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The effect of story presentation rates on story retelling by individuals with Down syndrome

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ABSTRACT
The current study examined the effect of story presentation rates on story recall performance in 35 individuals with Down syndrome and 3 control groups (35 mental age matched, 35 syntax comprehension matched, and 35 syntax production matched children). Three short audiotaped stories were presented to each individual at three different rates (normal, storyteller [slow with expressive inflections], and slow rate). The effect of group but not rate was significant. Individuals with Down syndrome recalled more content words than the production-matched group and the production-matched group recalled fewer content words than the mental age matched and comprehension-matched groups. The results were interpreted in relation to working memory deficits in individuals with Down syndrome, developmental change in story recall of typically developing children, and the contribution of syntax comprehension to story recall.

Language production involves multiple levels of processing, including message formation, compilation of the linguistic components (phonetic phonological, syntactic, semantic, and pragmatic elements), and speech execution (Bock, 1982, 1996; Griffin & Bock, 1998). Although these processes occur relatively automatically in typically developing children, trade-off effects can be observed when the speaking task is effortful (Streim & Chapman, 1987). Individuals with Down syndrome (DS) experience deficits in morphosyntactic production in spontaneous narrative and conversational samples (Chapman, 1997; Vicari, Caselli, & Tonucci, 2000). Because individuals with DS may experience greater effort in morphosyntactic processes than individuals at the same or higher expressive language levels, tasks that reduce information processing load compared to spontaneous narrative might benefit them more than controls matched

on spontaneous narrative production. Story recall is such a task, because it provides propositional content, as well as models, of the lexical choices and syntactic structures to convey the narrative, compared to the production task of spontaneously organizing a narrative on a topic. Reduced processing demands (compared to spontaneous narration) might increase recall of lexical items and propositional content more for the group with DS, making them more closely resemble a group matched for mental age (MA). In this study we evaluate whether the reduced processing demands of story recall (instead of generating spontaneous narrative) selectively affect individuals with DS for auditory story presentation at a normal rate, and we investigate the possible additional ameliorating effects of slower speaking rates, with or without the engaging prosodic variation used by skilled storytellers. As individuals with DS have auditory short-term memory deficits (Kay–Raining Bird & Chapman, 1994; Seung & Chapman, 2000), they might benefit more from having stories presented at slower rates. In the following sections, we will review evidence for the behavioral phenotype in DS, the reduced demands of the story recall task compared to spontaneous narrative for a variety of populations, and the ameliorating effects of slower speaking rate.

EVIDENCE FOR A BEHAVIORAL PHENOTYPE IN DS

Children and adolescents with DS show a typical phenotype of deficits in expressive language and verbal short-term memory. The short-term memory span of individuals with DS is typically lower than their nonverbal cognitive level (Seung & Chapman, 2000; Marcell & Weeks, 1988). Their language production level is lower than that of their comprehension and nonverbal cognitive skills (Chapman, 1995, 1997; Chapman & Hesketh, 2000; Dykens & Hodapp, 2001; Marcell & Weeks, 1988). Individuals with DS speak in shorter utterances on average than their nonverbal cognitive levels or syntax comprehension levels would predict in spontaneous language production (conversation samples or narrative samples). The short-term memory span of individuals with DS is typically lower than their nonverbal cognitive level (Marcell & Weeks, 1988; Seung & Chapman, 2000). Chapman and associates (Boudreau & Chapman, 2000; Miles & Chapman, 2002) examined narratives generated by individuals with DS. Story content and length of narrative (Boudreau & Chapman, 2000) and thematic content (Miles & Chapman, 2002) of narratives based on wordless films and picture books were significantly better than typically developing children matched for syntax production and similar to those of groups matched for syntactic comprehension and nonverbal cognitive levels. The problems of individuals with DS in the content and organization of discourse, however, were not as great as problems in the computational aspects of language skill (morphosyntax) in narrative.

