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Discourse Macrolevel Processing After Severe Pediatric Traumatic Brain Injury

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The purpose of this study was to determine if discourse macrolevel processing abilities differed between children with severe traumatic brain injury (TBI) at least 2 years postinjury and typically developing children. Twenty-three children had sustained a severe TBI either before the age of 8 ($n = 10$) or after the age of 8 ($n = 13$). The remaining 32 children composed a control group of typically developing peers. The groups' summaries and interpretive lesson statements were analyzed according to reduction and transformation of narrative text information. Compared to the control group, the TBI group condensed the original text information to a similar extent. However, the TBI group produced significantly less transformed information during their summaries, especially those children who sustained early injuries. The TBI and control groups did not significantly differ in their production of interpretive lesson statements. In terms of related skills, discourse macrolevel summarization ability was significantly related to problem solving but not to lexical or sentence level language skills or memory. Children who sustain a severe TBI early in childhood are at an increased risk for persisting deficits in higher level discourse abilities, results that have implications for academic success and therapeutic practices.

One of the most formidable tasks to improving the long-term cognitive-linguistic outcome in pediatric brain injury is to better understand the paradox of recovery for many of these children. For example, why is it that many children with severe brain injury show remarkable recovery on standardized language and cognitive measures, yet fail in the classroom? Whereas the answer to this quandary is certainly multifaceted, new evidence suggests that discourse macrolevel deficits may contribute to learning difficulties that persist at later stages post brain injury. This study examines discourse macrolevel abilities in children with severe traumatic brain injury (TBI) in relation to the moderating effect of age at injury.

DISCOURSE MACROLEVEL PROCESSING

Definition

Discourse macrolevel processing is conceptualized as extracting the most important information from connected language (Ulatowska & Chapman, 1994; van Dijk, 1995). Measures of macrolevel processing are those that require processes of reduction and transformation of information while preserving the central meaning. Types of macrolevel texts include summaries, main ideas, outlines, titles, and interpretative statements. These texts are shorter versions of the original discourse text, recursively conveying the same general meaning but containing less detail (van Dijk, 1995). Discourse macrolevel processing is contrasted with microlevel processing, in which the focus is on the isolated details, number of words and word types, and grammatical proficiency in conveying information.

Development

The cognitive abilities underlying the development of discourse macrolevel processing have been classified as executive functions (Brown & Day, 1983; Chapman, Levin, & Lawyer, 1999). These executive functions include processes such as judgment and problem solving (involved in sorting information according to importance), manipulating information in working memory, selective retrieval of important information from memory, and inhibition of less important or irrelevant details. The linguistic prerequisites of discourse macrolevel processing include comprehension of the discourse content, adequate vocabulary skills, and syntactic proficiency to convey the ideas. High-level vocabulary skills and the use of more complex syntactic structures have also been associated with conveying information at more generalized levels as required in macrolevel texts (Johnson, 1983; Ulatowska & Chapman, 1994). Pediatric TBI has been associated with impairments in all of these cognitive and linguistic domains (Levin, Ewing-Cobbs, & Eisenberg, 1995).

The majority of studies on the summary skills focus on normally developing children and show that macrolevel processing becomes refined with increasing age (Brown & Day, 1983; Johnson, 1983; Kinnunen & Vauras, 1995; Revelle, Wellman, & Karabenick, 1985; Vauras, Kinnunen, & Kuusela, 1994). When elementary school-age children (first through fifth grade) summarize information, they rely predominantly on the strategy of simple deletion of less important details with retention of important information. More mature summarizers, typically high school and college age, combine ideas across paragraphs and transform information into more generalized–transformed statements. As a result, they are able to convey more information in fewer words when compared to younger children (Brown, Day, & Jones, 1983). Nonetheless, even elementary school age children (6 to 10 years of age) use transformational strategies in summaries approximately 30% of the time as compared to a sixty percent ratio in college students when the content is within their knowledge base (Johnson, 1983).

Discourse Macrolevel Abilities in Children With TBI

Studies of macrolevel processing have served to elucidate the dissociations that can occur between macro and microlevel processing in adult populations (Chapman, Ulatowska, et al., 1997; Chapman, Ulatowska, King, Johnson, & McIntire, 1995; Chapman et al., in press; Ulatowska & Chapman, 1994). For example, patients with aphasia and relatively intact cognition exhibit preserved macrolevel processing but marked disruption in microlevel details.

Studies of macrolevel processing in children have emerged to examine the full scope of cognitive-communicative problems in children with TBI, which has gone unidentified with the use of standardized cognitive and linguistic tests (Chadwick, Rutter, Brown, Shaffer, & Traub, 1981; Chapman, Levin, & Lawyer, 1999; Levin

& Eisenberg, 1979). New evidence suggests that discourse macrolevel processing may be particularly vulnerable to the effects of severe TBI, especially the earlier the injury, and recovers slower than microlevel abilities (Brookshire, Chapman, Song, & Levin, 2000; Chapman et al., 1992; Chapman et al., 1998; Chapman et al., 2001; Chapman, Watkins, et al., 1997; Dennis, Barnes, Donnelly, Wilkinson, & Humphreys, 1996; Dennis, Barnes, Wilkinson, & Humphreys, 1998; Dennis, Guger, Roncadin, Barnes, Schacter, 2001; Dennis, Purvis, Barnes, Wilkinson, & Winner, 2001; Yorkston, Jaffe, Polissar, Liao, & Fay, 1997). Specifically, children with severe TBI show a marked reduction in recall of the gist information and on formulating a synthesized, interpretative statement (Chapman, Watkins, et al., 1997), although they may remember a great deal of the isolated facts, depending on the task demand on memory (Chapman et al., 1992; Chapman et al., 1998; Chapman et al., 1999).

Limitations in Macrolevel Discourse Processing Research

There are two major limitations in previous research concerning macrolevel discourse processing in pediatric TBI. First, the discourse tasks were not specifically designed to require macrolevel processing. For example, the discourse tasks asked for verbal and written retells rather than summaries (Brookshire et al., 2000; Chapman et al., 1992; Chapman et al., 1998; Chapman, Levin, Matejka, Harward, & Kufera, 1995; Chapman, Watkins, et al., 1997; Yorkston, et al., 1997; Yorkston, Jaffe, Liao, & Polissar, 1999). Second, the discourse tasks utilized brief narrative texts that placed minimal demands on condensing information (Ulatowska & Chapman, 1994). In fact, short texts are harder to reduce and transform because the information is already condensed.

It remains unclear whether children with severe brain injury fail to convey the most important, macrolevel meaning due to an inability to distinguish the most important points from the details. Alternatively, the reduced expression of important information may result from processing overload on tasks that emphasize the recall of details. Our team has speculated that children with brain injury may focus on the microdetails at the expense of macrolevel processing (Chapman et al., 1999). Because facility in macrolevel processing is related to learning achievement in the classroom setting (Kinnunen & Vauras, 1995), identification of poor discourse macrolevel processing by children with TBI could serve as a useful diagnostic and intervention guideline at subsequent, long-term recovery intervals (Johnson, 1983; Malone & Mastropieri, 1992; Stein & Kirby, 1992; Ulatowska & Chapman, 1994).

