

Do noise and linguistic skills influence lexically-guided perceptual learning?

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1. Introduction

Listeners use their lexical knowledge to interpret ambiguous input [1] (e.g., *cactu[f/s]*, where [f/s] is an ambiguous sound between /f/ and /s/, tends to be interpreted as *cactus* because *cactuf* is not an English word). This remarkable flexibility of the speech perception [2] allows listeners to quickly adapt to an idiosyncratic input through retuning of phonetic category boundaries. The process of retuning is termed lexically-guided perceptual learning [1] and has been demonstrated for both native [3] and non-native listeners [4-6]. In the present paper, we further investigate the mechanisms underlying retuning.

For lexical retuning to occur, lexical knowledge is critical. Background noise interferes with the intelligibility of words in the speech stream. When the input is fully masked with noise (apart from the critical sound), no lexical retuning occurs for native listeners [7]. Moreover, the mere presence of noise (even if not on the target word or words directly following or preceding it), decreases the perceived reliability of the lexical information [8]. In the present study we investigate how noise-induced uncertainty in having heard the word influences the flexibility of the native and non-native perceptual system.

Apart from external influences, doubt about the lexical status of a heard item may also stem from insufficient lexical knowledge of the listener or doubt that the ambiguous sound is an existing speech sound. The ability to notice phonological regularities in language is connected to the ability to recognize phonological patterns in languages [9]. The second research question in the present study is whether linguistic skills influence retuning. We measure the ability to recognize phonological patterns with the Llama-D [10] and lexical knowledge with LexTale [11].

2. Experimental set-up

In four experiments 99 native English and 114 non-native Dutch listeners were exposed to a short story in English, containing 38 target words with /l/ or /ɪ/ (no /l/ and /ɪ/ anywhere else). Half of the participants were exposed to a version of the story where all /l/s were substituted by an ambiguous sound between /l/ and /ɪ/, and the other half to a version where all /ɪ/s were replaced. Half of the native and non-native listeners were presented with the story without noise and the other half with a story where stretches of speech-shaped-noise (SNR=0 dB) of varying length were added to the story but never on the target words or the words preceding or following them. Next, participants performed a phonetic categorization task on five different versions of the [l/ɪ] sound embedded in two minimal pairs followed by the two language tests.

3. Results

Statistical analyses of the phonetic categorization responses (with generalized linear mixed-effect models [12]), showed that in the clean listening condition, both the native listeners for one minimal pair ($\beta=1.363$, $SE=0.602$, $p < .05$) and the non-native listeners for both minimal pairs ($\beta=1.188$, $SE=0.359$, $p < .001$) demonstrated lexical retuning, as shown by a significantly higher number of /ɪ/-responses by the listener group exposed to the /ɪ/-ambiguous version of the story compared to those exposed to the /l/-ambiguous version. Crucially, the native listeners, but not the non-native listeners, still showed lexical retuning in the partially-masked noise condition ($\beta=0.738$, $SE=0.349$, $p < .05$).

The analysis of the impact of the linguistic skills showed that only the Llama-D scores of the non-native listeners modified retuning, with a higher Llama score corresponding to less lexical retuning ($\beta=-0.01$, $SE=.004$, $p < .01$).

4. Discussion and conclusion

A possible explanation for the non-flexibility of the non-native perceptual system is based on [7]'s suggestion that the presence of intermittent noise makes listeners less confident about the words they hear. This might then suggest that the critical items with the ambiguous sounds need to be processed deeply enough for lexical retuning to occur. As shown by [7] when input is fully masked with noise, also native listeners fail to do that. Apparently, when noise is only intermittent only the flexibility of the non-native system suffers. This difference between the native and non-native perceptual system can be caused by a reduced exploitation of contextual information by the non-native listeners. Of the linguistic skills, only Llama scores were shown to modify retuning in the present study and only for the non-natives. We postulate (cf. [13]) that, listeners better able to recognize phonological patterns are better able to remember a slight mismatch of the acoustic input with the stored representation and might weight bottom-up information more strongly than top-down information. As shown previously for native listeners [13], listeners better at keeping both the lexical and mismatching acoustic form in their memory demonstrate less retuning, since they rely less on lexical information. Why in the present study this was the case only for the non-native listeners is a question for further research. The absence of the effect for LexTale could be due to the high English proficiency of the tested group which corresponded to upper-intermediate proficiency.

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6. References

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