EVIDENCE FOR THE REDUCED PROCESSING DEMANDS OF STORY RECALL COMPARED TO SPONTANEOUS NARRATIVE

Story recall or retell is a commonly used clinical and research tool that has advantages over other tools. First, story retelling is less demanding for partici-

pating children than generating spontaneous narrative (Liles & Duffy, 1995; Merritt & Liles, 1987, 1989; Purcell & Liles, 1992; Sutter & Johnson, 1995). Immediate story recall would likely reduce the effort required to generate a spontaneous story for children with DS who typically show language production deficits. Second, it provides us with richer information than a sentence as a unit of production (Bamberg & Damrad–Frye, 1991; Tager–Flusberg, 1995) while controlling story context across participants (Ripich & Griffith, 1988). Paul and Smith (1993) utilized a structured story retell task (i.e., Bus Story; Renfrew, 1977) with 4-year-old children. They studied narrative production of children who were identified as late talkers (slow in expressive language development) when they were 2 years old and a control group of typically developing children. When the story retell of the children was evaluated at age 4, children who remained as late talkers at age 4 scored lower in narrative measures compared to the normal control group and to late-talking children who made progress toward the normal group.

Story recall has been studied in various populations including children with attention-deficit/hyperactivity disorders (Lorch et al., 1999), children with learning disabilities (Copmann & Griffith, 1994; Griffith, Ripich, & Dastoli, 1986; Ripich & Griffith, 1988), children with mental retardation including DS (Bacon & Rubin, 1983; Loveland, McEvoy, Tunali, & Kelley, 1990; Luftig & Greenson, 1983; Tager–Flusberg, 1995), and children with language impairment (Graybeal, 1981; Merritt & Liles, 1987, 1989; Paul & Smith, 1993; Purcell & Liles, 1992).

Loveland et al. (1990) compared storytelling characteristics of children with DS and autism who were matched for age and verbal–mental level. The authors reported that both groups generated primitive narratives with different profiles that were related to the syndrome specific phenotypes: children with DS demonstrated more communicative gestures compared to the children with autism, and children with autism produced more "bizarre" responses that were interpreted as a syndrome-related deficit in pragmatics. Crais and Chapman (1987) examined children with language learning disabilities (LLDs) and reported that the LLD group performed poorly in story recall and in answering questions that require making inferences, compared to a receptive vocabulary matched control group. Wolman, van den Broek, and Lorch (1997) examined story recall and reported that children with mild mental retardation recalled less of the story content compared to the children with learning disabilities. Wilson and Ivani–Chalian (1995) found that the story recall subtest on the Rivermead Behavioral Memory Test was the most difficult of the subtests for the individuals with DS. These studies examined characteristics of stories in terms of quantity and quality of story recall, evaluating recall of story grammar elements (Stein & Glen, 1979), number of total utterances recalled, or complexity of story recall.

Several variables have been identified to affect story recall in typically developing children. Those include story schema, existence of causality within the story, constructive memory related to a child's prior knowledge (Greenhoot, 2000), and language comprehension. The majority of that research has been done in typically developing children and has focused on the effect of schema on story recall (Davidson & Hoe, 1993; Hudson & Nelson, 1983). Nezworski,

Stein, and Trabasso (1982) found that story schema plays a significant role in retrieving stories. Also having causal connections within the story assisted children in recalling the content words more accurately (van den Broek, Lorch, & Thurlow, 1996).

EFFECTS OF SPEAKING RATE ON COMPREHENSION AND PRODUCTION

Comprehension of syntax is affected by speaking rate for sentences in typically developing children, with poorer comprehension by kindergarten and second-grade children at faster rates (4.7–6.3 syllables/s) than slow rates (2.6–3.4 syllables/s; Berry & Erickson, 1973). Individuals with specific language impairment and auditory short-term memory deficits show increased difficulty in fast-mapping novel words in production but not comprehension when presentation rates are fast, rather than slow (Ellis Weismer & Hesketh, 1996).

Processing factors affecting verbal short-term memory or story comprehension might differentially affect the task for individuals with DS. To the extent that long-term knowledge, rather than verbal short-term memory, plays a role in story recall (Cain, Oakhill, Barnes, & Bryant, 2001), recall performance of individuals with DS might resemble cognitively matched or syntax comprehension matched comparison groups, rather than a group matched for syntax production. To the extent that auditory short-term memory factors determine story recall, individuals with DS might more closely resemble the syntax production group.

