

CORTICAL PROCESSING OF SPOKEN WORDS IN SLI CHILDREN

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INTRODUCTION

Specific language impairment (SLI) is associated with a pervasive impairment of language-related functions, particularly with limited vocabulary and poor verbal short-term memory (1, 2). In SLI adults, the speech-evoked cortical activation in the left and right superior temporal cortex does not attenuate by stimulus repetition and differentiate between words and pseudowords as clearly as in non-impaired adults (3). The auditory cortical responses show striking developmental changes from childhood to adolescence (4, 5). We followed the effects of word repetition and lexicality on speech-evoked neural responses in SLI and non-impaired children using magnetoencephalography (MEG).

METHODS

Stimuli, experimental setup and subjects

- spoken real words (150 items) and pseudowords (100 items)
- duration 550 ms (7-8 letters)
- presented every 2.5 seconds
- 75 real words repeated immediately after the first presentation
- total length of the experiment 8 + 8 minutes

"listen to the stimuli and respond to proper names by button press" (probability 6%)

306-channel Elekta Neuromag with continuous head position tracking and movement compensation (6)



Subjects

Children (mean age 9 yrs 7 months; range 106 – 127 months) from 'Etiology of dysphasia, symptoms and prognosis' -project

- 10 with no history of language impairment
- 11 children with a diagnosed SLI

COGNITIVE PROFILE OF THE TWO SUBJECT GROUPS

Tests	Controls	SLIs	significant P
Vocabulary (a)	26.0 (7.1)	17.8 (10.3)	C > SLI
Block design (a)	43.5 (6.7)	44.8 (11.1)	
Digit span score (a)	7.0 (1.2)	5.9 (1.0)	C > SLI
Pseudoword repetition (b)	12.5 (0.8)	10.2 (2.3)	C > SLI
Sentence repetition (b)	26.6 (1.8)	22.9 (4.0)	C > SLI
Phonological processing (b)	31.9 (3.3)	27.7 (2.2)	C > SLI
Sentence reading (c)	13.2 (3.1)	10.8 (4.1)	
Reading speed (/min)	83.1 (35.5)	63.4 (30.5)	
Naming speed (ms)	46.6 (9.8)	48.4 (7.9)	

(a) WISC-III (Wechsler, 1991), (b) NEPSY (Korkman et al., 1998)
 (c) ALLU (Elementary School Reading Test, Lindeman et al., 1998)
 standard deviations in parentheses

■ = tests that distinguished SLIs from the control group
 C = control subjects, SLI = SLI subjects

EVOKED RESPONSES - CONTROL CHILDREN

Adults: N100 response followed by a longer-lasting N400 response (3, 7)
Children: N100, N250 and a delayed N400 response (maximum ~ 600 ms)
N400 activation: attenuated by the immediate repetition of spoken words

