limited such that they did not access a preexisting "robbery" script or schema.

Without efficient use of or access to a story schema, the child may be forced to rely instead on less efficient rote processes, memorizing discrete bits of information. Webster et al. (1992), evaluating logical memory in adults with right-brain injury, wrote:

When the theme of the story is either poorly presented or very unfamiliar to the listener, the subject's background knowledge may not be evoked and he/she will not be able to integrate the different elements into a meaningful story (Bransford & Johnson, 1973). Under these circumstances, the subject must rely on memory processes that do not integrate information but serve to create distinctive features for each of the sentences, much like the strategies used for learning a list consisting of unrelated words (Einstein, McDaniel, Bowers, & Stevens, 1984). (p. 223)

Protocols exemplifying the productions of children from the ALL group and their matched controls appear in the

Appendix. Productions of the ALL group characteristically consist of a concatenation of distinctive features for each of the sentences and do not demonstrate relationships between and among those features. For the controls, in contrast, the story schema—a robbery and its impact on the protagonist and her family—organizes interpretation and retelling of the narrative.

Although these findings by no means rule out a contribution of attentional compromise to prose memory deficits in these children, as Brouwers and Poplack (1990) suggested, they do provide strong evidence that metacognitive issues figure prominently and they support the conclusions of Rodgers et al. (1992) that were based on a list-learning task.

Our study, however, was directed toward a task that may have broader implications for cognition. The findings implicate the relational processing by which connections are made between what is known and what is to be known. The apparent learning difficulties encountered by these children may reflect the cumulative limitation of opportunities to consolidate and integrate newly acquired information into preexisting conceptual networks, which diminishes the long-term elaboration of these networks and their applicability to similar or novel contexts. By necessity, these children may rely on less economical strategies, such as monitoring individual bits of information, that may themselves be particularly inefficient in this group (Waber et al., 1990, 1992). Alternatively, a primary limitation of rote recall may diminish the quality of relational processing.

Although the neural bases for cognitive changes in ALL survivors are not well established, speculation has focused on white matter (Moore, Copeland, Ried, & Levy, 1992; Rourke, 1987; Waber et al., 1990; Wilson et al., 1991). Early damage to white matter, it has been argued, will be manifest primarily as non-verbal learning disabilities (Rourke, 1987). The present study suggests that such integrational deficits can be manifest in the relational aspects of language processing.

These findings may also have broad implications for facilitating learning, or the development of a more expansive knowledge base, in these children and, more specifically, for the enhancement of oral and written discourse. If recall of discrete bits of information does not presuppose the integration of those units into a unified whole, then strategies to facilitate that integration might be considered an essential component of instruction. Such metacognitive strategies might include the use of imagery (Bell, 1991) or the co-construction (teacher–student) of relevant schemata prior to presentation of new material.

References


Appendix

Sample Protocols of Two ALL Patients and Their Control Matches

ALL (11-Year-Old Boy)

"Anna Thompson was living in South Boston. She had four kids. She applied for a cooking job. She made $54. She got robbed at State Street and the children didn’t eat for two days."

Control (11-Year-Old Boy)

"Her name was Anna Thompson and she was employed as a cook and she reported to the City Hall that she was mugged of $56 and that her, she had four children and her rent was due and the police were touched by her story."

ALL (10-Year-Old Girl)

"Ann. She lived in Boston and worked as I don’t know. She robbed $50 from a bank. She had two children. They hadn’t eaten in two days and the cops heard the story and helped her get some money."

Control (10-Year-Old Girl)

"Anna Thompson, she was just hired at a school to be like a lunch person and she just been robbed and held up at City Hall and $56 was stolen from her and she had four children and they hadn’t eaten for two days. And so the police felt bad for her. So they took up a collection. I don’t remember the rest. The rent was due."

Received August 11, 1993
Revision received December 7, 1993
Accepted January 20, 1994