Homophones, Lexical Retrieval, and Sensitivity to Detail

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Lexical storage of homophones

- Do homophones have shared phonological representations?

![Diagram showing the phonological representation of "son" and "sun" sharing the same pronunciation](image)
Lexical storage of homophones

- Do they have independent lexical entries that happen to have identical phonological representations?

\[
\text{son} \quad /\text{sən}/ \\
\text{sun} \quad /\text{sʌn}/
\]
Evidence for separate phonological entries:

- Distinct frequency effects in lexical access (e.g. Caramazza et al. 2001, Simpson & Burgess 1985, Grainger et al. 2001)
- Weak or absent priming between homophone mates (e.g. Schvaneveldt et al. 1976, Masson & Freedman 1990)
- Phonetic differences, based on frequency and part of speech (Gahl 2008, Guion 1995)
There is evidence for influence of homophones on each other (e.g. Jescheniak & Levelt 1994)

But they could interact without having shared representations
This study

An AX discrimination task, to determine:

- How listeners’ knowledge of homophones influences interpretations of phonological forms
- Listeners’ sensitivity to acoustic details, particularly as potential cues for discriminating between homophone mates
23 native speakers of American English (mean age 21.6; 7 male)

No reported speech or hearing disorders
Same-Different Task

- Listeners heard pairs of words and pressed a button to decide whether they were the same or different.
- Counter-balanced for right-left responses.
- Response time measured from the beginning of the second word.
Stimuli

- Words produced in isolation, in randomized order, recorded in a sound-attenuated booth
- Five types of pairs
  1. homophone-homophone pairs (e.g. sun-son)
  2. same pairs for a word with a homophone (e.g. sun-sun)
  3. same pairs for a word with no homophone (e.g. cat-cat)
  4. different pairs, with a single segmental contrast (e.g. pat-cat)
- The ratio of apparent ‘same’ pairs (1-3) to ‘different’ pairs (4) was equal
- Two speakers; in all word-pairs, the two words were from different speakers
Within a block, differences were always in the same position:
Onset (e.g. *pat-cat*), nucleus (e.g. *kit-cat*), coda (e.g. *cap-cat*)

Each listener completed three blocks, one of each contrast type

Block order was balanced across participants
Hypotheses: Lexical influence

- Hypothesis 1: Homophones are processed as lexically distinct items, even in non-semantic tasks, and thus will act like competitors in processing.
- Counter-Hypothesis 1: Homophones have shared phonological representations, and will behave as a single unit rather than competitors.
Hypotheses: Phonetic detail

- Hypothesis 2: Listeners are sensitive to non-contrastive acoustic detail (cf. E.g. Babel & Johnson 2010), and will accordingly respond more quickly and with higher accuracy to phonologically identical pairs that are more acoustically similar.

- Counter-Hypothesis 2: Listeners are not influenced by non-contrastive acoustic detail, and thus their response patterns will not be influenced by acoustic distance between items of a pair.
Linear mixed effects model for log response times, excluding *different* pairs

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. Error</th>
<th>t value</th>
<th>p value</th>
</tr>
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<tbody>
<tr>
<td>Intercept</td>
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<td>4.5e-02</td>
<td>2.9</td>
<td>0.0065**</td>
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<tr>
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<td>2.7e-02</td>
<td>-3.2</td>
<td>0.0012**</td>
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<td>Type Hph-Hph</td>
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<td>3.0e-02</td>
<td>-1.2</td>
<td>0.24</td>
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<tr>
<td>ContrastType C</td>
<td>5.5e-02</td>
<td>8.7e-03</td>
<td>6.3</td>
<td>&lt; 0.001***</td>
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<tr>
<td>ContrastType O</td>
<td>-1.2e-02</td>
<td>8.6e-03</td>
<td>-1.3</td>
<td>0.18</td>
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<tr>
<td>Response ‘same’</td>
<td>-1.6e-01</td>
<td>2.3e-02</td>
<td>-6.8</td>
<td>&lt; 0.001***</td>
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<tr>
<td>TypeNon-hom:ResponseSame</td>
<td>1.0e-01</td>
<td>2.8e-02</td>
<td>3.7</td>
<td>&lt; 0.001***</td>
</tr>
<tr>
<td>TypeHph-Hph:ResponseSame</td>
<td>4.0e-02</td>
<td>3.2e-02</td>
<td>1.2</td>
<td>0.21</td>
</tr>
</tbody>
</table>

*Intercept: Type = Same hom; ContrastType = N; Response = ‘different’*
Significant differences in mean response time based on contrast type in different pairs ($p < 0.001$ for all comparisons).