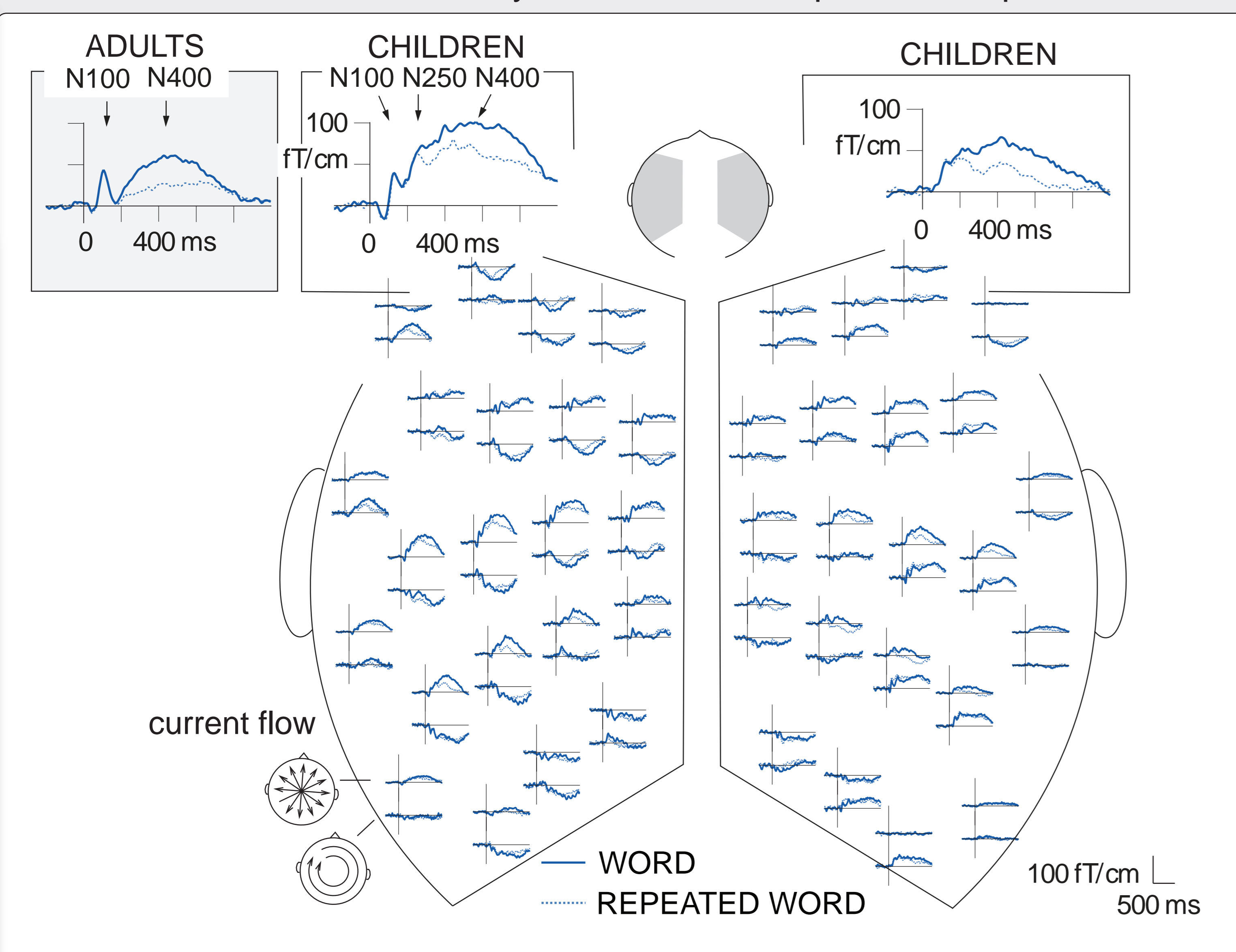


Fig 1. Mean evoked responses recorded by planar gradiometer MEG sensors and calculated across 10 control children to spoken words presented for the first time and to their immediate repetitions. The responses are displayed for the 22 channel pairs centered above the temporal areas that show the maximum signal.

MINIMUM CURRENT ESTIMATES - CONTROL CHILDREN

Activation centers around the bilateral superior temporal cortices during the N100, N250 and N400 responses.