Here we varied story presentation rates to examine the effect of additional time or prosodic information to process and recall the story in individuals with DS. The rates included a normal speaking rate condition and two slow conditions (one with the heightened prosodic variation characteristic of engaging storytellers; Sutter & Johnson, 1995). In the present study, we presented audiotaped stories that varied in presentation speed (normal rate, storyteller rate, and slow rate) to each participant. Manipulation of the story presentation rates was selected to evaluate the reduced language-production performance of individuals with DS at a relatively larger unit (i.e., a short story) compared to a string of numbers (Seung & Chapman, 2000) or single-sentence level tasks (Seung & Chapman, 2003).

The purpose of this study was to compare group performances for spoken recall of recorded stories at three presentation rates, as indicated by number of words recalled. We asked four questions: Do individuals with DS have better story recall than typically developing children matched on spontaneous narrative production, but not compared to those who were matched on nonverbal MA or syntax comprehension? Would individuals with DS benefit from having extra processing time or information (either slow rate of story presentation or slow rate and extra prosodic information of storyteller rate)? Does syntax comprehension contribute to story recall in DS and control groups? Is there a developmental difference in story recall performance in the typically developing control groups?

METHOD

Participants

The participants with DS were part of a longitudinal study in which we tested the same individuals four times at approximately 2-year intervals. The story recall task was carried out at Time 3. We recruited participants (initially aged 5–20 years, in approximately equal distribution across the age span) with DS from the state of Wisconsin and northern Illinois through the human subject core at the Waisman Center in Madison, Wisconsin, and through newsletters for parent groups. Typically developing children were recruited at ages 2 through 6 (the range of mental ages and syntax comprehension and production levels) through the database of local births at the human subjects core, fliers at local stores, and bulletin boards in small towns outside Madison.

Participants included 35 individuals with trisomy 21 DS and three statistically matched control groups ($n = 35$ in each control group). The three control groups consisted of a nonverbal MA-matched group (MA group) who were matched on a mean age equivalent score of the Pattern analysis and Bead memory subtests of the Stanford–Binet test (Thorndike, Hagen, & Sattler, 1986), a syntax comprehension matched group (comprehension group) who were matched on the age equivalent score of the Test for Auditory Comprehension of Language—Revised (TACL-R; Carrow–Woolfolk, 1985) total score, and a syntax production matched group (production group) who were matched on mean length of utterance (MLU) of a 12-min narrative sample. Each participant's hearing and middle ear function were screened by a certified audiologist. Hearing thresholds were obtained at 500, 1000, and 2000 Hz at 20 and 40 dB in the sound field, and individuals with a hearing loss greater than 45 dB (i.e., mild hearing loss) were excluded from the study. Also excluded from the study were individuals who relied primarily on signing to communicate. Children in the comparison groups were excluded if their cognitive or language assessment scores fell more than 2 *SD*s below the average for their age. We elected the broader definition of normal range because we wanted to be sure the DS phenotype differences among skills were outside the normal range; but for those concerned that the criterion might have led to the inclusion of children with language impairment, defined according to a 1.5-*SD* criterion, an inspection of scores reveals that only 2 children's Peabody Picture Vocabulary Test—Revised (Dunn & Dunn, 1981) scores fell between −1.5 and −2 *SD* (standard scores were 76 when $M = 100$, $SD = 15$). All of the TACL-R scores fell above −1.5 *SD* of the mean.

The participants' characteristics are summarized in Table 1. The difference between the DS and matched control group did not reach statistical significance, $t\ (67) = 0.5$ for nonverbal MA between the DS and MA-control group, $t\ (67) = 0.2$ for TACL total score between the DS and comprehension matched control group, and $t\ (68) = 0.4$ for MLU between the DS and production-matched control group. The mother's years of education was an index of socioeconomic status; there were no group differences in mother's education, $F\ (1, 3) = 1.7$, $p > .05$. There were significant group differences in pure tone average thresh-

Table 1. *Characteristics of participants* (N = *35 in each group*)

