



Word Frequency Effects in Adolescents with and without Specific Language Impairment (SLI): An Event-Related Potential Study

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Abstract

The purpose of this study was to determine the influence of word frequency (WF) on event-related potentials (ERPs) in adolescents with and without *Specific Language Impairment* (SLI). ERP studies investigating WF effects have shown that high frequency words evoke significantly smaller N400 amplitudes (e.g., Van Petten & Kutas, 1990; Rugg, 1990). N400 amplitude has been interpreted to reflect ease of stimulus processing (Kutas & Federmeier, 2000). In a prior study of WF effects in typical adults, we found that auditory lexical processing elicits a broad anterior WF effect (Sizemore & Evans, 2008). In the present study, participants listened to a series of high and low frequency words matched for initial consonant, duration, imageability, neighborhood density, and phonotactic probability. Results showed that while typical adolescents showed an effect of WF in both ERP waveforms and behavior, adolescents with SLI only showed a WF effect behaviorally. This lexical processing difference may negatively affect higher-level language processing abilities such as sentence comprehension in adolescents with SLI.

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Background and Purpose

- Event-related brain potentials (ERPs) were recorded during a lexical decision task in adolescents with and without SLI.
- In prior ERP studies investigating word frequency in typical adults, low frequency words elicited larger amplitude ERP waveforms than high frequency words.
- Specific aims:
 - To determine the effect of word frequency on lexical processing in adolescents with and without SLI as measured by reaction times, accuracy, and ERP amplitudes
 - To investigate lexical processing differences in adolescents with SLI and NL peers

Method

Participants		Method		p
		SLI (N = 12)	NL (N = 12)	
Age (years; months)	Mean (SD)	15;3 (1;3)	14;3 (1;3)	0.28
	Range	12;2 - 18;6	10;9 - 18;9	
Nonverbal IQ ^a	Mean (SD)	103.25 (15.49)	112.42 (8.33)	0.08
	Range	82 - 127	100 - 126	
Formulated Sentences ^b	Mean (SD)	7.67 (3.70)	13.33 (1.37)	< 0.001
	Range	2 - 14	10 - 15	
Recalling Sentences ^b	Mean (SD)	2.92 (2.43)	11.67 (1.92)	< 0.001
	Range	1 - 8	8 - 14	
Nonliteral Language ^c	Mean (SD)	77.75 (9.30)	103.92 (11.97)	< 0.001
	Range	64 - 92	81 - 129	
Meaning From Context ^c	Mean (SD)	78.42 (11.80)	112.50 (10.34)	< 0.001
	Range	62 - 93	94 - 129	
Receptive Vocabulary ^d	Mean (SD)	85.00 (11.39)	106.50 (7.06)	< 0.001
	Range	66 - 101	95 - 116	
Expressive Vocabulary ^d	Mean (SD)	82.50 (10.12)	104.58 (9.29)	< 0.001
	Range	63 - 102	88 - 115	

^a Leiter-R, standard scores (Mean = 100, SD = 15), Roid & Miller, 1997

^b CELF-4, subtest standard scores (Mean = 10, SD = 3), Semel, Wiig, & Secord, 2003

^c CASL, subtest standard scores (Mean = 100, SD = 15), Carrow-Woolfolk, 1999

^d CREVT-2, standard scores (Mean = 100, SD = 15), Wallace & Hammill, 2002

Stimuli

- One syllable words; CVC or CVCC; nouns, verbs, and adjectives
- Nonwords created from real words by either substitution of V or final C

Word List	Word List			p		
	High Frequency (N = 100)	Low Frequency (N = 100)	Nonwords (N = 100)	HF vs. LF	NW vs. HF	NW vs. LF
Word Frequency	Mean (SD)	210.33 (200.18)	2.40 (1.99)	n/a	< 0.001	n/a
	Range	40 - 1207	1 - 9			
Log Word Frequency	Mean (SD)	3.18 (0.34)	1.27 (0.30)	n/a	< 0.001	n/a
	Range	2.60 - 4.08	1.00 - 1.95			
Phonotactic Probability	Mean (SD)	0.021 (0.10)	0.008 (0.007)	0.008 (0.007)	0.19	0.18
	Range	0.0013 - 1.0076	0.0007 - 0.0392	0.0013 - 0.0361		
Imageability	Mean (SD)	5.06 (1.11)	5.15 (0.96)	n/a	0.51	n/a
	Range	2 - 7	2 - 7			
Neighborhood Density	Mean (SD)	21.73 (6.56)	21.72 (6.22)	16.59 (7.07)	0.99	< 0.001
	Range	4 - 36	9 - 35	1 - 32		< 0.001

