



Free recall of word lists differing in phonological similarity, word frequency, and phonotactic pattern frequency in SLI

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Abstract

Phonological encoding refers to the reciprocal processes in which phonological strings are broken down into smaller units for subsequent tasks like recall or repetition, or where smaller units are combined into larger phonological strings for articulation. It can be measured by having listeners recall lists of words differing in phonological similarity among list items. Participants typically recall fewer phonologically similar words, presumably because traces of similar words interfere with one another in the phonological store. To examine group differences in efficiency of phonological encoding, 16 children with SLI (mean age 10;2) and age-matched controls recalled lists of CVC words, two to six items in length, differing in phonological similarity without replacement. Word lists also differed orthogonally along another two dimensions affecting recall by typical adults—word frequency and phonotactic probability. Results reveal that all children recalled fewer words from phonologically similar lists. While children with SLI recalled fewer words overall, they were less affected by phonological similarity, suggesting less efficient phonological encoding. All children recalled more high frequency words and more words with frequently occurring sound patterns. However, the two groups did not differ in their sensitivity to these measures. Both groups also showed similar serial position curves. These results suggest that children with SLI have reduced capacity and less efficient phonological encoding strategies, but remarkably similar memory processes. [Research supported by NICHD DC-05553, DC-04072, and DC-005650.]

Memory Deficits in SLI

Children with SLI have difficulty with verbal recall.

In recall tasks, children with SLI recall fewer items than their typically developing peers. Some theories view this as an underlying cause of SLI¹, while others view memory deficits as resulting from a more pervasive linguistic deficit².

¹Gathercole & Baddeley, 1990; ²van der Lely & Howard, 1993; MacDonald & Christiansen, 2002

Children with SLI may use less efficient rehearsal strategies.

In Baddeley & Hitch's working memory model, auditory words are assumed to be stored in the phonological loop, subject to decay unless they are actively maintained, such as through rehearsal. Recall is better for items at the beginning and end of a list—primacy and recency effects, respectively. Primacy effects are attributed to rehearsal of initial items, while recency effects are attributed to output of the storage buffer at time of recall. Children with SLI exhibit reduced primacy effects, suggesting poorer rehearsal.

Baddeley & Hitch, 1974; Kirchner & Klatzky, 1985; Mainela-Arnold & Evans, 2005

Reduced capacity or linguistic impairment?

Another way to examine rehearsal is by having listeners recall lists of phonologically similar vs. dissimilar words. During rehearsal, traces of similar items interfere with one another so they are recalled less well. Children who use less efficient encoding strategies are less influenced by phonological similarity among items to be recalled.

Baddeley & Hitch, 1974; Liberman, Shankweiler, Liberman, Fowler & Fischer, 1977

Children with SLI use less efficient phonological encoding strategies, at least when their memory resources are exceeded.

Children with SLI show the expected phonological similarity effects for shorter word lists, but not for longer lists. However, these studies recombined a single set of words, so children heard each word multiple times. Practice effects likely influenced recall.

Gathercole & Baddeley, 1990; James, van Steenbrugge & Chiveralls, 1994; c.f., Montgomery, 1995; van der Lely & Howard, 1993

Language knowledge also influences recall.

In the process of redintegration, decaying, partial phonological traces are reconstructed from established lexical and/or sublexical knowledge¹. Adults use both of these, word frequency and phonotactic probability, to facilitate recall².

¹Thorn, Gathercole & Frankish, 2005; ²Roodenrys, Hulme, Lethbridge, Hinton & Nimmo, 2002

Research Questions

1. Do children with SLI encode phonological information less efficiently? Are they less influenced by phonological similarity among items to be remembered?
2. Do children with SLI show the same redintegration processes as children developing language typically? Is their recall facilitated by word frequency and phonotactic probability?
3. Do children with SLI show the same serial position effects? Are rehearsal processes similar for both groups?