	DS		MA		Comprehension		Production	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
CA	16.39	4.48	4.53	1.21	4.19	1.17	3.15	0.83
Nonverbal age[a]	5.58	2.02	5.26	1.86	4.43	1.52	3.36	0.81
PPVT-R[b]*	6.25	2.68	5.00	1.71	4.68	1.43	3.39	1.19
TACL-R[c]*	4.72	1.28	5.04	1.72	4.57	1.27	3.32	0.67
MLU[d]*	3.34	1.59	5.38	2.21	4.83	1.78	3.49	1.55
Education[e]	13.54	1.98	14.21	1.73	14.66	1.88	14.37	2.22
Hearing[f]	22.7	11.2	6.3	7.2	7.7	5.0	5.6	7.0

Note: DS, Down syndrome; MA, mental age; CA, chronological age; PPVT: DS > comprehension and production group, MA and comprehension > production group; TACL: DS, MA, and comprehension > production group; MLU: MA and comprehension > DS and production group.

[a]Matched on a mean of Pattern analysis and Bead memory subtest age equivalent scores of the Stanford–Binet Test (Thorndike, Hagen, & Sattler, 1986).

[b]Age equivalent score of the Peabody Picture Vocabulary Test—Revised (PPVT-R; Dunn & Dunn, 1981).

[c]Age equivalent score of the Test for Auditory Comprehension of Language—Revised (TACL-R) total score (Carrow–Woolfolk, 1985).

[d]Mean length of utterance (MLU) in morphemes of the 12-min narrative sample.

[e]Mother's education in years in school.

[f]Mean pure tone threshold at 20 and 40 dB in frequencies of 500, 1000, and 2000 Hz in left and right ears.

*$p < .05$.

olds, F (1, 3) = 36.1, $p < .05$. Even though there was a significant group difference in pure tone average, the mean pure tone average in the DS group was within acceptable limits for understanding speech. The gender of the participants was not a primary research question, but we tried to have a balanced number of boys and girls. There were 18 males and 17 females in the DS group, 20 males and 15 females in the MA group, 21 males and 14 females in the comprehension group, and 20 males and 15 females in the production group.

Procedures

Research assistants in communicative disorders at the University of Wisconsin–Madison administered the research protocols. Each participant listened to a total of three different audiotaped stories varying in rate (normal, storyteller [slow rate with inflection], and slow). Stories were simplified and adapted from Crais and Chapman (1987) and taped at 3.0–3.2 words/s for the *normal rate,* 1.4–1.5 words/s for the *storyteller,* and 1.4–1.5 words/s for the *slow* rate. The storyteller condition was also slow and included more varied prosody than the slow rate condition (Sutter & Johnson, 1995). This condition was included to compare the effects of more engaging prosody at the same slow rate. The participants listened

to one story at a time after the following instructions: "You are going to listen to a story. Then you're going to tell the story back to me. Listen very carefully." Immediately after listening to the story, the examiner asked the participant to tell the story back to her. An examiner prompted participants at the end of the story retelling task by saying "Is that all?" "Is there anything else?" or "Anything else about the story?" Listener effects on story performance arise when the speaker knows that the listener already knows the story (Menig–Peterson, 1976; Peterson, 1990; Sonnenschein, 1988) and when there is no other reason to be recounting the story (e.g., rehearsal). In this study, although the listener was the same across the three stories, the stories were different and their order of presentation and recall were counterbalanced across listeners.

Each participant's story recall performance was audio- and videotaped. Individuals' story recalls were transcribed by graduate assistants using the Systematic Analysis of Language Transcripts (SALT; Miller & Chapman, 1990). The following is one of the stories used in the study. The other stories are provided in Appendix A.

> Once there was a lion. In the morning he woke up hungry. He went to the river to look for something to eat. There was a monkey looking for bananas. The lion asked the monkey "Can I come down to drink?" The monkey laughed and said "Oh, yes, lion." And just as the lion got near, the monkey swung up into the tree. The lion went home hungry that day.

