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On the perception of voicing in whisper: A cross-modal semantic priming study

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This work addresses the question of the one-line pre-lexical processing and the role of the fine phonetic details in the recognition of the voicing feature in French whispered words. As produced without vocal fold vibration, the [+voice] obstruents are not immediately recognised. But if few more time is left to the listener, they are well recognized. It suggests that this time may be used by the listener to extract from the acoustical signal the phonetic details necessary to reconstruct voicing during word recognition process.

Background & Questioning

Whisper: voiceless speech
- Open glottis > no vocal f. vibration
- ambiguity: [+voice] phonemes become voiceless
- not a linguistic or phonological process (vs. assimilation rules)
- a communication requirement to reduce the distance perceptibility

Phonetic traces of voicing
- Production: C or V durations, intra-oral pressure, glottal opening...
- Perception: few studies, difficult comparisons, off-line tasks
  > variable levels of recognition, often better than chance
  > a bias towards [-voice].

Phonetic details in word recognition and lexical representation
- Real-time process of phonetic details in spoken word recognition
  > on-line processing with time pressure
- Granularity of the phonological representation of word
  > exemplar vs. abstract

Cross-modal semantic priming experiments

<table>
<thead>
<tr>
<th>C</th>
<th>Voicing</th>
<th>word prime</th>
</tr>
</thead>
<tbody>
<tr>
<td>[-voice]</td>
<td>/pedal/</td>
<td>related</td>
</tr>
<tr>
<td>[+voice]</td>
<td>/pedal/</td>
<td>related</td>
</tr>
</tbody>
</table>

Lexical task: “Is the letter sequence on the screen a French word?”
Phonated vs. whispered speech (as at the ear of a close listener)

Material and subjects

6 minimal contrasts of voicing: /p t k f s l/ vs. /b d g v z 3/

Primes
- 20 minimal pairs (péda-le pédale)

Targets
- the most frequent semantical associate of the prime > 20%
- from a free association task by 30 subjects (péda-le vélo; le pédale)

Controls
- prime not semantically related to the target (quittance-viaux/feux)

Non-word Targets = 50% (for the task)
- 40%: pseudo semantically unrelated (kortiss’-Ansiz–valio from future)
- 10%: pseudo semantically related (kortiss’-Ansiz-valio from related)

Related prime-target stimuli = 20% (tested items)
17 French listeners per test list (N=408)
8 test lists in whisper + 4 in phonated
x2 prime-target delays
> each prime or target presented once only to the same listener

Results

Mean Reaction Times (in ms) and Standard Errors for the control (c) and related (r) primes. Percentages of correct responses inside the bar and significant priming effects (* p < .05)

0 ms delay
- [+voice] as [-voice] obstructed primes show priming effect
  > immediate recognition of voicing
- priming disappears with 50-ms longer delay

50 ms delay
- [+voice] obstructed words show only immediate priming
- [+voice] obstructed words show only late priming
No voiceing incongruence shows priming effect

Conclusion

For whispered [+voice] obstruents
- the recognition takes time
  > but never confounded with voiceless (ambiguity)

> the voicing processing seems to start as soon as the whispered word is heard, but more time is needed to identify the [+voice] feature.

A reconstruction process takes place that suggests
- not exemplar lexical representation
- but an extraction of phonetic details from the signal

The phonetic knowledge (i.e. of C/V durations) is used in a pre-lexical reconstruction process of more abstract units : phonological feature or phoneme.