Purpose of Study

The primary purpose of this study was to determine the long-term consequences of severe TBI in childhood on discourse macrolevel processing as compared to typi-

cally developing peers through the elicitation of a summary and a lesson statement after listening to a narrative. A secondary goal was to explore the moderating effects of age at injury on discourse macrolevel processing. Additionally, we examined the relations between discourse macrolevel processing and performance on related cognitive and linguistic measures.

METHODS

Participants

Fifty-five children, ages 7 to 14 years of age at the time of testing, participated in this study. The participants were recruited from a larger research project examining cognitive and linguistic recovery after brain injury. Twenty-three of the children suffered severe brain injuries at least 2 years prior to testing and 32 were typically developing children.

Children with TBI were eligible for inclusion according to the following criteria: (a) TBI requiring hospitalization at least 2 years prior to assessment; (b) case history evidence that the injury resulted from a nonpenetrating head trauma, for example, motor-vehicle collision, or blow to the head; (c) documentation that injury was severe as established by a Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974) score of 3 to 8; (d) age 7 through 14 years at time of assessment; and (e) English as the primary language of at least one of the child's caregivers. Exclusion criteria for the study included (a) a prior history of neurologic or psychiatric disorder, (b) grade failure or previous diagnosis of learning disability or mental deficiency, (c) evidence of child abuse, and (d) a previous head injury resulting in hospitalization. Global outcome, assessed using a modified Glasgow Outcome Scale (Jennett & Bond, 1975) revealed that approximately 35% of the TBI group made a good recovery; however, almost 61% of these children were judged to have moderate disability.

To examine age at injury effects on discourse macrolevel processing, the TBI group was divided into two groups, that is, an early injury group consisting of children injured before 8 years of age and a late injury group consisting of children injured after 8 years. The cutoff of age 8 years was selected primarily because this is the age when summarization ability is emerging. Recent evidence suggests that children with traumatic brain injuries occurring prior to or during cognitive skill development are more vulnerable than when the injury occurs after the skill is well-developed (Ewing-Cobbs, Levin, Eisenberg, & Fletcher, 1987).

Table 1 summarizes demographic and clinical features of the two groups. Univariate analyses revealed no significant differences for age at test and parental socioeconomic level as reflected by the parent's education. However, there was a significant difference in gender distribution between the control and TBI group (p

TABLE 1
Demographic and Clinical Features of the Control and Severe Childhood Head Injury Groups

Variable	*Control*[a]	*Severe*[b]
Mean age at test (years)	11.70 (*SD* 2.77)	12.42 (*SD* 2.10)
Young (<8 years)		11.10 (*SD* 1.81) Range: 7.6–13.9
Old (>8 years)		13.44 (*SD* 1.74) Range: 11.2–14.0)
Mean age range since time of injury (years)		
Young (<8 years)		5.24 (*SD* 1.13) Range: 3.0–6.9
Old (>8 years)		3.64 (*SD* 0.83) Range: 2.6–5.8)
Mean parental education (years)	14.23 (*SD* 2.97)	13.30 (*SD* 2.15)
Gender		
Male	15	17
Female	17	6
Mechanism of injury		
Fall		1
Auto passenger		10
Motor vehicle–pedestrian		4
Bicycle		4
Motorcycle		1
Sports or play		3
Hit by falling object		0
Other		0
Glasgow Outcome Scale		
Good recovery		8
Moderate recovery		14
Information not available		1

[a]$N = 32$. [b]$N = 23$.

= 0.05), with the TBI group containing a larger proportion of males (control = 47%; TBI = 74%).

Narrative Stimuli

The experimental discourse stimuli involved a didactic long narrative entitled the "The Rich Man and the Shoemaker." This narrative was adopted from a second-grade reading text to ensure that the linguistic level was age appropriate (Appendix). The central meaning of "The Rich Man and the Shoemaker" is relevant to all ages because the story's actions convey a life-long lesson that "money does not necessarily bring happiness." Thus, the story's linguistic and conceptual complexity was appropriate for children ages seven years and older. The story consisted of two episodes (i.e., setting, action, resolution) conveyed through 45 sentences and

548 words. This relatively long story was chosen to discourage attempts at verbatim recall. The participants were instructed to condense the information.

Procedures

Participants were tested individually in a quiet room. Prior to hearing the narrative passage, the child was briefly familiarized with what it means to give a summary and a lesson. The examiner instructed the child to choose one of two familiar videocassette movie covers, either "The Beauty and the Beast" or "The Lion King." According to the child's preference, the examiner asked the child to listen carefully and then read the back of the video cover, after which, the examiner emphasized how much information was in the actual movie and how the summary on the video cover gave only the main events leaving out all the unimportant, extra details. The child was also told that the story taught an important life lesson. In a pilot testing, consisting of 10 controls and 9 TBI children, we found that all participants showed the ability to reduce the information in the form of a summary given specific examples. Several lesson examples, for the video story, were provided to ensure that the child understood the task. Several lessons were also given to illustrate to the child that there might be several ways to derive an appropriate interpretive lesson. Then the examiner told the child to listen carefully to a story, called "The Rich Man and the Shoemaker." The examiner reminded the child that he or she would not have to remember all the details of the story but just the main point from the story. Immediately after hearing the story, the child was asked to give a shortened version of the story in his or her own words. The child was told to include enough information so that the general meaning was clear and to leave out the less important details. The child was then asked to give a lesson that could be learned from the story. The child's summary and lesson responses were audiotaped and transcribed verbatim.

Linguistic and Cognitive Measures

To assess the relation of specific language and cognitive abilities to discourse macrolevel skills, performance on selected measures administered in the larger project were used. Cognitive measures of problem solving and memory and linguistic measures of vocabulary and sentence formulation were selected based on the literature that these domains are prerequisite to development of macrorules in summarizing texts (Brown & Day, 1983; Chapman et al., 1998; Stein & Kirby, 1992; Ulatowska & Chapman, 1994).

Problem solving was assessed using the raw score on the Block Design subtest from the Wechsler Abbreviated Scale for Intelligence (WASI; Wechsler, 1999). This test requires that participants recreate a three-dimensional block design provided by the examiner with a matching, two-dimensional block design using wooden blocks.

To address the potential role of memory deficits in summarizing a story, a test of verbal recall, the California Verbal Learning Test (CVLT)–Children's Versions (Delis, Kramer, Kaplan, & Ober, 1986) was given. The CVLT measures free recall of a 15-word list given in five consecutive trials. The sum of recall over all five trials was the memory measure (raw score) used in this study.