Transcription

Audiotaped samples were transcribed using SALT (Miller & Chapman, 1990) on a Vax mainframe computer. Graduate assistants transcribed samples orthographically following SALT conventions. Transcribers listened to the sample three times, and if one could not understand the segment, it was designated unintelligible. Utterance boundaries were determined by intonation pattern (i.e., rising or falling) or a pause longer than 2 s. Conjoined main clauses were segmented after the second clause, to limit the effect of discourse linking with "and." Transcription reliability was checked for all transcripts by a second transcriber and disagreements noted as additions, omissions, or changes to morphemes or changes to segmentation. Disagreements were resolved for the final transcription. The mean number of summed disagreements (additions plus omissions plus changes) per story per participant in morpheme transcription was 1.2 for the DS group and 1.78 for the control group. The mean number of disagreements in utterance segmentation were .3 per story for the DS group and .05 per story for the control group.

Scoring

We ran SALT 1 analyses upon completion of transcription and generated a word list for each story that included the words in the story with frequencies of their occurrence. A research assistant compared the SALT 1 word lists for the stories with the SALT 1 word lists for individual story retells and scored the frequencies of occurrence of content words by referring to the story gist word list.

Table 2. *Descriptive summary of number of words recalled in Condition × Group* (n = *35 in each group*)

	Story Condition					
	Normal		Storyteller		Slow	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*
Down syndrome	5.7	5.0	5.0	4.9	6.1	5.7
Mental age	7.1	6.0	6.4	5.7	6.7	6.3
Comprehension	4.9	5.0	6.3	6.5	6.5	5.1
Production	3.2	4.3	2.8	2.8	2.9	3.6

Credit was given to each occurrence in the story. For example, *monkey* occurred four times in Story A. Therefore, if a participant produced *monkey* six times during Story A recall, a maximum of 4 was scored as frequency of words recalled. A graduate student rescored 10% of the sample to check interrater reliability. Ninety percent agreement was obtained between the raters, and the differences were reviewed and changes in data entry were followed before executing statistical analyses.

RESULTS

Whether the groups differed in story recall as a function of different story presentation rates were examined using an analysis of variance (ANOVA). The dependent measure was the number of content words recalled.

Number of content words recalled: Lexical-level performance

The number of words recalled at three different story rates in each group is provided in Table 2. The effect of story presentation rate on story recall was analyzed using a Conditions (normal, storyteller, slow rate) × Groups (DS, MA, comprehension, production groups) ANOVA. Condition was a within-subject factor (3) and group a between-subjects factor (4). The main effect of group was significant, $F\ (1, 3) = 4.23$, $p < .05$, $\eta^2 = .09$, power = .85. Neither the story rate main effect nor the story rate by group interaction effect was significant.

Because the main effect of group was significant (see Figure 1), post hoc tests were used to compare groups. We selected Dunnett's C test, which does not require equal variances to control for Type I errors across the multiple pairwise comparisons. Significant differences ($p < .05$) were found between the DS and production groups ($\Delta M = 2.64$, $SE = .93$), the MA and production groups ($\Delta M = 3.75$, $SE = 1.2$), and the comprehension and production groups ($\Delta M = 2.94$, $SE = 1.0$).

The results supported the hypothesis that recall would improve with children's development. The language production matched group (youngest group) recalled fewer content words than the other typically developing matched

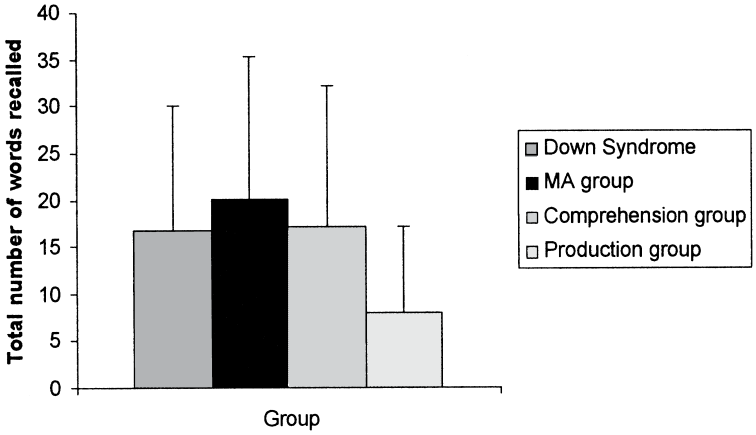

Figure 1. Story presentation rate and Down syndrome. The total number of content words recalled in each group.

