

Top-down effect of syntactic category expectations on spoken word recognition

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During spoken language processing, a listener must simultaneously identify words in the speech stream and arrive at a meaningful parse of each sentence. Measures of syntactic expectations [1,2] are successful predictors of cognitive performance in parsing tasks [3,4,5]. If readers deploy such probabilistic knowledge about these expectations during parsing, then might this information also have an impact on the simultaneous task of spoken word recognition? This would indicate that the processor is integrating many sources of information from context (e.g. syntactic expectations), even at the low level of phoneme/word identification.

In a phonetic identification task, participants were presented with target words in a noun-biasing or verb-biasing context such as (1) or (2).

- (1) Tom liked the _____. [noun-biased context]
- (2) Dennis liked to _____. [verb-biased context]

They responded whether the first consonant of the target was a “p” or a “b” on each trial. The targets’ waveforms were manipulated by changing the voice-onset time (VOT) of the initial stop consonant, making some words phonetically ambiguous between a voiced and voiceless initial consonant, resulting in a *bay-pay* and a *buy-pie* continuum. The phonetically ambiguous words were also of ambiguous syntactic category (noun vs. verb). In this way, phonological ambiguity and syntactic category ambiguity were crossed: in the *bay-pay* continuum, the voiced alternate is generally a noun; in the *buy-pie* continuum, the voiced alternate is generally a verb.

Because these were crossed, the critical test of whether syntactic category expectation can impact spoken word recognition is a CONTEXT x CONTINUUM interaction. This would indicate that participants are more likely to label ambiguous stimuli such that the syntactic category of their response and the category predicted by the context are consistent. For instance, the determiner “the” sets up an expectation for a noun. Subjects who demonstrate a CONTEXT x CONTINUUM interaction will be more likely, after hearing “the,” to make a “p”-response when an ambiguous target came from the *buy-pie* continuum, but to make a “b”-response when it came from the *bay-pay* continuum.

Indeed, subjects showed the critical CONTEXT x CONTINUUM interaction ($p < 0.001$), indicating that participants responded in a way that was biased towards congruency between their response’s syntactic category and the expectation set up by the context. There was also a main effect of CONTINUUM ($p < 0.01$): subjects made more “p”-responses to ambiguous targets from the *bay-pay* continuum than to targets from the *buy-pie* continuum. This finding could be due to another top-down effect from word frequency; the more frequent word in the *bay-pay* continuum is *pay* (“p”-response), but the more frequent word in the *buy-pie* continuum is *buy* (“b”-response).

Taken together, these findings indicate that the speech processor uses information about syntactic expectations to identify words during processing. Syntactic information can potentially be a rich resource for decoding the speech stream in a noisy environment. Though sentence processing and spoken word recognition have typically been studied as separate problems in psycholinguistics (but, see e.g. [6]), an important next step is to develop models of speech processing that work in conjunction with sentence processing models in order to explain the mechanisms behind auditory language processing.

References

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