

BACKGROUND

- Listeners exploit their knowledge of the statistical properties of language (word frequency, phoneme probability) when comprehending degraded speech [1,2].
- *Linguistic experience* may contribute to a listener's ability to identify words, even among people who share the same native language [3,4].
- Limited study of how long-term language knowledge influences native listeners' ability to resolve an ambiguous speech signal at different levels of noise disruption.
- **Aim:** Determine if cognitive factors, vocabulary knowledge, and the statistical properties of language are predictive of a listener's ability to identify words at different levels of noise disruption.

METHOD

Participants

- 103 young healthy listeners (mean = 21 yrs, sd = 3 yrs, range = 18 to 34 yrs), 58 females and 45 males.
- English speakers with normal hearing and no history of speech, language, neurological problems.

Experimental Speech Stimuli:

- 128 semantically anomalous phrases. Spoken by eight healthy native speakers — 4 females, 4 males (21 to 42 yrs).
- Mixed with noise shaped to match the talker's average spectrum and presented at -5, -2, +1 and +4 dB SNR.

METHOD cont.

Listening experiment

- Listeners presented with 128 phrases and asked to repeat what they thought they heard. Encouraged to guess if unsure.
- Thirty-two phrases presented from each noise condition, four phrases included from each speaker — all phrases counterbalanced and randomized.

Data Analysis

- Phrase responses recorded and transcribed by two research assistants.
- Any disagreements resolved by a 3rd consensus rater.

Listener-Based Variables

- Collected from each listener via established behavioural tests.
- Variables include: Working memory (Reading Span Test [5] & WAIS-IV [6]), receptive vocabulary (Peabody Picture Vocabulary Test, PPVT, [7]), nonverbal IQ [6] and processing speed [6].

Lexical Variables

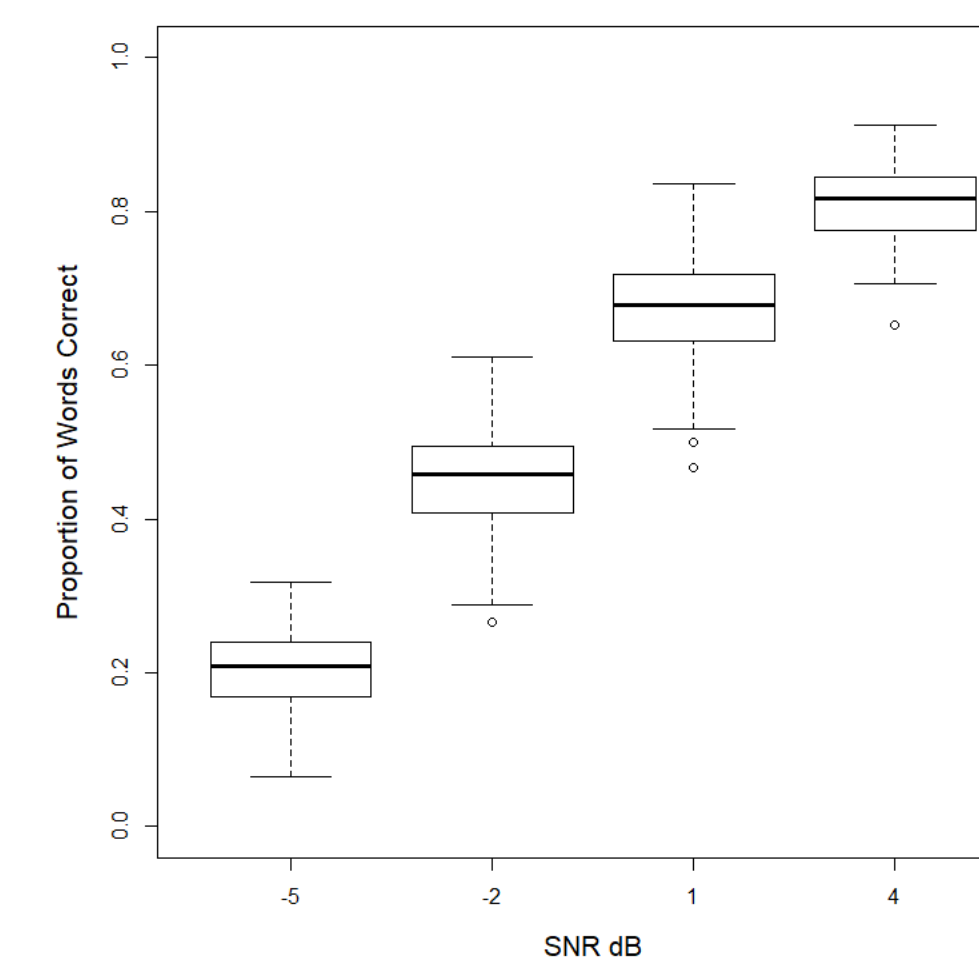
- *Lexical variables* (i) Lexical frequency; (ii) phonological Levenshtein distance (PLD); and (iii) phonotactic probability.

Statistical Analysis

- *Binomial mixed effects models* with word accuracy (correct/incorrect) as the dependent variable.
- *Fixed effects:* SNR, vocabulary knowledge, working memory capacity, processing speed, non-verbal IQ, word frequency, phonological neighborhood density (i.e. PLD), and phonotactic probability.

RESULTS

Figure 1: Variation in listener accuracy across the four SNR conditions.



- No ceiling or floor effects in listener performance.
- Overall, vocabulary and working memory had significant effects on word recognition, when controlling for intelligence.
- Lexical factors and SNR had the largest effects on word recognition.

Table 1: Effect of vocabulary knowledge, cognitive factors, and lexical cues on accurate word recognition.

Fixed Effect	b	SE	p
SNR dB	0.381	0.005	<.001
Vocabulary score	0.046	0.023	.044
Working memory	0.059	0.022	.006
Non-verbal intell.	0.012	0.024	.613
Processing speed	0.038	0.021	.070
PLD	0.376	0.050	<.001
Phonotactic prob.	0.068	0.051	.177
Word frequency	0.305	0.052	<.001

Note: PLD = phonological Levenshtein distance

RESULTS cont.

Table 2: Model coefficients at each SNR.

Fixed Effect	-5 dB SNR	-2 dB SNR	+1 dB SNR	+4 dB SNR
Vocabulary	0.007	0.053	0.077	0.034
WM	0.044	0.055	0.087	0.050
NVI	-0.007	0.012	0.024	0.013
Proc. speed	0.071	0.034	0.036	0.018
PLD	0.402	0.406	0.375	0.343
Phon. prob.	0.051	0.067	0.050	0.081
Word freq.	0.293	0.295	0.329	0.392

Note: WM = working memory, NVI = non-verbal intelligence, proc. = processing, PLD = phonological Levenshtein distance

- Across SNRs, listener-based and lexical variables varied in the strength of their effects on word identification accuracy.

DISCUSSION

- Lexical variables and SNR had the largest influence on word identification accuracy.
- Vocabulary and working memory had robust but relatively subtle effects on word identification accuracy — with effects greatest at moderate levels of signal degradation.
- Examination of these same effects in the ageing population would be of interest.

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