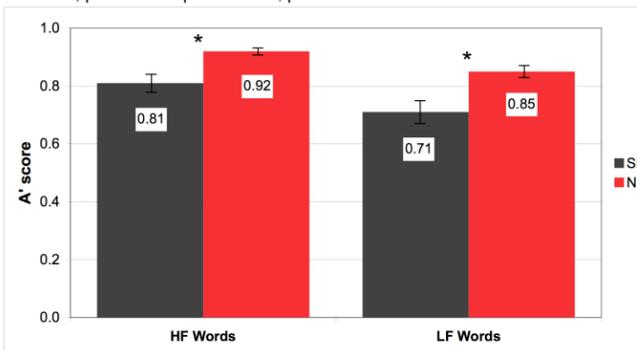
Task

- Word detection task; participants heard a series of words and nonwords
- Instructed to press one button if they heard a word and another button if they heard a nonword
Example: HF "boat", LF "gourd", NW [pæf]

Results

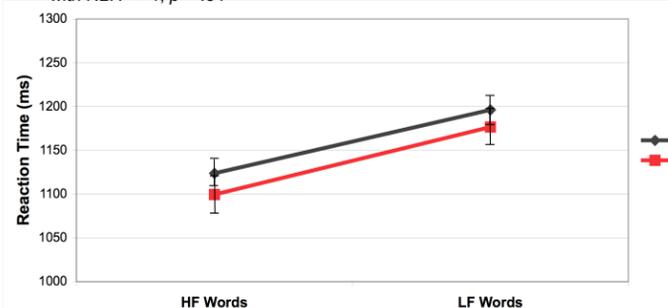
Accuracy

- Repeated measures ANOVA with **Frequency** (high, low) and **Group** (SLI, NL) as factors, and nonverbal IQ as a covariate
- Adolescents were significantly better at discriminating HF words than LF words from nonwords: $F(1,21) = 4.6, p = .04$, partial eta squared = .18, power = .53
- Adolescents with SLI were significantly *less* accurate at discriminating both HF and LF words from nonwords than adolescents with NL: $F(1,21) = 6.5, p = .02$, partial eta squared = .24, power = .68



Reaction Times

- Repeated measures ANOVA with **Frequency** (high, low) and **Group** (SLI, NL) as factors, and nonverbal IQ as a covariate:
- No difference in adolescents' reaction times to HF words versus LF words: $F < 1, p = .44$
- No difference in reaction times between adolescents with SLI and adolescents with NL: $F < 1, p = .64$