The Vocabulary subtest of the WASI (Wechsler, 1999) was administered and a raw score was computed. This test requires the child define a number of words increasing in complexity from concrete to more abstract. The raw score for the Formulated Sentences subtest of The Clinical Evaluation of Language Fundamentals (CELF; Semel, Wiig, & Secord, 1995) was used as a measure of lower-level, sentential language ability. As the name suggests, the subtest requires the child to verbally formulate sentences from words provided by the examiner. The provided words range from simple nouns (i.e., children), verbs (i.e., gave), and adjectives (i.e., younger) to more complex temporal (i.e., until, by the time) and causal (i.e., because, in spite of) phrases and relations.

Discourse Measures

The summary responses were analyzed using a systematic method developed by the first author based on the work of Kirby and colleagues (Kirby, 1988, 1991; Kirby & Cantwell, 1985; Kirby & Pedwell, 1991; Kirby & Probert, 1988) and from Kinnunen and Vauras (1995), and they were detailed in a scoring manual for our purposes. Each child's summary was divided into individual t units. A t unit is roughly equivalent to a sentence or a complete idea that can generally stand alone (Hunt, 1965). A t unit is defined as one independent clause and all the dependent clauses that modify it. The total number of t units in each child's summary was counted as a measure of amount of language used. Then each t unit was coded according to whether it was transformed or untransformed using the coding schema outlined in Table 2.

The score used to compare macrolevel discourse processing between the severe TBI and control group was the percentage of macrolevel t units contained within the summary productions. The percentage represented the total number of transformed t units (t units receiving a rating of 4–9; Table 2) divided by the total number of t units. The percent of t units transformed in the summary productions was used as a global index to distinguish between summaries that showed minimal transformation of the explicit information (t units rated as 1–3, Table 2) from those that demonstrated a modest use of macrolevel rules to condense information. Sample stories and scoring are shown in the Appendix.

The interpretative story lesson was evaluated using a rating scale ranging from 0 to 9 points. The scoring procedure was modified from work of Delis, Kramer, and Kaplan (1984) and has been used extensively by our team for over 12 years.

TABLE 2
Discourse Coding Schema for Transformation Analysis

Score	*Level of Transformation*	*Description*
0	Inappropriate inclusion of information	Incorrect, repetitious, unimportant information that is vaguely stated
1	Untransformed information: Copying or minimally paraphrasing original information	Unimportant information: Story details not necessary to convey central meaning
2		Important information: Vaguely stated
3		Important information: Verbatim or close semantic paraphrase of the story information
4	Transformed information: Combining explicit ideas into more concise and generalized statements	Important information: Transformed through inferencing, connecting information within an episode, but vaguely stated
6		Important information: Transformed through inferencing, connecting information within an episode
9		Important information: A generalized interpretation across the entire story content

The scale includes the components of concrete versus abstract, accuracy, and completeness of response. Sample responses and scoring are shown in Table 3.

To establish reliability of the analyses, 25% of the summaries and lessons were randomly selected and analyzed separately by two trained raters. Reliability scoring for the summary response yielded point-by-point interrater agreements of 92% for t units and 95% for transformed and untransformed units. Reliability scoring for the interpretative lesson response was 94%.

RESULTS

Statistical Analyses

A SAS procedure called GENMOD was used in modeling the summary task measures of (a) amount of information (i.e., number of t units) and (b) percent of information transformed in the summary productions. The GENMOD procedure uses a generalized estimating equation (GEE), which generates likelihood ratio chi-square values (Liang & Zeger, 1986). The SAS procedure of GENMOD was used because the outcome variables were not continuous, normally distributed

TABLE 3
Scoring of Lesson Transformation and Example Responses

Score	*Level of Transformation*	*Examples*
0	Incorrect concrete or incorrect abstract	Do not steal anyone's money
Untransformed information: Concrete		
1	Minimally correct concrete: Summary-like statement of an event in the story	The shoemaker should have found a better hiding spot for the money
2	Partially correct concrete: Only part of the lesson is given correctly, and the other part is omitted	The shoemaker should not have worried about money
3	Correct concrete: Complete moral that is tied to the text and is related specifically to the characters in the story	The shoemaker should have been happy with what he had and not worry about being rich
Transformed information: Abstract		
4	Minimally correct abstract: An attempt at generalization but incomplete, partially inaccurate, or not the expected main moral	Be yourself all the time, even if you do not have money
6	Partially correct abstract: Only part of the lesson is expressed abstractly and correctly and the remainder is omitted	Money is not the most important thing in the world
9	Correct abstract: Correct main moral, not specifically tied to the story characters, and generalized across the entire story based on real-life context	Being happy is better than being rich

measures. The outcome variable for percent of information transformed was divided into two categories. Specifically, a cutoff value of 20% was selected to divide the participants into either low transformers who used 20% or less transformed statements in their summaries or high transformers who used more than 20% transformed statements. These criteria were based on empirical evidence that children ages 6 to 10 years transform summary information at an approximate level of 30%. We chose a 20% cutoff to be on the conservative side. Injury and age at test were independent variables.

To determine age at injury effects after TBI on the ability to transform information in summaries, a lower value of 0% was established a priori based on our pilot data that few transformed statements were used by children with TBI. Thus the outcome variable for transformed statements was used to divide the TBI group into two groups—a no transformer group (0% transformed statements) and a trans-

former group (>0% transformed statements). The Fisher's Exact Test was adopted for this analysis, because 25% of the cells had expected counts less than 5. The younger age at injury group was defined as younger than 8 years old when they were injured ($n = 10$) and the older age at injury group was equal to or older than 8 years at the time of injury ($n = 13$). As stated earlier, this age split was based on empirical evidence that the age of 8 years is the age when summarization ability is emerging. Consequently, we hypothesized that this age may represent a period when children are more vulnerable to the negative effects of traumatic brain injury on the development of discourse summary skills (Ewing-Cobbs, Levin, Eisenberg, & Fletcher, 1987). The outcome variable for the lesson response divided the groups by a cutoff of 9 versus a rating of less than 9. A score of 9 represented an abstract, correct, and complete response. The same SAS procedure GENMOD was used in modeling this variable as described earlier. Spearman rank correlation coefficients were calculated to examine relations with a single macrolevel discourse score (i.e., percent of units transformed) to the two cognitive (Block Design and CVLT) and two linguistic measures (Vocabulary and CELF).

Summary Productions

Group effects. The statistical analysis revealed a significant difference in the percent of transformed information in the summary productions between the TBI group and the control group, $\chi^2(1, N = 55) = 3.79, p = .05$. Compared to controls, the TBI group produced less transformed information in their summaries (see Figures 1 and 2). No significant age at test effects was found for transformed statements.

