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The Interaction of Auditory Processing and Semantic Processing in Wernicke's Aphasia

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Background

The auditory comprehension impairment in Wernicke's-type aphasia (WA) is clinically challenging at the chronic state. Limited therapy research has targeted phonological input, lexical and semantic stages of comprehension with inconsistent findings. More positive outcomes are associated with higher therapy dosage (>60hrs) (e.g. Fleming et al., 2021). Along with dose, specificity is a key aphasia treatment principle – i.e. treatment should focus on the primary impairment (Kiran & Thompson, 2019). The cognitive profile of chronic WA is best described as a combination of acoustic, phonological and semantic processing impairments (Robson et al., 2012). A systematic link between acoustic-phonological processing and auditory comprehension has been repeatedly demonstrated at the chronic stage (e.g. Robson, Grube et al; 2013), however, similar associations with semantic processing have not. Given the integral role of semantic analysis in auditory comprehension, the lack of associative evidence may result from small under-powered studies. This study collated data from a large group of participants with WA across multiple neuropsychological measures to explore the relationship between auditory comprehension, acoustic-phonological and semantic processing.

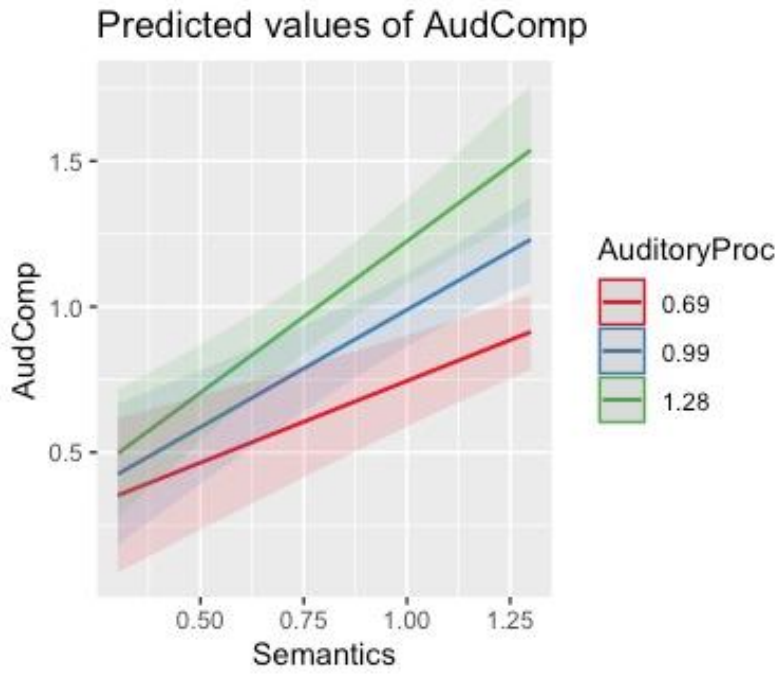
Method

A multiple regression analysis was performed using normalised neuropsychological data from 37 participants with chronic WA. The dependent variable, auditory comprehension, was derived from four published and unpublished comprehension assessments covering single word, phrase and sentence levels. Two independent variables were derived from a broad assessment battery: (1) Acoustic-phonological processing (frequency and dynamic modulation detection, word and nonword phonological discrimination) and (2) Semantic processing (non-verbal semantic association tests and written synonym judgement tests). Age, peripheral hearing thresholds and time-post-stroke data were available for 35 participants and entered as covariates. Lesion volume was available for 32 participants and explored as a covariate in a secondary analysis.

Results

A model containing auditory processing and semantic processing as main effects with the covariates was a better fit to the data than a model with covariates only ($F(2,29) = 12.783$, $p<0.001$). In this model only auditory processing was a significant predictor of Auditory Comprehension (Beta = 0.857 (SE = 0.286), $t = 2.996$, $p<0.01$). A model containing the interaction between auditory and semantic processing also significantly predict Auditory Comprehension (Beta = 0.813 (SE = 0.147), $t = 5.536$, $p<0.001$). The interaction showed that when auditory processing was poor, better semantic processing improved Auditory Comprehension a moderate amount. However, when auditory processing was better retained, better semantic processing resulted in greater gains in Auditory Comprehension, Figure 1. Including lesion volume as a covariate did not change the results.

Figure 1: Plot of the interaction between Auditory Processing and Semantics predicting Auditory Comprehension levels for participants with WA



Conclusions

Impaired Auditory processing is a key driver of comprehension impairments in WA. Retained semantic processing has only a limited capacity to compensate for a heavily disrupted input signal. However, comprehension is influenced by semantic processing to a greater extent in individuals with better retained auditory processing. Therapy should focus on auditory processing in severe cases of WA whereas mixed auditory and semantic therapy is appropriate for milder impairments.

References

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