groups. The results also supported the hypothesis that content recall by the DS group would be better than their production matched group. However, the results did not support the hypothesis that different groups would recall content words differently in different story conditions. Recall did not differ significantly in the normal versus slow conditions or in the storyteller condition. There was not a significant interaction effect between groups by conditions. Our stories did not contrast the full range of the rate variable. None were presented at fast rates, but the slow rate failed to show a predicted advantage for the DS group and the production group. The results of the post hoc analyses support the hypothesis that story recall by individuals with DS was commensurate with the comparison groups matched for nonverbal MA and syntax comprehension level and was better than the typically developing group matched for syntax production. The results support the expected developmental difference of the youngest group (syntax production group) in recalling fewer content words than the other control groups. Thus, the control group comparisons confirm a divergence for the group with DS between their expressive syntax production as indexed by MLU from spontaneous narrative (the matching variable) and the lexical content of their story retells.

Predictors of story recall within groups

Multiple regression analyses were conducted separately within the groups of participants with DS and the typically developing children as a whole to predict the individual variation in story recall in words. Two models were examined. In Model 1, the predictors evaluated were syntax comprehension (TACL), nonverbal MA, and syntax production (MLU). In Model 2, chronological age (CA) was added to the predictors of Model 1. In our previous study (Chapman, Seung,

Table 3. *Summary of multiple regression analysis for variables predicting story recall in words* (n = *35 for Down syndrome,* n = *105 for control group*)

	Variable	B	*SE* B	β
Down syndrome				
Model 1	TACL-R*	6.50	2.85	0.63
	MA	1.13	1.23	0.17
	MLU	0.30	1.78	0.04
Model 2	TACL-R	4.48	2.66	0.43
	MA	0.72	1.12	0.11
	MLU	0.31	1.60	0.04
	CA*	1.09	0.39	0.37
Control				
Model 1	TACL-R*	4.77	1.51	0.50
	MA	0.87	1.25	0.10
	MLU	0.89	0.67	0.13
Model 2	TACL-R*	4.44	1.62	0.46
	MA	0.32	1.54	0.04
	MLU	0.81	0.68	0.11
	CA	1.30	2.13	0.11

Note: See Table 1 for term definitions.
*$p < .05$.

Schwartz, & Kay–Raining Bird, 2000), we reported a significant contribution of syntax comprehension to the production measures (MLU, intelligibility, and total utterances) in a spontaneous narrative sample. We anticipated that syntax comprehension would be the strongest predictor of words recalled and MA, MLU, and CA did not contribute a significant explained variance when entered after comprehension in the model.

The results of the multiple regression analysis are summarized in Table 3. Within the DS group, the predictors accounted for 65% of the variance (adjusted $R^2 = .61$) in words recalled, F (3, 31) = 18.77, $p < .01$. The standardized coefficient (beta) for syntax comprehension was significant ($t = 2.28$, $p < .05$), but the beta was not significant for either MA or MLU. When CA was added to the predictors for words recalled in Model 2, 72% of the variance was accounted for by the predictors (adjusted $R^2 = .68$). The beta for CA was significant for words recalled ($t = 2.85$, $p < .05$), but the beta for syntax comprehension was not significant. This was the result of the size of the standard error as presented in Table 3.

Within the typically developing children ($n = 105$), predictors accounted for 45% of the variance (adjusted $R^2 = .44$) in words recalled, F (3, 101) = 27.93, $p < .01$. The beta for syntax comprehension was significant ($t = 3.16$, $p < .05$). Again, only the beta for syntax comprehension was significant ($t = 3.47$, $p < .05$). When we added CA as an additional predictor, the change was minimal (variance accounted for was 46%, adjusted $R^2 = .43$ for the words recalled).

The multiple regression results suggest that individuals with DS who have

better syntax comprehension performance are likely to recall stories better, and their CA contributed substantially to the predictions of words recalled. However, this result needs to be interpreted carefully. As shown in Table 3, the magnitude of beta in TACL was larger than that of the CA, but the standard error of the TACL was relatively larger than that of the CA. The results also suggest that typically developing children who have better syntax comprehension are more likely to have better recall of spoken stories. The syntax comprehension level contributed more in the DS group than in the typically developing children.