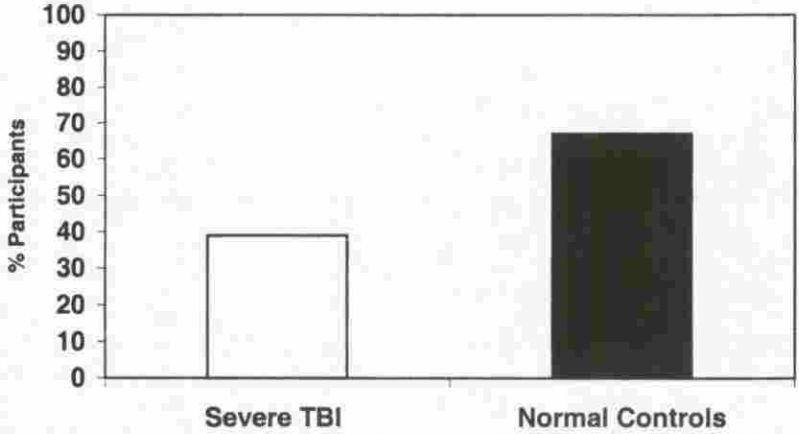

FIGURE 1 Percentage of control and severe TBI children whose summaries had greater than 20% transformed statements.

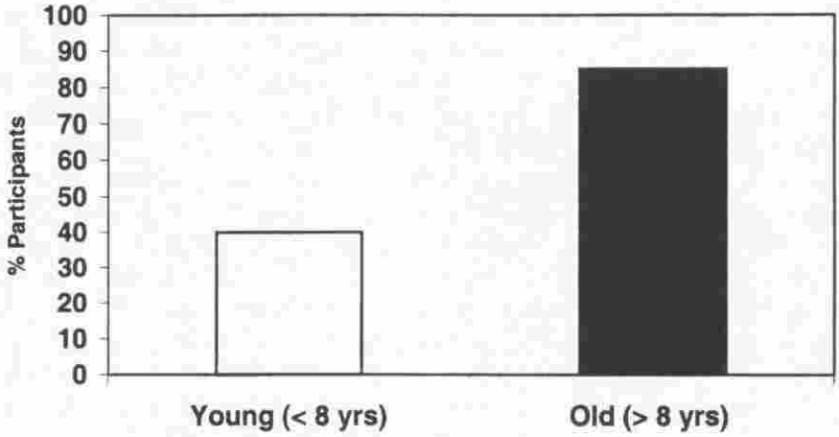

FIGURE 2 Percentage of severe TBI children (<8 years at injury) and severe TBI children (>8 years at injury) whose summaries contained transformed statements.

For the amount of language measure, there were no significant differences between the control and severe TBI groups. Both groups showed a similar degree of reduction in the amount of language used to give a summary of the original lengthy story containing 45 t units. There was a significant age at test effect, $\chi^2(1, N = 55) = 7.58$, $p = .006$, with older children using more t units.

For the interpretative lesson response, no significant difference was found between the severe TBI and control groups. There was an age at test effect, $\chi^2(1, N = 55) = 10.7$, $p = .001$, with older children being more likely to produce an accurate, complete, and abstract response.

Age-at-injury effects. A significant difference was found between the young age at injury (<8 years) versus the older age at injury (>8 years) group on the ability to transform information, $\chi^2(1, N = 23)$, $p < .05$. As shown in Figure 2, children with earlier age at injury produced significantly fewer transformed propositions in their summaries as compared to children injured at later ages.

Linguistic and Cognitive Measures

A significant difference was found between the control group and the TBI group on the Formulated Sentences subtest of the CELF ($p = .01$). No group differences were identified on the other measures of the Block Design subtest of the WASI ($p = .13$), CVLT ($p = .28$), or the Vocabulary subtest of the WASI ($p = .07$). There was no significant gender effect between groups on discourse processing performance or on the other cognitive and linguistic measures.

As shown in Table 4, statistical analyses revealed a significant positive correlation between the discourse macrolevel score in transforming information in summary production and the Block Design subtest of the WASI ($r = .57$; $p = .02$). No significant correlations were found between this same discourse macrolevel measure and the other measures, including the memory measure, that is, CVLT ($r = -.17$; $p = .22$); the Vocabulary subtest (WASI; $r = .45$; $p = .07$); or the subtest of Sentence Formulation, that is, CELF ($r = .19$; $p = .18$).

DISCUSSION

Children with chronic stage (>2 years postinjury) and severe TBI had more difficulty transforming discourse information in the form of summaries. Our data indicated that children with severe TBI showed significantly less use of transformation macrorules in their summary productions as compared to control children. Instead, the summary texts of children with severe TBI contained predominantly untransformed information shown by copying or minimally paraphrasing the original content. Thus, the children with severe TBI were more likely to use a lower level "copy–delete" strategy in condensing information than typically developing children. Whereas the ability to transform information in summaries was significantly reduced in the severe TBI group, a limited number of these children were able to transform some information.

One caveat with using percentage of transformed t units is that this measure does not take into account differences in amount of t units produced. However, it is important to recognize that more t units are not necessarily better when producing transformed summaries. An individual can produce a concise high-level summary in just a few statements. We are currently investigating a complementary measure

TABLE 4
Spearman Rank Correlation Coefficients of Discourse Summary Score With Other Cognitive and Linguistic Measures

Factor/Measure	*r*	*p*
WASI: Block Design	.57	.02*
CVLT: Monday List	–.17	.22
WASI: Vocabulary	.45	.07
CELF: Formulated Sentences	.19	.18

Note. WASI = Wechsler Abbreviated Scale of Intelligence Block Design raw score (Wechsler, 1999); CVLT = California Verbal Learning Test recall across Trials 1 through 5 of Monday List, raw score (Delis, Kramer, Kaplan, & Ober, 1986); WASI = Wechsler Abbreviated Scale of Intelligence Vocabulary raw score (Wechsler, 1999); CELF = Clinical Evaluation of Language Fundamentals Formulated Sentences raw score (Semel, Wiig, & Secord, 1995).

*$p < .05$.

of summary ability, namely a coherence and depth of processing rating, to characterize the qualitative aspect of the summary productions.

These results do not indicate that children with TBI form inaccurate mental representations of textual information. Rather, the summarization pattern shown by the majority of the children with severe TBI suggest that they continue to construct meaning at lower levels—being tied more to the lowest level of meaning as conveyed by the individual pieces of information. They displayed a marked reduction at intermediate levels of making inferences across sentences and at higher levels where summary statements are constructed to represent the global meaning of the text as a whole. It has been suggested that encoding information at lower–superficial levels makes the later retrieval of information more effortful and less likely since detail-based memory tends to be more transient over time (van Dijk, 1995). Moreover, the bias toward detail based encoding has been associated with low achievement in classroom contexts (Brown & Day, 1983; Johnson, 1983; Malone & Mastropieri, 1992; Stein & Kirby, 1992).