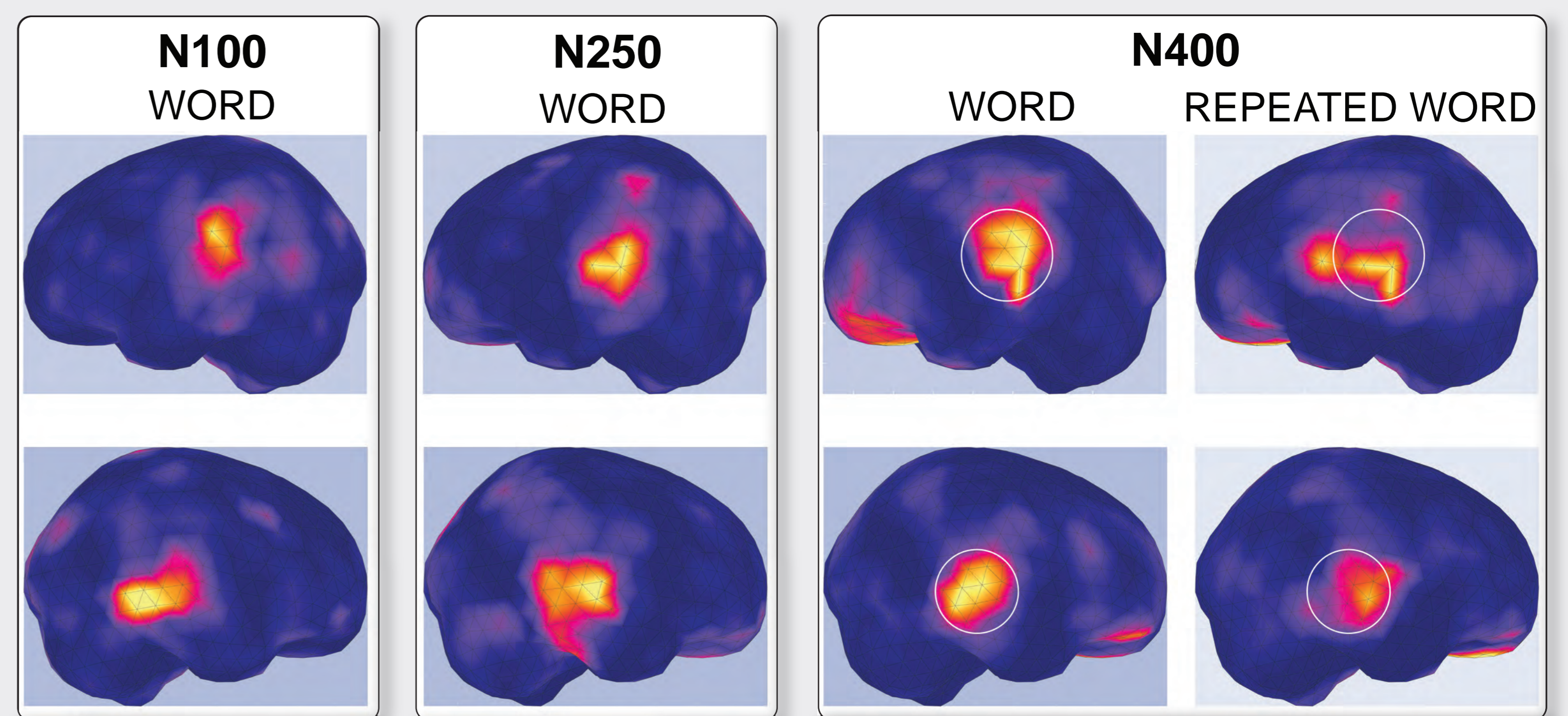


Fig. 2. MCEs (8) for spoken words during the N100, N250 and N400 responses. The estimates were calculated for each child and then averaged across all control children using a default brain model. Activation is integrated over 120-140 ms (N100), 230-270 ms (N250) and 400-600 ms (N400).

CURRENT DIPOLES - SLI AND CONTROL CHILDREN

The bilateral N400 responses modeled as equivalent current dipoles (9)

Activation to spoken words vs. repeated words:

- Onset phase of the N400 reflects activation of lexico-semantic representations (3,7)
- SLI children: the repetition effect (index of short-term maintenance of activation) 400-600 ms after word onset was nonexistent in the left hemisphere (in control children $p < 0.04$).