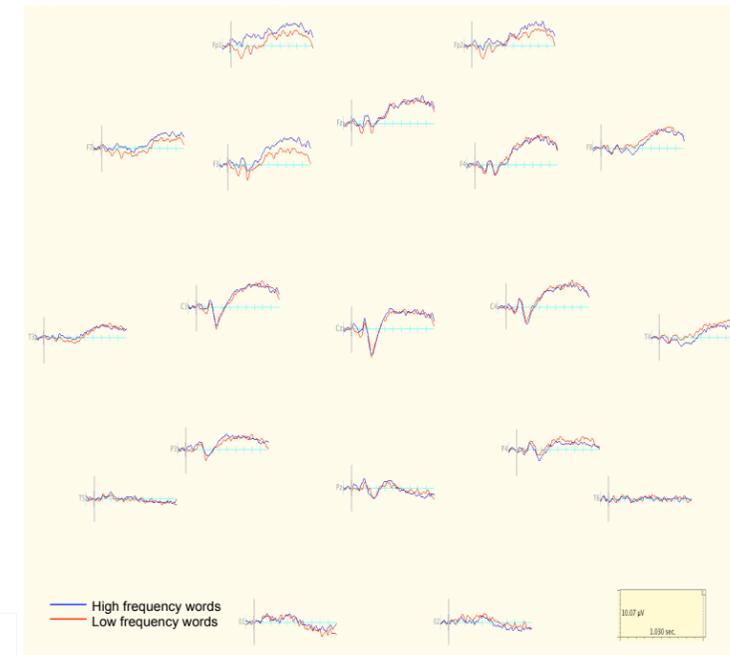
ERPs

- Repeated measures ANOVA with **Frequency** (high, low), **Anteriority** (Anterior channels: Fp1, Fp2, F3, F4, F7, F8, Fz; Central channels: C3, C4, Cz, T3, T4; Posterior channels: T5, T6, P3, P4, Pz, O1, O2), and **Group** (SLI, NL) as factors, and nonverbal IQ as a covariate
- 600-700 ms
 - Frequency x Group** interaction: $F(1,21) = 4.66, p = .04$, partial eta squared = .18, power = .54
 - Anteriority x Group** interaction (marginal): $F(2,42) = 3.14, p = .08$, partial eta squared = .13, power = .45
 - Main effect of **Group**: $F(1,21) = 4.52, p = .04$, partial eta squared = .18, power = .53
- 700-800 ms
 - Frequency x Group** interaction: $F(1,21) = 5.52, p = .03$, partial eta squared = .21, power = .61
 - Anteriority x Group** interaction: $F(2,42) = 5.26, p = .02$, partial eta squared = .20, power = .68
- 800-900 ms
 - Frequency x Group** interaction (marginal): $F(1,21) = 3.36, p = .08$, partial eta squared = .14, power = .42
 - Anteriority x Group** interaction: $F(2,42) = 5.09, p = .02$, partial eta squared = .20, power = .67

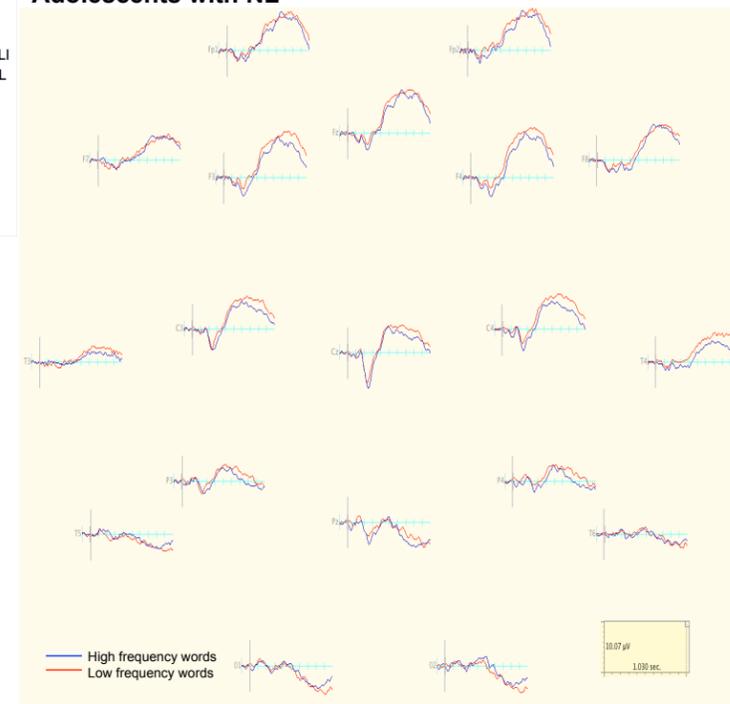
Results cont.

- Grand average HF vs. LF waveforms at Fp1, Fp2, F7, F3, Fz, F4, F8, T3, C3, Cz, C4, T4, T5, P3, Pz, P4, T6, O1, O2

Adolescents with SLI



Adolescents with NL



Summary

- Adolescents with SLI responded as quickly to HF and LF words as NL peers, though they were less accurate than NL peers in distinguishing HF and LF words from nonwords.
- ERP amplitudes were higher for low frequency words -- for adolescents with NL only.
- Overall, ERP amplitudes were lower for adolescents with SLI than NL peers.
- While adolescents with SLI do show a WF effect in accuracy/RT, this effect was not present in their ERP responses.
- Results suggest that adolescents with SLI process lexical items differently than adolescents with NL.
- Both ERP and RT results do not support slower speed of processing accounts of SLI.

Implications:

- Lexical representations of adolescents with SLI may be degraded and may require greater processing resources to manipulate than typical peers.
- Theories of sentence comprehension in SLI need to directly examine the impact of lexical representations on syntactic processing.

References

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