The study of summary performance extends previous discourse findings related to macrolevel processing in pediatric TBI (Chapman et al., 1992; Chapman, Levin, et al., 1995; Chapman et al., 1998; Chapman, Watkins, et al., 1997). In earlier studies, the study participants did not have specific instructions to focus on the main points. Rather, they were asked to retell the stories in as much detail as possible and their retells were subsequently analyzed according to whether or not the children included the important points. Using a more focused macrolevel discourse task that required selective reduction of information, children with severe TBI were found to perform significantly below their typically developing peers in developing higher level strategies of condensing information when tested 2 years or more after their brain injury.

Developmental studies reveal that the ability to transform information in summaries continues to evolve from a copy–delete strategy advancing to a more advanced strategy of transforming information at a more global level of semantic representation. This transition begins in early school years and is refined throughout adolescence and into college age (Brown, Day & Jones, 1983; Johnson, 1978). Most of the children in this study were injured prior to or during the stage when discourse transformation skills are emerging. Consequently, we postulate that the children who sustained severe TBI failed to develop later-emerging cognitive-linguistic skills required for summarization (Chapman & McKinnon, 2000). These data add to the mounting evidence that sustaining a brain injury in childhood prior to or during skill acquisition may alter or impede subsequent acquisition of that ability (Dennis, 2000; Ewing-Cobbs, Levin, Eisenberg, & Fletcher, 1987).

Furthermore, this study supports our hypothesis that a younger age at injury can have a more deleterious impact on the ability to acquire transformation rules. The children injured before 8 years of age performed lower than those injured after this age in transforming story information in their summary productions even though

they all experienced similar levels of injury severity. In addition, even though the young age at injury (<8 years) group had a mean of 2 more years to recover from their injuries (injury test interval) than the older age at injury (>8 years) group, the young age at injury group performed significantly poorer. This pattern of poorer long-term outcome in children with younger age at injury is consistent with previous evidence of age at injury effects (Chapman et al., 1998; Levin, Song, Ewing-Cobbs, Chapman, & Mendelsohn, 2001).

Discourse macrolevel processing is related also to the status of particular cognitive skills such as memory and problem solving. Memory problems common to severe TBI may have contributed to difficulties in transforming information in their summaries. Summarization skills rely on the integrity of memory systems because the individual must comprehend the meaning, retrieve from short-term memory the most important information, and then transform the information through inferencing (Brown & Day, 1983; Chapman et al., 1999; Kinnunen & Vauras, 1995). However, performance on an episodic memory measure did not correlate with ability to transform discourse information in a summary in this study. That is, children with higher recall did not necessarily show an increased use of transformed information. In fact, if anything, the relation was the reverse of expected in that there was a negative correlation.

The failure to find a relation between episodic recall may not be surprising given the different processing demands of macrolevel text processing and detail-based recall of textual information. Conveying the global meaning of a discourse text in the form of a summary may be dissociated from the ability to recall specific details (Reyna & Brainerd, 1998). Empirical evidence has shown that individuals typically recall little of the explicit story information even on immediate recall (Kintsch & van Dijk, 1978). In efficient text processing, knowledge of the central meaning persists despite limited memory of the precise words and sentences. The negative relation between episodic memory and transformed discourse summaries (i.e., increased memory for specific words being associated with reduced use of transformed information) suggests that focusing on the explicit details may hamper an individual's ability to engage in macrolevel processing. Thus, focusing on the detail may occur at the expense of extracting a more generalized meaning. Moreover, this pattern may be exacerbated if the individual has cognitive limitations, although this possibility needs to be explored.

Problem-solving abilities may play a role in acquiring the ability to transform information as implicated by the significant correspondence between transformed information in summary productions and performance on the nonverbal problem-solving measure. Summarizing requires comprehension of the isolated facts that make up the whole discourse text, sorting them according to importance, and appreciating the relation of the isolated facts to the central meaning of the whole discourse text. Similarly, solving a block design puzzle involves breaking the whole into its parts and appreciating the relation of the parts to the whole. Previous

discourse studies in brain-damaged populations have identified a significant relation between discourse macrolevel processing and cognitive performance on nonverbal problem-solving measures (Brookshire et al., 2000; Culhane, Chapman, & Levin, 1993).

The relation between the children's performance on the vocabulary subtest and the production of transformed summary information approached but failed to reach significance. Future studies should explore the nature of this relation. Previous studies have found a relation between vocabulary and discourse competence (Dennis & Lovett, 1990). Because summarizing information requires paraphrasing information at more generalized levels, a well-developed vocabulary may facilitate the expression of global ideas (Ulatowska & Chapman, 1994). In addition, the second structured measure of linguistic competence, that is, the ability to generate sentences from scrambled words, also did not correlate with the ability to produce transformed statements in the summary texts. This latter test probably taps a skill very different from that measured by sequencing ideas in connected language.

Whereas the cognitive measures used in this study revealed intriguing associations (problem solving–Block Design) and disparities (detail recall of word lists–CVLT) with discourse macrolevel measures, future studies should consider other cognitive measures to elucidate the cognitive mechanisms underlying discourse macrolevel processing. One important theoretical question is whether macrolevel processing in other cognitive domains, such as visual stimuli, is also impaired in pediatric brain injury. Second, whereas episodic memory for a list of words did not correspond to discourse macrolevel processing in this study, episodic memory as measured by tasks involving connected language may have been associated with discourse transformation ability. Moreover, measures of working memory capacity may be more informative and could be a key underlying cognitive prerequisite in supporting summarization skills. Summarization involves holding the information in working memory while mentally manipulating the information to make the necessary inferences to recode the content at a transformed level (van Dijk, 1995). Working memory limitations have a purported detrimental effect on inferential abilities (Worling, Humphries, & Tannock, 1999). In future research, it would be important to consider whether working memory capacity is a predictor of summarization skills in pediatric brain injury populations. In the linguistic domain, abstraction of similarities between two concepts could reveal higher level inferencing between two vocabulary items.

In addition to summarization, we evaluated discourse macrolevel processing on a task requiring formulation of the interpretive–generalized lesson expressed in a single statement. Whereas previous studies found significant impairments on generalized lesson responses in children with severe TBI at one year postinjury and longer (Chapman et al., 2001; Chapman, Watkins, et al., 1997), these results did not reveal a significant difference. Added to prior data showing that the ability to

produce an interpretive statement recovers slower than recall of discourse information (Chapman et al., 2001), these findings suggest that summary ability may be even more vulnerable to the effects of severe TBI than constructing a single global statement.

One possible explanation for the failure to find a difference in this study may have been due to a ceiling effect. In the discourse stimuli used herein, the characters were humans, whereas the characters in the previous studies were animals. To generate a lesson from the actions of animal characters requires another level of transposing the meaning from animal actions to human actions. Deciphering a lesson from human actions may be conceptually easier. However, the fact that there were age at test effects suggests that there is a developmental aspect implicating some degree of increasing complexity, even when humans are the actors from which the lesson has to be derived. Alternatively, the children may have had more exposure to the lesson that "money does not bring happiness." As a result of experience, this lesson may have been more salient than those conveyed in previous discourse stories. Additionally, the narrative stimuli used in earlier studies required more levels of inferencing to derive an interpretive statement, mitigating ceiling effects.