DISCUSSION

Group differences were revealed in story-recall performance, although the contrast of normal and slow speaking rates did not affect content word recall. Individuals with DS, and the comparison groups matched for MA and syntax comprehension level recalled more content words than the syntax production control group. Further, syntax comprehension skill contributed to the prediction of individual variation in both the DS and typically developing groups.

Working memory and story retelling: Theoretical framework

To retell a short story immediately after hearing it, we need to depend on several factors, including auditory working memory that stores verbatim information for a brief period (Baddeley, 1990); long-term episodic and semantic memory (Tulving, 1972); and language comprehension that processes phonological, morphosyntactic, semantic, and pragmatic aspects of language (Fletcher & Clayton, 1994; Poulsen, Kintsch, Kintsch, & Premack, 1979). In the current study, the DS and MA groups did not differ in nonverbal MA, receptive vocabulary, or syntax comprehension, but differed in spontaneous syntax production. The findings of commensurate story recall in words with the MA group and comprehension group, coupled with the portion of variance accounted for by syntax comprehension, suggest that story recall was affected more by syntax comprehension and long-term knowledge or overall cognitive level than by working memory, which holds relatively unprocessed information in temporary buffer. When auditory verbal short-term memory must be depended upon, in contrast (Seung & Chapman, 2000), the DS group did not show a longer digit span than the production group and did show a shorter digit span than the MA group. The disparity of results in these two studies are considered an outcome of the differences in processes involved; the digit span task depends on working memory more than comprehension processes, and the story recall task depends more on comprehension processes and long-term knowledge.

Relation between syntax comprehension and story recall

Story recall is a self-organized outcome of story comprehension involving a complex process that includes multiple levels of processing including syntax comprehension and mental representation of the story (Norbury & Bishop,

2002). The results of the multiple regression analyses indicate a strong connection between syntax comprehension and story recall.

The role of world knowledge has been demonstrated in other studies as well. Poulsen et al. (1979) studied the effect of comprehension on story recall of 4- and 6-year-old children. They found that children reconstruct a scrambled story based on story schema into a meaningful story and that they recalled stories better in a normal condition compared to the scrambled condition. Increased causal structure can also improve story recall. Lorch et al. (1999) interpreted their results to mean there was a positive linear relationship between recall and number of causal connections within a story.

Developmental change in story recall

The poorer story recall in the production group compared to the other typically developing children (i.e., MA and comprehension groups) suggests developmental change with age. The children in the production group were the youngest (mean age of 3.2 years) in our study. Developmental change associated with age has been reported along a broad continuum. A child's narrative development begins at around 3 years of age and progresses onward (Stein & Policastro, 1984). Around 5–6 years of age, a child's narrative includes focused event sequences (McCabe & Rollins, 1994). Varnhagen, Morrison, and Everall (1994) reported age-related developmental increases in story recall (amount of recall) in a study comparing preschoolers and first graders. Bamberg and Damrad–Frye (1991) reported developmental differences in the use of evaluative comments in children's narratives that compared narratives of 5- and 9-year-old children with those of college students. The differences between the DS and MA groups and between the DS and comprehension groups on words recalled did not approach statistical significance, although they differed significantly from the syntax production control group. These findings indicate that story recall performance is more commensurate with their nonverbal cognition and language comprehension levels than their production levels.

Limitations of the current study

Overall poor performance on story recall. Story recall performance in number of content words recalled was notably low in all four groups. There are several factors that might have contributed to the story recall performance obtained in the current study. Recall was measured through verbatim occurrence of content words; gist-based measures might have shown more evidence of recall (and conversely, measures depending on syntactic proficiency might have shown less).

Lack of visual support for story interpretation and memory might also have played a role. Listening to audiotaped stories might have required more effortful attention than watching a videotaped story by the participants (Johnson, 1988). The task might also have been more conducive to holding the children's attention if picture props were available to facilitate activation of a mental model

(Johnson–Laird, 1983; Newton, 1994) of the stories or if the story was presented in pictures as well (Berman, 1995). Gibson, Glynn, Takahashi, and Britton (1995) reported that stories accompanied by pictures improved performance in both children with mild mental retardation (10–13 years old) and typically developing children (6–7 years old). Beck and Clarke–Stewart (1998) presented a segment of a dramatic movie to 5-year-old children and asked a set of questions that guided the children's attention to the important feelings and facts of the movie and corrected misunderstanding of the children's comprehension. The results yielded better recall and comprehension of the narratives when the participants were asked a set of questions that were relevant to the stories. Merrit, Culatta, and Trostle (1998) also made several suggestions for improving narrative performance of children with language impairment.

