Ganong effects for lexicality but not for frequency

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Ambiguous sounds are often judged in a way that would yield a real word: for example, when identifying a token that is ambiguous between /d/ and /t/, participants are often more likely to choose /t/ when the sound is in the context *_arp* (where identifying it as /t/ yields the real word *tarp*, whereas identifying it as /d/ yields the nonword **darp*) than when the sound is in the context *_am* (where identifying it as /t/ yields the nonword **tam*, whereas identifying it as /d/ yields the real word *dam*). This top-down influence on ambiguous sound judgment is the Ganong effect [1]. One might expect frequency to exert a similar top-down influence, i.e., people might identify the sound as /t/ more often in the context *_ime* (where it would yield a relatively high-frequency word *time*, whereas identifying the sound as /d/ would yield a lower-frequency word *dime*), and less often in the context *_or* (where it would yield a word relatively low-frequency word *tore*, whereas identifying the sound as /d/ would yield a higher-frequency word *door*).

Such an effect was observed in an experiment by Connine and colleagues [2]. While that experiment used a large sample of continua and edited the stimuli in a systematic and well-controlled way, one potential source of variance in the findings is that the continua biased towards or against aspirated identifications were from separate recordings (e.g., recordings of *deem* and *team* for a continuum where /t/ responses are more likely, and recordings of *dear* and *tear* for a continuum where /d/ responses are more likely). Thus, in spite of the careful and systematic manipulation of the stimuli, there may be low-level acoustic differences between those continua. To control for such differences, Shen and Politzer-Ahles [3] used bisyllabic Mandarin stimuli so that the exact same recordings could be used in different continua. For example, *duìhuà* ("conversation") is a higher-frequency word than *tuìhuà* ("degeneration"), whereas *duìyì* ("play chess") is a lower-frequency word than *tuìyì* ("retire). Shen and Politzer-Ahles [3] made one aspiration continuum with the syllable *{d/t}uì*, and spliced different second syllables onto it, in order to create continua with identical acoustics on the critical syllables but with different top-down biases. Their results replicated those of Connine and colleagues [2], but the careful acoustic control came at the expense of generalizability: they only used two continua, whereas Connine and colleagues [2] used 46. To test the generalizability and replicability of a frequency-based Ganong effect using acoustically matched stimuli, our pre-registered study (https://osf.io/6e35g/) adopts the same design as Shen and Politzer-Ahles [3] but with more stimuli; we also include word-nonword continua as a control condition to test whether the lexicality-based Ganong effect [1] is replicated.

The continua we used are shown below. For each three place of articulation, one item (two continua) was used to test the frequency-based Ganong effect and one item (two continua) to test the lexicality-based Ganong effect. Stimuli were recorded by a female speaker of standard Mandarin, and aspiration continua were created by taking aspirated tokens of each first syllable (*pì*, *tàn*, and *kuān*) and systematically removing 5 ms of aspiration at a time. Different second syllables were then spliced to these to yield the different continua, and the categorical boundaries were identified with a discrimination test with four Mandarin speakers. Tokens at the boundary and up to 4 steps before or after the boundary were used, resulting in 9-step continua.

	bilabial	**alveolar**	**velar**
Aspirated yields a high-frequency word	*{p/b}ìhuà*	*{t/d}ànwàng*	*{k/g}uānchǎng*
Aspirated yields a low-frequency word	*{p/b}ìjìng*	*{t/d}ànshì*	*{k/g}uānxīn*
Aspirated yields a real word	*{p/b}ìrú*	*{t/d}ànsuǒ*	*{k/g}uānróng*
Aspirated yields a nonword	*{p/b}ìmiǎn*	*{t/d}àngāo*	*{k/g}uāndiǎn*

Results from 53 participants (out of a planned 70) are shown below. It is clear that, while there is a strong Ganong effect for the lexicality manipulation (b=0.76, z=5.61, p<.001 in a binomial mixed-effects model), there is no significant frequency-based Ganong effect (b=.01, z=0.28, p=.780). The size of the frequency-based Ganong effect was not reliably moderated by reaction time (b<0.01, z=0.09, p=.925), which is consistent with Connine and colleagues [2]. There is suggestive evidence that it was moderated by place of articulation ($\chi^2(2)$=8.00, p=.018), but only to the extent that the frequency-based Ganong effect was very marginal in alveolar stimuli (b=0.13, z=1.70, p=.090) and substantially lower in velar and, particularly, labial stimuli.