The inconsistency on the two discourse macrolevel tasks, that is, summary and lesson response, in children with severe TBI at least 2 years post injury is intriguing. Why should a story lesson be less impaired after severe TBI than the ability to summarize and transform information? One possibility is that formulating a lesson relies more on real life experiences and less on manipulating large segments of textual information. Alternatively, deriving lessons from narratives may be a more common learning experience whereas training in summarization skills is rarely provided (Hidi & Anderson, 1986). Summarization skills tend to be self-taught; however, children with learning problems have been shown to benefit from direct training, achieving higher levels of comprehension, memory, and improved summary skills as reflected in transforming information (Kinnunen & Vauras, 1995).

One obvious question is whether or not the children with severe TBI understood what it means to give a summary. Perhaps differences between summary and lesson responses were due to the participant's understanding of the task. Both groups produced texts that were reduced in terms of the amount of language used to convey their summaries as compared to the original story. In fact, both groups showed a similar amount of reduction in the amount of language. Based on this finding, it was felt that the children with severe TBI did understand that they were to condense the original content. However, the severe TBI group differed from the control group in the reduction strategies employed to produce summaries.

This study supports previous data suggesting that children who suffer severe TBI may show deficits on discourse macrolevel tasks (Chapman, Levin, et al., 1995; Chapman, Watkins, et al., 1997). The findings reported herein extend these findings to tasks that directly measure macrolevel processing, that is, summary

tasks. Summarization requires cognitive manipulation of large chunks of information and inferencing across statements. Stein and Kirby (1992) have claimed that one can infer from an individual's summary the cognitive processes that went into its construction.

CONCLUSIONS AND IMPLICATIONS

Children who sustain a severe TBI prior to adolescence are at risk for failing to acquire the ability to transform information required for generating summaries. Moreover, children with earlier injuries may be at greater risk for long-term impairments in transforming information than children who are older at the time of injury. Future studies are needed to examine recovery of discourse macrolevel processing abilities in longitudinal studies.

Although our data do not bear directly on injury severity effects, some preliminary evidence indicates that children with milder levels of TBI severity are not as impaired as children with severe TBI (Chapman et al., 2001). Nonetheless, children with milder degrees of TBI may experience some reduced ability to engage in macrolevel processing (Chapman et al., 1992), but this requires further investigation.

Frontal brain regions have been implicated in tasks requiring organizing lengthy discourse information during retell (Chapman et al., 1992; Chapman et al., 2001) as well as on tasks requiring macrolevel processing (Nichelli et al., 1995). It would be of interest to evaluate whether a relation exists between discourse macrolevel processing and frontal lobe injury in children with TBI. It may be that site of lesion interacts with age at injury with frontal lesions showing an incremental impact on subsequent development of macrolevel strategies.

These results would suggest that constructing macrolevel texts in the form of summaries is more difficult than providing interpretive statements for children with severe TBI. We have previously argued that diagnostic and treatment protocols relating to information processing abilities should proceed from retells to interpretive statements, with the most difficult being summaries (Chapman et al., 1999). These results would support such a sequence.

For children with TBI, impaired macrolevel processing may contribute to poor school achievement. The ability to produce macrolevel texts is related to learning achievement in the classroom setting for typically developing children (Kinnunen & Vauras, 1995). It would be of interest to study whether discourse macrolevel processing is related to academic performance in children with TBI.

Summarization may prove to be a promising therapeutic milieu in pediatric TBI because a person's ability to produce a summary directly represents how well he or she comprehends, remembers, and is able to use this information for later learning. The ability to summarize relies not only on linguistic competence, but also on cog-

nitive processes, and is correlated with academic achievement (Brown & Day, 1983). The evidence that learning skills in low achievers can be enhanced has stimulated interest in macrolevel processing in TBI (Kinnunen & Vauras, 1995; Stein & Kirby, 1992). Students' success in school relies largely on their repertoire of learning strategies and metacognitive skills (Brown & Day, 1983).

If children with TBI have greater than expected difficulties in producing macrolevel texts, then perhaps more appropriate interventions could be designed to give them explicit training in macrolevel strategies, that is, "when" and "how" to apply metacognitive knowledge to utilize macrolevel processing. Because earlier age at injury has an increased detrimental effect on discourse processing, perhaps earlier interventions could help to mitigate these age effects. Future clinical trials that incorporate summary training versus more traditional approaches would be beneficial in developing more appropriate treatments with the hope of enhancing learning achievement in children with TBI.

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REFERENCES

Brookshire, B. L., Chapman, S. B., Song, J., & Levin, H. S. (2000). Cognitive and linguistic correlates of children's discourse after closed head injury: A three year follow-up. *Journal of the International Neuropsychological Society, 6,* 741–751.

Brown, A. L., & Day, J. D. (1983). Macrorules for summarizing texts: The development of expertise. *Journal of Verbal Learning and Verbal Behavior, 22,* 1–14.

Brown, A. L., Day, J. D., & Jones, R. S. (1983). The development of plans for summarizing texts. *Child Development, 54,* 968–979.

Chadwick, O., Rutter, M., Brown, G., Shaffer, D., & Traub, M. A. (1981). A prospective study of children with head injuries. II. Cognitive sequela. *Psychological Medicine, 11,* 49–61.

Chapman, S. B., Culhane, K. A., Levin, H. S., Harward, H., Mendelsohn, D., Ewing-Cobbs, L., Fletcher, J. M., & Bruce, D. (1992). Narrative discourse after closed head injury in children and adolescents. *Brain and Language, 43,* 42–65.

Chapman, S. B., Levin, H. S., & Lawyer, S. L. (1999). Communication problems resulting from brain injury in children: Special issues of assessment and management. In S. McDonald, L. Togher, & C.

Code (Eds.), *Brain damage, behavior, and cognitive series*. Hove, East Sussex, UK: Lawrence Erlbaum Associates, Inc.

Chapman, S. B., Levin, H. S., Matejka, J., Harward, H. N., & Kufera, J. (1995). Discourse ability in head injured children: Consideration of linguistic, psychosocial & cognitive factors. *Journal of Head Trauma Rehabilitation, 10,* 36–54.

Chapman, S. B., Levin, H. S., Wanek, A., Weyrauch, J., & Kufera, J. (1998). Discourse after closed head injury in young children. *Brain and Language, 61,* 420–449.

Chapman, S. B., & McKinnon, L. (2000). Discussion of developmental plasticity: Factors affecting cognitive outcome after pediatric traumatic brain injury. *Journal of Communication Disorders, 33,* 333–344.

Chapman, S. B., McKinnon, L., Levin, H. S., Song, J., Meier, M. C., & Chiu, S. (2001). *Longitudinal outcome of verbal discourse in children with traumatic brain injury: Three-year follow-up*. Journal of Head Trauma Rehabilitation, *16*(5), 1–15.