Also significant in phonologically non-contrastive items for coda blocks vs. others ($p < 0.001$), but not between onset and nucleus blocks ($p = 0.18$).

**Figure:** Response Times by Contrast Type
Homophone Effects

Results

Pair Type

Homophone mate pairs: Same or different?

Hph-hph pairs patterned like same pairs:

- The majority of responses were ‘same’ (89.3%; 90.2% for same pairs and 4.0% for different pairs)
- ‘same’ responses were significantly faster than ‘different’ responses (1044 ms vs. 1469 ms, p < 0.001), paralleling faster responses of ‘same’ for same pairs (1058 ms vs. 1354 ms, p < 0.001)
Lexically unambiguous (cat-cat) same pairs were identified as ‘same’ more frequently (91.1%) than lexically ambiguous (sun-sun) same pairs (88.3%) or hph-hph (sun-son) pairs (89.3%); the latter two types did not differ.
Response times by pair type

- Response times exhibited the same pattern as responses, largely due to speed of ‘different’ responses

**Figure:** Response Time by Type and Response
Hesitance to identify the same word as ‘same’ when it was a word for which a homophone exists may reflect uncertainty about whether homophones are identical or just close phonological neighbors.

cf. slower responses for words with high neighborhood density (e.g. Vitevitch & Luce 1999)
Response time was negatively correlated with word frequency in same pairs \((\text{sun-sun, cat-cat}): r(248) = -0.16, p = .01\)

**Figure:** Response Time by Word Frequency, All Same Pairs
The correlation between response time and frequency was weaker considering only lexically unambiguous pairs (cat-cat): $r(170) = -0.083, p = 0.28$

May in part reflect duration differences in production, though the correlation between response time and word duration did not reach significance: $r(170) = 0.11, p = 0.15$

The correlation between word duration and frequency was also weak: $r(170) = -0.086, p = 0.26$
The correlation between response time and frequency was strongest among words with homophones (sun-sun): $r(78) = -0.22, p = 0.045$

Likely reflects duration differences in production, given that listeners could not discriminate between homophone mates.

There was a positive correlation between response time and word duration: $r(78) = 0.26, p = 0.016$

Among words with homophones, there was a negative correlation between word duration and frequency: $r(78) = -0.21, p = 0.056$
Negative correlation between neighborhood density and response time among lexically ambiguous items ($r(158) = -0.29, p < 0.001$)
The result for lexically ambiguous items is counter to competition-based explanations of inhibitory neighborhood density effects in other tasks.

Might suggest that more neighbors facilitate faster evaluation of phonological category contrasts in that region due to greater representation.

Weaker correlation among lexically unambiguous items ($r(170) = -0.092, p = 0.23$).
Acoustic details: Lexically ambiguous pairs

- Acoustic differences between items had a consistent positive correlation with response time for lexically ambiguous phonologically matching pairs
- Though it only reached significance in some measures

<table>
<thead>
<tr>
<th></th>
<th>F0 mean</th>
<th>F0 range</th>
<th>vowel dur.</th>
<th>spectral tilt</th>
</tr>
</thead>
<tbody>
<tr>
<td>hph-hph (sun-son)</td>
<td>0.28**</td>
<td>-0.0085</td>
<td>0.13</td>
<td>0.35***</td>
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<td>same, hph (sun-sun)</td>
<td>0.091</td>
<td>-0.0054</td>
<td>0.045</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Table: Acoustic Correlations with RT
Acoustic details: Lexically unambiguous pairs

- This trend was not present in lexically unambiguous pairs
- Suggests that attention to these details is mediated by listeners expecting differences

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</tr>
</thead>
<tbody>
<tr>
<td>same, non-hph (cat-cat)</td>
<td>0.071</td>
<td>0.011</td>
<td>0.032</td>
<td>0.045</td>
</tr>
</tbody>
</table>

Table: Acoustic Correlations with RT
Homophones must be stored as separate lexical items, along with separate phonological entries.

Having separate phonological entries creates some uncertainty about phonological contrasts, resulting in slower decisions and more ‘different’ responses to lexically ambiguous pairs.
Frequency and neighborhood density

- Frequency is negatively correlated with response time, but likely only as a result of the correlation between frequency and word duration.
- Negative correlation between neighborhood density and response time – phonological contrasts benefit when supported by lexical contrasts.
Attention to detail

- At least when evaluating words produced in isolation, listeners are more influenced by phonological contrasts than phonetic details.
- However, greater acoustic distance in multiple measures is correlated with response time, for lexically ambiguous items.