Rate manipulations. Failure to observe any difference for the slow-rate condition may have resulted from the recording of the slow-rate condition not sounding natural to the participants, but the slow rate with more expressive prosody (storyteller condition) did not improve performance. The study would have benefited from inclusion of a faster than normal rate as well.

Use of MLU to match production group. Eisenberg, Fersko, and Lundgren (2001) have suggested that the MLU be regarded as a measure of utterance length, instead of a measure of morphosyntax. The utility of MLU as a measure of morphosyntax will decrease once a child's MLU is higher than 4 or a child reaches the age of 45–54 months (Bernstein & Tiegerman–Farber, 1997) unless utterance segmentation conventions are adopted, as here, that control for the use of *and* as a means to increase utterance length. (We allowed only one pair of clauses to be conjoined by *and* or *and then* before introducing a period.) When such segmentation criteria are added and the sample is a narrative one, the MLU measures typically show increases through 7–9 years of age (see Leadholm & Miller, 1995). However, the MLU clearly fails to capture all forms of syntactic progress, including the pragmatic knowledge of relatively older children who can take the discourse context into account (e.g., use of ellipsis in responding to questions by an adult conversation partner, single word yes/no response to questions, imitation of adult utterance; Johnston, 2001).

Use of content words as a measure of recall. Verbatim recall of story sentences occurred only rarely in the transcripts. This fact excludes both a potential measure and a potential concern regarding the use of verbal recall as a measure of story recall: that performance was only imitative. Word recall measure was selected for analysis of story recall due to the relatively poor performance of the study participants in amount recalled. When story recall performance was defined in terms of the number of propositions (Foss & Hakes, 1978), where a proposition was defined as the smallest meaningful unit of a sentence (a gist), the pattern of results was similar to the results reported here. Had propositional recall been better, story recall measures could have been used that reveal higher levels of story recall, such as story grammar elements (Applebee, 1978; Page & Stewart, 1985; Stein & Glenn, 1979), story points (Wilensky, 1983), or *t*-unit

measures that reveal syntactic complexity (a main clause plus subordinate clauses; Hunt, 1970). These higher level measures should be examined in the studies where recall levels permit their use.

FUTURE DIRECTIONS

A follow-up of the current study could contrast story recall directly for spoken presentation versus a method that can improve the recall of propositions across the groups, including picture presentation and verbal scaffolding. Schneider (1996) examined effects of story modality (picture vs. oral presentation) on story recall with children with language impairments and found improved recall with pictures. Beck and Clarke–Stewart (1998) reported that children retold the stories better when they discussed the movie afterward with an adult following a "pedagogical protocol" (i.e., monitor children's comprehension of stories via structured sets of questions relevant to the story). This paradigm should be examined as an intervention tool for children with DS, who may benefit from story-based language intervention. In addition, other factors that may impinge on story recall of individuals with DS require investigation. Increased causal structure has been identified as making stories easier for children to remember (Lorch et al., 1999; Wolman et al., 1997) and might be differentially effective for children with DS compared to the syntax production controls.

APPENDIX

STORY B

Once there was a boy named John. He wanted to marry a king's daughter. The king said that first John had to find out which of the king's ducks was a girl duck. The magician whispered to John the girl duck always went into the water first. So John took the ducks to the lake. He said that the first duck into the water was a girl. John was right and the king's daughter married him.

STORY C

Once there was a little dog named Frank who belonged to a girl named Susan. Frank wanted to play. He scratched on the door. Susan opened it. And Frank jumped into her arms wagging his tail. Susan looked puzzled. "Do you want to play?" she asked. She got the frisbee from the closet and walked with Frank to the park. There she threw the frisbee as far as she could and each time Frank caught it in his mouth and brought it back.

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