Chapman, S. B., Ulatowska, H. K., Franklin, L. R., Shobe, A. E., Thompson, J. L., & McIntire, D. D. (1997). *Proverb interpretation in fluent aphasia and Alzheimer's disease: Implications beyond abstract thinking. Aphasiology, 11,* 337–350.

Chapman, S. B., Ulatowska, H. K., King, K., Johnson, J. K., & McIntire, D. D. (1995). Discourse in early Alzheimer's disease versus normal advanced aging. *American Journal of Speech-Language Pathology, 4*(4), 124–129.

Chapman, S. B., Watkins, R., Gustafson, C., Moore, S., Levin, H. S., & Kufera, J. A. (1997). Narrative discourse in children with closed head injury, children with language impairment, and typically developing children. *American Journal of Speech-Language Pathology,* 6(2), 66–76.

Chapman, S. B., Zientz, J., Weiner, M., Rosenburg, R., Frawley, W., & Burns, M. H. (in press). Discourse changes in early Alzheimer's disease, mild cognitive impairment, and normal aging. *Journal of Alzheimer's Disease and Associated Disorders*.

Culhane, K. A., Chapman, S. B., & Levin, H.S. (1993, February). *The relationship of discourse and cognitive task performance following closed head injury.* Paper presented at the International Neuropsychological Society Meeting, San Antonio, TX.

Delis, D. C., Kramer, J., & Kaplan, E. (1984). *The California Proverb Test*. Unpublished protocol.

Delis, D. C., Kramer, J. H., Kaplan, E., & Ober, B. A. (1986). *The California Verbal Learning Test: Research edition*. New York: The Psychological Corporation.

Dennis, M. (2000). Developmental plasticity in children: the role of biological risk, development, time, and reserve, *Journal of Communication Disorders, 33,* 321–332.

Dennis, M., Barnes, M. A., Donnelly, R. E., Wilkinson, M., & Humphreys, R. P. (1996). Appraising and managing knowledge: Metacognitive skills after childhood head injury. *Developmental Neuropsychology, 12,* 77–103.

Dennis, M., Barnes, M. A., Wilkinson, M., & Humphreys, R. P. (1998). How children with head injury represent real and deceptive emotion in short narratives. *Brain and Language, 61,* 450–483.

Dennis, M., Guger, S., Roncadin, C., Barnes, M., & Schachar, R. (2001). Attentional-inhibitory control and social behavioral regulation after childhood closed head injury: Do biological, developmental, and recovery variables predict outcome? *Journal of the International Neuropsychological Society, 7,* 683–692.

Dennis, M., & Lovett, M. W. (1990). Discourse ability in children after brain damage. In Y. Joanette & H. H. Brownell (Eds.), *Discourse ability and brain damage: Theoretical and empirical perspectives*. New York: Springer-Verlag.

Dennis, M., Purvis, K., Barnes, M. A., Wilkinson, M., & Winner, E. (2001). Understanding of literal truth, ironic criticism, and deceptive praise following childhood head injury. *Brain and Language, 78,* 1–16.

Ewing-Cobbs, L., Levin, H. S., Eisenberg, H. M., & Fletcher, J. M. (1987). Language functions following closed-head injury in children and adolescents. *Journal of Clinical and Experimental Neuropsychology, 9,* 575–592.

Hidi, S., & Anderson, V. (1986). Producing written summaries: Task demands, cognitive, operations, and implications for instruction. *Review of Educational Research, 56,* 473–493.

Hunt, K. W. (1965). *Grammatical structures written at three grade levels.* Research Report No. 3, Champaign, IL: National Council of Teachers of English.

Jennett, B., & Bond, M. (1975). Assessment of outcome after severe brain damage. *Lancet, 1,* 480–484.

Johnson, N. S. (1978). *A structural analysis of the development of story recall and summarization.* Unpublished doctoral thesis, University of California, San Diego.

Johnson, N. S. (1983). What do you do if you can tell the whole story? The development of summarization skills. In K. E. Nelson (Ed.), *Children's Language* (pp. 315–383). New York: Gardner.

Kinnunen, R., & Vauras, M. (1995). Comprehension monitoring and the level of comprehension in high- and low-achieving primary school children's reading. *Learning and Instruction, 5,* 143–165.

Kintsch, W., & van Dijk, T. (1978). Toward a model of text comprehension and production. *Psychological Review, 85,* 363–394.

Kirby, J. R. (1988). Style, strategy, and skill in reading. In R. R. Schmeck (Ed.), *Learning strategies and learning styles* (pp. 229–274). New York: Plenum.

Kirby, J. R., & Cantwell, R. H. (1985). Use of advance organizers to facilitate higher-level text comprehension. *Human Learning, 4,* 159–168.

Kirby, J. R., & Pedwell, D. (1991). Students' approaches to summarization. *Educational Psychology, 11,* 297–307.

Kirby, J. R., & Probert, P. J. (1988, September). *Instruction in the processes of summarization.* Paper presented to the International Congress of Psychology, Sydney, Australia.

Levin, H. S., & Eisenberg, H. M. (1979). Neuropsychological impairment after closed head injury in children and adolescents. *Journal of Pediatric Psychology, 4,* 389–402.

Levin, H. S., Ewing-Cobbs, L., & Eisenberg, H. (1995).Neurobehavioral outcome of pediatric closed head injury. In S. H. Broman & M. E. Michel (Eds.), *Traumatic head injury in children* (pp. 70–94). New York: Oxford.

Levin, H. S., Song, J., Ewing-Cobbs, L., Chapman, S. B., & Mendelsohn, D. (2001). Word fluency in relation to severity of closed head injury, associated frontal brain lesions, and age at injury in children. *Neuropsychologia, 39,* 122–131.

Liang, K. Y., & Zeger, S. L. (1986). Longitudinal data analysis using a generalized linear model. *Biometrika, 73,* 13–22.

Malone, L. D., & Mastropieri, M. A. (1992). Reading comprehension instruction: Summarization and self-monitoring training for students with learning disabilities. *Exceptional Children, 58,* 270–279.

Nichelli, P., Grafman, J., Pietrini, P., Clark, K., Lee, K. Y., & Miletich, R. (1995). Where the brain appreciates the moral of a story. *Neuroreport, 6,* 2309–2313.

Revelle, G. L., Wellman, H. M., & Karabenick, J. D. (1985). Comprehension monitoring in preschool children. *Child Development, 56,* 654–663.

Reyna, R., & Brainerd, C. J. (1998). Fuzzy-trace theory and false memory: New frontiers. *Journal of Experimental Child Psychology, 71,* 194–209.

Semel, E., Wiig, E. H., & Secord, W. A. (1995). *Clinical evaluation of language fundamentals* (3rd ed.). San Antonio: Psychological.