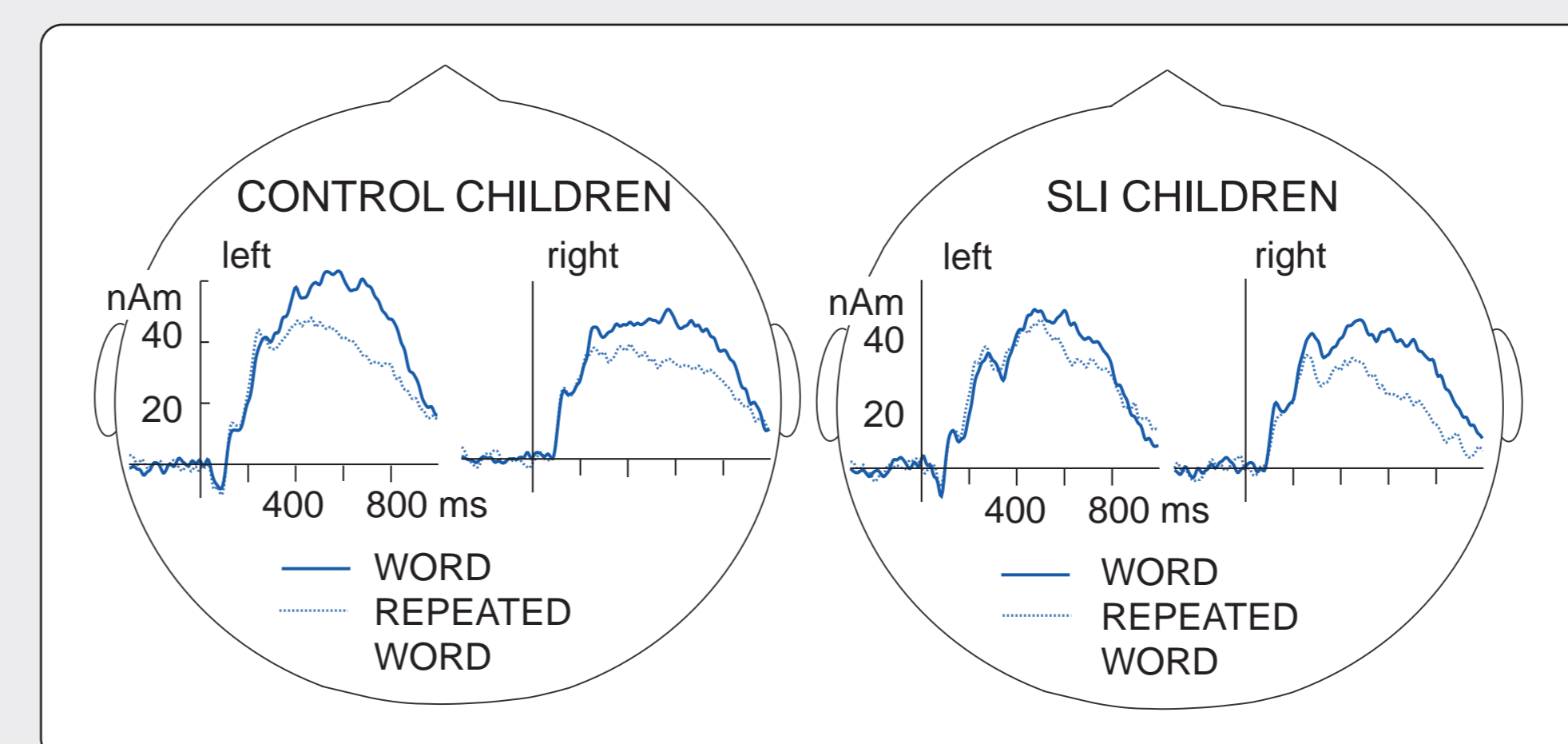


Fig. 3. The mean time course of activation in the left and right superior temporal cortex in control and SLI children for words and repeated words.

Activation to spoken words vs. pseudowords:

- SLI children: the lexicality effect (index of continued recruitment of lexico-semantic candidates for pseudowords) 600-800 ms after word onset in the left hemisphere was missing (in control children $p < 0.01$).

