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The role of contextual-pragmatic information in speech perception: an eye-tracking study

Yenan Sun, Eszter Ronai, Alan Yu, Ming Xiang

The University of Chicago

THE UNIVERSITY OF CHICAGO

Objectives and background

Investigate whether the **contrastive function of prenominal adjectives can affect perception of voicing** in initial plosives:

- effect on behavioral judgments on phonetic categorization?
- effect on online processing?

Listeners integrate information from disparate domains. We look at phonetic-pragmatic interaction.

- Top-down influence of lexical information on categorical perception (Ganong, 1980).
- Influence of pragmatic inferences regarding upcoming coreference on phonetic perception (Rohde & Ettlinger, 2012).

Methods and participants

28 native monolingual speakers of American English.

Visual World Paradigm eye tracking:
Participants presented with a visual display while hearing a sentence with the form "Click on the ADJ NOUN", e.g. "Click on the red bear".

- NOUN: one of the words from two minimal pairs {bear/pear, bees/peas}
- ADJ: one of {red, gold, grey, teal}

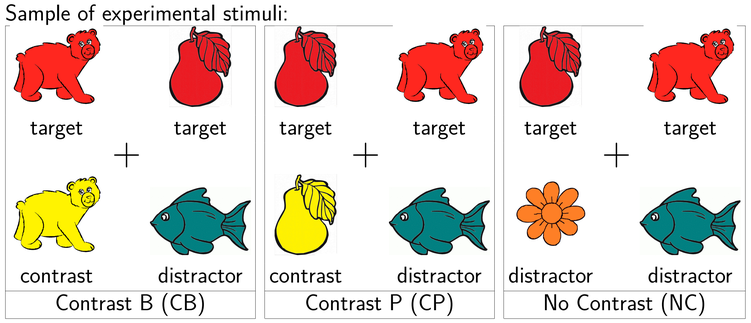
7 × 3 design, within subjects.
Phonetic manipulation: 7 conditions

- Target stimuli: two 7-step VOT continua (*bear* to *pear*, *bees* to *peas*).
- Aspiration from /p/ was added in increments of 7 ms to /b/.
- Audio stimuli identical across pragmatic conditions, normalized pitch.

Pragmatic manipulation: 3 conditions

- All contained two objects with the same color, both temporarily compatible with the instruction.
  - CB: contrasting object with a different color, from the "b" category.
  - CP: contrasting object with a different color, from the "p" category.
  - NC: control condition, no contrasting object.

Sample of experimental stimuli:



Predictions

Contrast objects trigger pragmatic Gricean reasoning → facilitate the disambiguation of two potential targets (Sedivy et al. 1999). On many VOT steps, there is no clear target, it would depend on the interaction of the two cues.

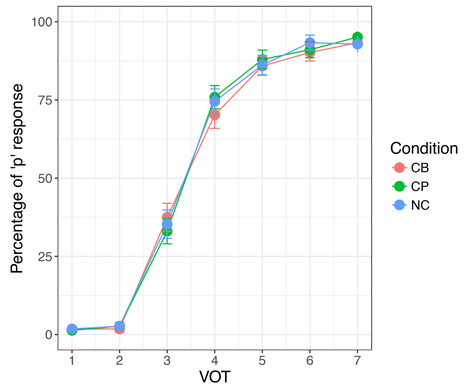
Participants should be **biased towards the object that has a contrast** comparison: *bear*/*bees* under CB and *pear*/*peas* under CP.

- Different categorization as compared to NC.
- More looks to the target as compared to NC.

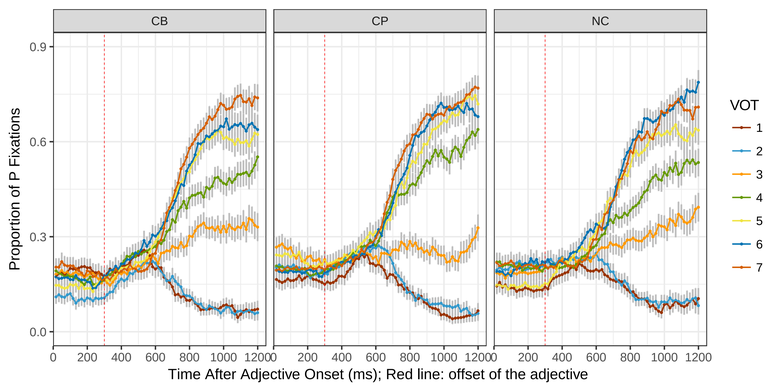
Results

Behavioral: probability of clicking on the "p" objects:

- significant effect of VOT ($p<.0001$)
- pragmatic contrast manipulation non-significant
- p-identification does not reach 100% at the /p/-end of the continuum



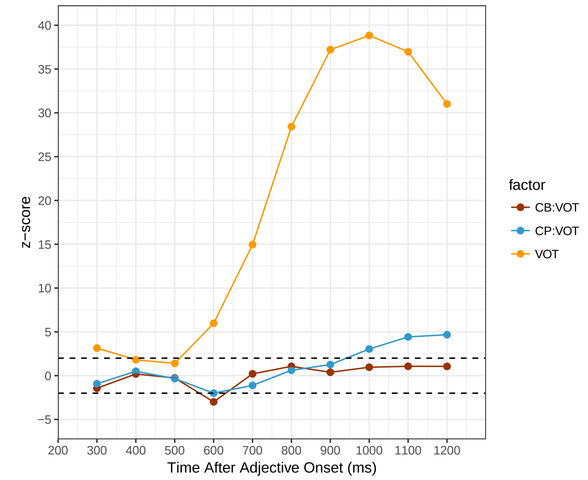
Online: proportion of looks to the "p" objects:



Running logistic regression models (fixations to the "p" objects in NC as baseline)

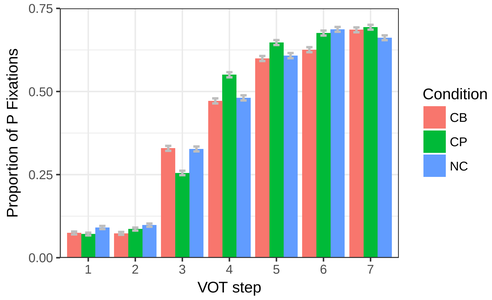
- a robust effect of VOT ($p<.0001$), starting from 500ms after the adjective onset (about 200ms after the noun onset), and continuing throughout the trial
- a significant interaction between VOT and CP ($p<.001$) in a relatively late time window (800-1200ms)
- no effect of CB: the original sound was /b/ → more (e.g. formant) cues for /b/
  - sounds perceived as "p" have more conflicting/suboptimal "p" acoustic cues → pragmatics can have more of a role with "p" than with "b"

To pinpoint the time window where the interaction of VOT and CP is significant, we ran logistic regression models on every 100ms time bin. Plotting the z-score of the coefficients for the effects VOT, CB:VOT, and CP:VOT:



Closer look at the later time window (800-1200ms, plotted below):

- facilitatory effect of CP at VOT step 4 ($p<.001$) and 5 ($p<.001$) and 7 ($p<.01$)
- inhibitory effect of CP at VOT step 1 ($p<.001$) and 3 ($p<.001$)



Discussion

Phonetic categorization output (behavioral judgment data) completely determined by the acoustic cues (VOT) → **no direct effect of pragmatic** contrast.

Constrained pragmatic influence in online processing:

- Effect appeared late.
- Asymmetry: perception of "p", but not "b", is affected.
  - "p" had more incongruous acoustic cues (since p tokens were modified from the b tokens) → more room for pragmatics.
- Precise nature of pragmatic effect: conditioned on behavioral response.
  - Facilitation: when phonetic and pragmatic cues point in the same direction. Inhibition: when the two cues are incongruous.

Conclusion

Pragmatic cues are secondary to the bottom-up acoustic information during consonant perception.

References

Ganong, W. F. (1980). Phonetic categorization in auditory perception. Journal of Experimental Psychology: Human Perception and Performance, 6, 110–125. | Sedivy, J. C., Tanenhaus, M. K., Chambers, C. G., & Carlson, G. N. (1999). Achieving incremental semantic interpretation through contextual representation. Cognition, 71(2), 109-147. | Rohde, H., & Ettlinger, M. (2012). Integration of pragmatic and phonetic cues in spoken word recognition. Journal of Experimental Psychology: Learning, Memory, and Cognition, 38(4), 967.