Method

Participants

16 monolingual English-speaking children with SLI and 16 age-matched control children participated. All children had highly intelligible articulation and nonverbal IQ scores greater than 85. The children with SLI included 2 with E-SLI and 14 with ER-SLI, 9 females and 7 males aged 8;7 to 11;8. The age-matched control children included 8 females and 8 males aged 8;5 to 12;3.

Group	Age	CELF FLS	CELF RLS	PPVT-III	EVT	NWR	CLPT
SLI	10;2 (1;0)	72.4 (11.0)	68.7 (13.2)	91.3* (10.3)	81.9* (6.7)	78.9* (8.2)	36.3* (13.7)
TYP	10;2 (1;2)	110.7 (12.6)	---	107.1 (8.5)	98.3 (11.9)	87.5 (5.9)	55.5 (14.4)

Stimulus Materials

Eighty lists of CVC words ranging from two to six items in length were created. Two lists at each of five lengths varied along three orthogonal dimensions: phonological similarity, word frequency, and phonotactic probability.

The 1099 English CVC words rated high in familiarity were separated into high and low word frequency groups by a median split. They were then separated into high and low phonotactic probability groups by another median split. Thus, there were four groups of words: (1) high word frequency, high phonotactic probability (hi wf, hi pp); (2) hi wf, lo pp; (3) lo wf, hi pp; and (4) lo wf, hi pp. Words from each of the four groups were combined into 20 lists, four at each length (2 - 6 items). Two lists at each length contained phonologically similar words; two contained phonologically dissimilar words. Each word appeared in only a single list.

The 320 words were produced by a female speaker from the local dialect, with no duration differences due to wf or pp. Words were excised, normalized for volume, and concatenated into lists with a 1-s ISI. Time between lists was 5s for two-item lists, and increased with list length.

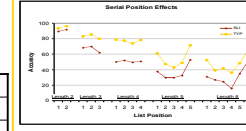
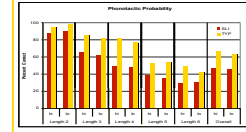
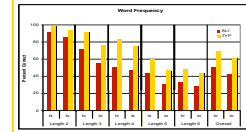
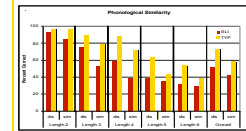
Procedure

Children were tested individually in a quiet room. They were told that they'd be hearing list of words, and that their job was to repeat them back in any order. In a blocked design, two-item lists were presented first, with list length increasing, concluding with six-item lists. Children's responses were recorded for subsequent scoring.

A word was scored as correct if it was repeated, with no restriction on order.

hi wf, hi pp		hi wf, lo pp	
dis	sim	dis	sim
give	rice	mouth	peak
worse	light	chain	tip
yell	wine	loop	cheap
ride	rain	wish	pitch
phone	line	dog	keep
make	wait	five	chip
lo wf, hi pp		lo wf, lo pp	
dis	sim	dis	sim
deed	pun	zoom	jug
hip	tin	peach	chick
wool	keen	knack	jerk
chess	ping	lull	chug
fern	kin	thief	jig
cave	pine	tide	chuck

Results



1. Group. Children with SLI recalled fewer words overall.
2. List Length. Accuracy decreased as list length increased. This effect was the same for both groups.
3. Phonological Similarity. All children recalled fewer phonologically similar words. A significant group x similarity interaction revealed that children with SLI showed a smaller phonological similarity effect than controls.
4. Word Frequency. All children recalled more frequently-occurring words. This effect was the same for both groups.
5. Phonotactic Probability. All children recalled more words with common phonotactic patterns (p=.07). A significant pp x wf interaction revealed that this effect was significant for frequent words, but not for less frequent words. This was the same for both groups.
6. Serial Position Effects. In longer lists, all children recalled list initial and list final items at higher rates. This effect was the same for both groups.

Conclusions

1. Children with SLI recalled fewer items overall, but showed the same sensitivity as children with NLD to word frequency, phonotactic probability, and serial position. This suggests that they can use language knowledge for redintegration, to facilitate recall.
2. However, because they are less influenced by phonological similarity among items to be recalled, their phonological encoding processes are less efficient, at least when memory resources are exceeded.

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