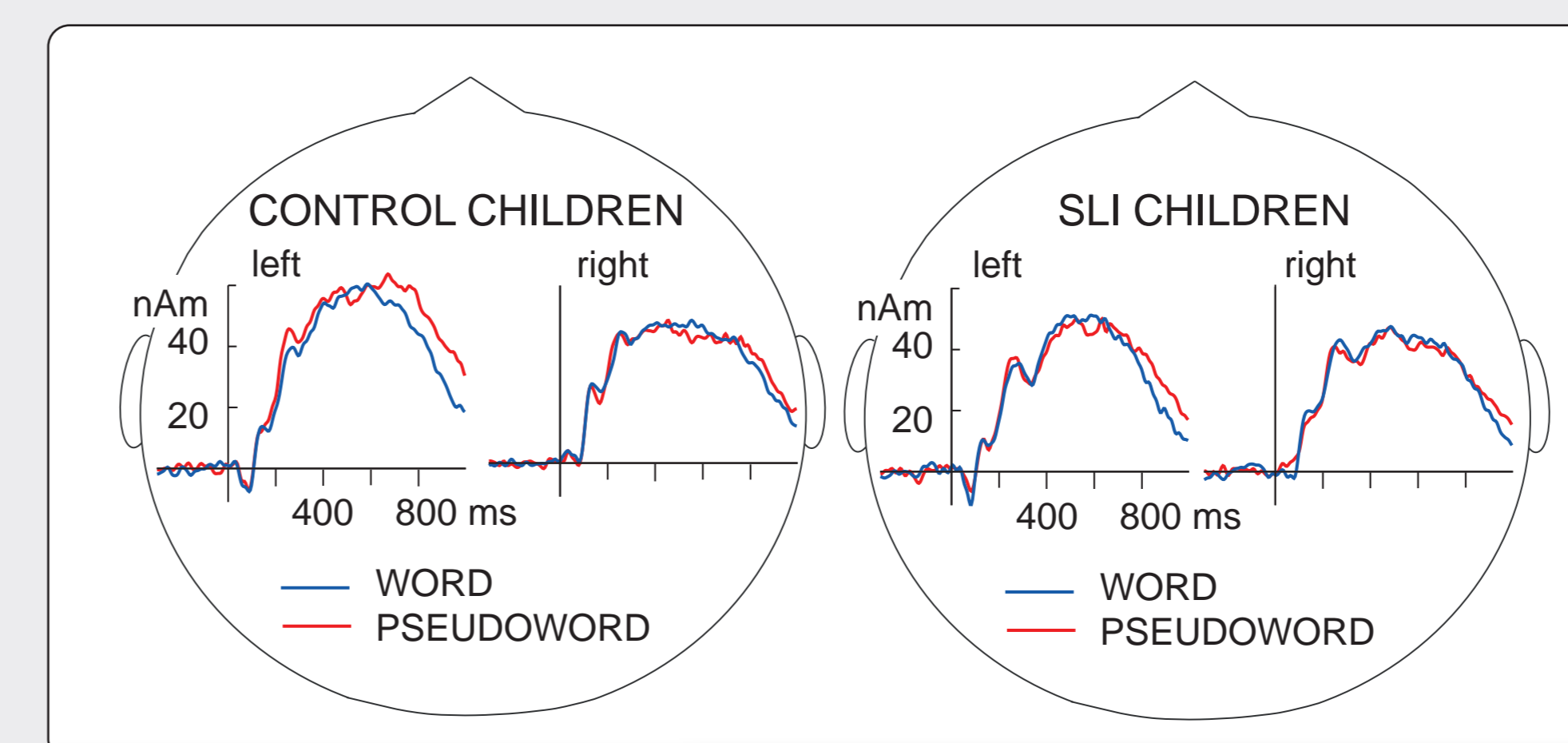
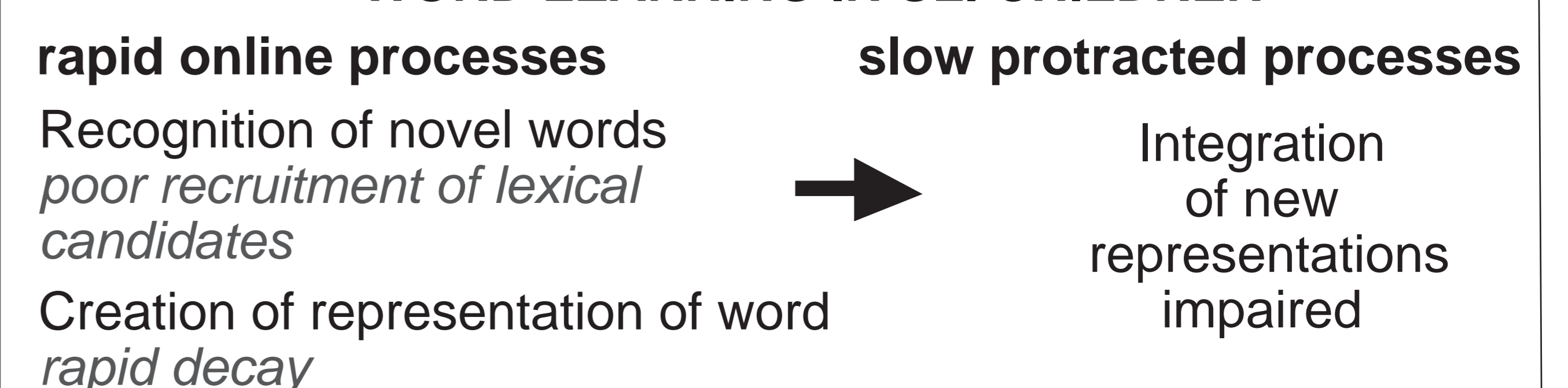


Fig. 4. The mean time course of activation in the left and right superior temporal cortex in control and SLI children for words and pseudowords.

CONCLUSIONS

In school-aged children, auditory cortical responses in the superior temporal cortices are still considerably immature. As in adults (3), the N400 response in control children was modulated by word repetition (first vs. immediate second presentation) and lexicality (words vs. pseudowords), but the N400 response and stimulus-induced modulations were about 200 ms delayed in children as compared with adults. In SLI children, the left hemisphere failed to respond normally to word repetition or lexicality manipulations. Our results indicate that the short-term maintenance of linguistic activation that underlies word recognition is clearly impaired in SLI. In SLI children, abnormal functioning of the left language-dominant hemisphere is particularly evident. The unusually rapid decay of speech evoked activation particularly in the left superior temporal lobe can contribute to impaired vocabulary growth associated with specific language impairment.

WORD LEARNING IN SLI CHILDREN



References:

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