The present results suggest that, contrary to previous reports, word frequency may not have the same kind of top-down effect on ambiguous speech sound categorization as lexicality does. The apparent frequency effect observed by Shen and Politzer-Ahles [3] may have been due to other, unknown confounding factors in the item used in that study. It is less clear how the results from Connine and colleagues [2] and the present experiment can be reconciled. One possibility is that frequency-based Ganong effects occur in English but not Chinese—although we had no *a priori* reason to hypothesize such a cross-linguistic difference—or that they occur in one-syllable simplex words but not in two-syllable compound words. Other possibilities are that the effects observed by Connine and colleagues [2] were due to low-level acoustic differences in the stimuli rather than to frequency (although it is unlikely that all 46 continua used in that study would have confounding acoustic differences in the same direction), or that the failure to observe a frequency Ganong effect in the present study represents a Type 2 or Type M error (although this is unlikely, given that the lexicality-based Ganong effect observed was so robust).

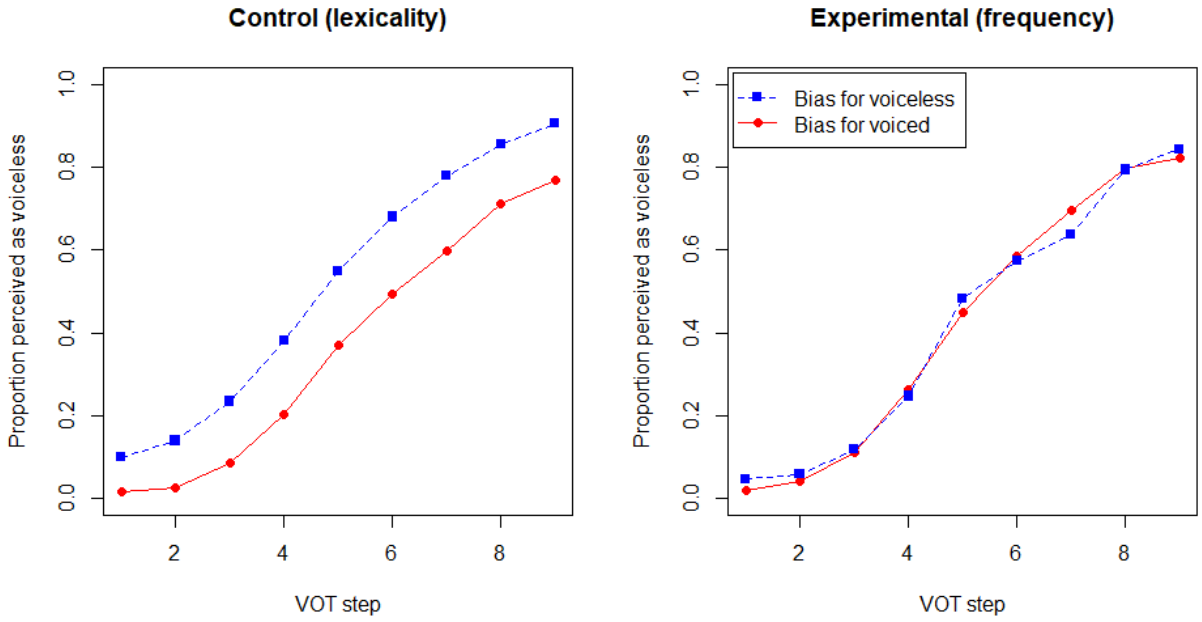

Fig.1 Results of the Ganong experiment for the lexicality contrast (left) and the frequency contrast (right). Where a Ganong effect is present, the blue dashed line with square markers should be higher than the red solid line with round markers.

References

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