Stein, B. L., & Kirby, J. R. (1992). The effects of text absent and text present conditions on summarization and recall of text. *Journal of Reading Behavior, 24,* 217–232.

Teasdale, G., & Jennett, B. (1974). Assessment of coma and impaired consciousness: A practical scale. *Lancet, 13*(2), 81–84.

Ulatowska, H. K., & Chapman, S. B. (1994). Discourse microstructure in aphasia. In R. L. Bloom, L. K. Obler, S. DeSanti, & J. S. Ehrlich (Eds.), *Discourse analysis and applications* (pp. 29–46). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

van Dijk, T. A. (1995). On macrostructure, mental models, and other inventions: A brief personal history of the Kintsch-van Dijk Theory. In C. A. Weaver, S. Mannes, & C. R. Fletcher (Eds.), *Discourse comprehension* (pp. 383–410). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Vauras, M., Kinnunen, R., & Kuusela, L. (1994). Development of text processing skills in high-, average-, and low-achieving primary school children. *Journal of Reading Behavior, 26,* 361–389.

Wechsler, D. (1999). *Wechsler Abbreviated Scale of Intelligence*. San Antonio, TX: Psychological.

Worling, D. E., Humphries, T., & Tannock, R. (1999). Spatial and emotional aspects of language inferencing in nonverbal learning disabilities. *Brain and Language, 70,* 220–239.

Yorkston, K. J., Jaffee, K. M., Liao, S., & Polissar, N. L. (1999). Recovery of written language production in children with traumatic brain injury: Outcomes at one year. *Aphasiology,13,* 691–700.

Yorkston, K. M., Jaffe, K. M., Polissar, N. L., Liao, S., & Fay, G. C. (1997). Written language production and neuropsychological function in children with traumatic brain injury. *Archives of Physical Medicine and Rehabilitation, 78,* 1096–1002.

APPENDIX A
Narrative Overview and Original Stimulus of "The Rich Man and the Shoemaker"

Overview

"The Rich Man and the Shoemaker" introduces the main characters as a poor but happy shoemaker and his rich, unhappy neighbor who cannot sleep due to the constant worrying about his money and the shoemaker's singing. The first episode ends with the rich man giving the shoemaker one hundred pounds of money as a plan to keep him from singing happy songs. The second episode is considered a turning point in which the previous events have led to a role reversal for the two characters. Now it is the shoemaker who has become restless, worrisome, and unhappy. The shoemaker's wife advises the shoemaker to give the money back to the rich man because she prefers to be poor and to hear him sing than to be rich. The shoemaker promptly returns the money to the rich man and exclaims, "I want my life back." Therefore, to realize the gist of the story, one has to appreciate the role reversal situation for the two main characters. Specifically, this story revolves around the generalized lesson that money is not the root of happiness.

Stimulus

Episode 1. There was once a poor shoemaker who worked very hard to make the money his family needed. Even though he was poor, he was happy and always sang as he worked. The people of the village would come to listen to his happy songs. Next door to the shoemaker lived a rich man. He had all the things he wanted, but still he was not happy. All he could do was worry about his money. He was so scared that someone would take his money that he could not

sleep most nights. Then when he would finally fall asleep, the shoemaker's singing would wake him up. The same thing happened every night and every morning. The rich man began to get more and more upset about the happy songs of the shoemaker. The rich man began to think of a way to make the shoemaker stop singing. One morning the rich man knocked at the shoemaker's door. The shoemaker was so surprised to see the rich man because he obviously would not need to have his shoes fixed. Indeed the rich man had not come to see about his shoes. He wanted to talk to the shoemaker about money. The rich man said to the shoemaker, "You are the happiest man I have ever known. Here! I have a surprise for you. You have earned it with all your happy songs." He gave the shoemaker a heavy bag of money. Then the rich man walked home, thinking to himself that he would finally get some sleep.

Episode 2. The shoemaker excitedly ran into his house to count the money. "One hundred pounds!" he said in surprise. "This is enough money for us to live on for the rest of our lives if we spend it wisely. I must not tell anyone, not even my wife." Now all the shoemaker could do was worry about his money. He did not sing anymore. He just thought of hiding places for his money. First, he hid it under the bed; then under the bed covers. He was scared that his wife would find the money when she went to bed. So he took the bag outside and hid it in the chicken house in the yard. While the shoemaker looked for places to hide his money, the rich man slept. It was now the shoemaker who had a sleepless night, tossing and turning. The shoemaker thought he would sleep once he found a good hiding place for the money, but no place seemed safe enough. Finally one day the shoemaker's wife said, "What is wrong? I have never seen you so unhappy. Please tell me what the matter is." The shoemaker took the money bag from the chicken house and told his wife they were rich. "I should be happy, but I'm not. I have never known such worry." His wife told him to take the money back to the rich man. "It's not so bad to be poor. I would rather hear you sing than have money." The excited shoemaker took the bag of money and ran to his neighbor. His knock woke the rich man. "I'm sorry, but I cannot keep your one hundred pounds," the shoemaker said. "I want my life back."

Examples of Transformed and Untransformed Narratives and Lessons (T = transformed, UT = untransformed, I = incorrect)

Sample A: Male child with severe TBI secondary to a motor vehicle collision. Age at injury 5.7 years. Age at test 12.6 years. Glasgow Outcome Scale: moderate recovery

Summary:
The shoemaker was um, was poor (UT) / yet he was very happy (UT) / and he always sang songs and everything (UT) / And the rich man was worried 'cause he had to keep track of his money (UT) / and he was always, didn't like hearing his singing (UT) / So he gave him some money (UT) / and then the shoemaker was all worried (UT) / and he hid the money under the bed (UT) / and then he hid the money under the bed covers (UT) / and then he hid the money in the chicken house (UT) / And his wife finally made him give the money back. (UT) /

Lesson: Don't steal anyone's money. (I)

Observations:
The child showed good reduction of information, however, failed to transform any of the information (0% transformation). Notice the child's use of correct, important information. However, the child produced specific detail qualities from the story which were closely paraphrased from the story. Therefore, the child did not demonstrate a clear understanding of the deeper meaning of the story in the summary or in the lesson statement.

Sample B: Male child. Age at test 12.9 years (Age-equivalent control)

Summary:
There's a shoemaker who is really, really happy about his life (T) / and there is a rich man who doesn't like his life and who keeps on worrying about his money (T) / Well, finally, the rich man gives the shoemaker a lot of money, switching places in life with him (T) / And then the poor man learns his lesson about taking the money and thinks, "I should have left my happy life alone." (T) /

Lesson: Money can't make you happy. (T)

Observations:
Notice that the child condensed and transformed the information into his own words (100% transformation), using relatively long sentences with clausal embeddings. With regard to the information, the child produced coherent, correctly ordered ideas that revolved around the role reversal for the characters, thus revealing the central meaning. Additionally, the child clearly stated the meaning of the story using a shortened lesson statement.