Experimental/scientific approach

• Research questions, hypotheses
• Quantitative results
• Strict limits on what can be inferred from those results
Stemberger and MacWhinney 1988

• Research question:
  – Are inflected words lexically listed?
    • e.g. ended: stored as end, -ed; end-ed; or ended?

• Ways to tell
  – “storage is assumed to increase the speed and accuracy of processing relative to no storage”
  – frequency effects
  – gang effects

• Reports results of 4 experiments/studies
Frequency

- **Token frequency**
  - how often a word or morpheme is used
  - English frequency data from Francis and Kučera 1982

- **Type frequency**
  - how often a specific pattern appears in a language’s lexicon
  - e.g. rarity of word-final /dz/ (adze)
Frequency effects

- Effects of token frequency
- High frequency forms
  - are produced faster than low frequency forms
  - are produced more accurately than low frequency forms
- “we expect to find frequency effects if inflected forms are stored in the lexicon...but no frequency effects” if no storage
  - e.g. *ended* stored as *ended* or *end-ed*
  - not constructed on the fly from *end + -ed*, because otherwise indistinguishable from *mended* (also *mend + -ed*)
Gang effects

• ≈ type frequency
• “...several words in the lexicon that are similar in form reinforce the patterns of phonemes or letters they have in common.”
• “...a new form of analogy in which a word that is being processed is compared to a larger number of words than in traditional analogy (where it is compared to only a single word), and these words affect processing by each contributing a small amount of reinforcement to bias the system toward a certain outcome.”
• E.g. nonsense word m-a-v-e---how is this pronounced?
  – 14 monosyllabic words ~[eiv] (e.g. cave)
  – 1 monosyllabic word ~[æv] (have)
Gang effects

• Factors influencing size of gang effect
  – having letters/phonemes in same position
  – # of members in gang
  – sharing more letters or phonemes

• predictions
  – e.g. [æŋk] past tense verbs (drank, sank, stank...) form a gang, should influence past tense form of spank
  – e.g. [ɔr] past tense verbs (wore, bore, swore, tore...) should influence past tense form of snore
  – e.g. [u] past tense verbs (knew, flew, grew, drew, blew, threw, slew...) should influence past tense form of chew

• “By their very nature, gang effects are only possible if forms are stored in the lexicon, and must be present if forms are stored in the lexicon.”
1. Naturally occurring errors

- What are error rates for regular vs. irregular past tense forms of verbs?
- Corpus of 7220 spontaneous errors by adults
- Examined error rates for “past and perfect” (participle) verb forms

(4) a. *Boy, that draw him out—drew him out.*
    b. *What was it you just sing? (sang)*
    c. *So we test ’em on it. (tested)*
    d. *That’s what I need to do. (needed)*
• Errors divided into 2 groups
  – regular vs. irregular verbs (*test* vs. *drew*)
  – subgroups by high vs. low frequency
• “high frequency” (> 35 occurrences per million words) forms like *ended*
• “low frequency” (< 35 “) forms like *mended*
• compared error rates for irregular vs. regular past tense forms of verbs: does frequency have an effect on error rate?
• Results for irregular verbs—a frequency effect

(5) | Individual frequency | Group frequency | Number of errors | Rate |
---|----------------------|-----------------|-----------------|------|
low |                      | 1735            | 17              | .00980 |
high|                      | 15012           | 39              | .00260 | ← significantly less

# verbs/group in FK82

– e.g. high-frequency *drank* vs. low-frequency *slew*: verbs like *drank* more accurately processed

– “at least high-frequency irregular forms are stored in the lexicon”

• (cautious interpretation of results; how could low-frequency irregular not also be stored?)
• Results for regular verbs—no frequency effect
• e.g. high-frequency *ended* vs. low-frequency *mended*

<table>
<thead>
<tr>
<th>Individual frequency</th>
<th>Group frequency</th>
<th>Number of errors</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td>21305</td>
<td>24</td>
<td>.00113</td>
</tr>
<tr>
<td>high</td>
<td>16315</td>
<td>11</td>
<td>.00072</td>
</tr>
</tbody>
</table>

• perhaps “the production of regular forms is so easy that low-frequency forms are not at that great a disadvantage, and there were consequently too few errors in the corpus to detect a significant difference”
2. Elicitation task

• Presented *was [verb]ing*
• Task: produce past tense as quickly as possible
• 75 CMU UGs
• *Verb* =
  – 10 high frequency, regular past tense, t/d-final verbs (e.g. *fit*)
  – 10 low frequency, regular past tense, t/d-final verbs (e.g. *lid*)
  – 20 distractor verbs
• What are no-marking error rates?
## Results

<table>
<thead>
<tr>
<th>Verb type</th>
<th>Number of errors</th>
<th>Number of trials</th>
<th>Rate</th>
<th>← significantly more errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>low frequency</td>
<td>28</td>
<td>700</td>
<td>.037</td>
<td></td>
</tr>
<tr>
<td>high frequency</td>
<td>13</td>
<td>700</td>
<td>.017</td>
<td></td>
</tr>
</tbody>
</table>

- *fit vs. lidded* (presumably produced as *lid*)
  - “This implies that at least high-frequency regularly inflected forms [like *ended*] are stored in the lexicon in some fashion. The results are compatible with low-frequency forms [like *mended*] being stored in the lexicon, but are also compatible with low-frequency forms being created on-line by a lexical-item-free rule.”
  - e.g. *mended* < *mend* + -ed
High frequency inflected forms are listed...

• ...but as two morphemes or one word?
• Stemberger and MacWhinney
  – errors like *tell-us-ing* (for *telling us*)
  – more common with
    • bimorphemic words than “similar nonmorphemic sequences” (e.g. *tell-ing vs. relic*)
    • high frequency than low frequency inflected words
  – “Insofar as shifts are a good argument for analysis into two morphemes...it appears that high-frequency lexical items are so analyzed.”
3. Another elicitation task

- Is there a gang effect on no-marking error rate for verbs like
  - *spank* (cf. 3 phonemes shared with *drank, sank, stank*)
  - *snore* (cf. 2 phonemes shared with *wore, bore, swore, tore*)
  - *chew* (cf. 1 phoneme shared with *knew, blew, grew, flew, drew, threw, slew*)
- If gang effect present (*drank* induces no-marking error in *spank*), prediction
  - 3-shared phoneme gangs induce errors $> 2 > 1$
  - (these gangs of equal size in lexicon)
- If gang effect present, would also support irregular past tense forms as lexically listed
Experiment design

• 3 lists of verbs. List 1:
  – 16 monosyllabic regular verbs that resemble irregular past tense forms (shared 3.1 phonemes, e.g. *spank*)
  – 16 regular verbs that don’t resemble irregular past tense forms (e.g. *flick*)
  – 16 regular verbs that don’t closely resemble irregular past tense forms
  – 16 irregular verbs (distractors)

• List 2:
  – 16 monosyllabic regular verbs that resemble irregular past tense forms (shared 2.1 phonemes, e.g. *choke*, cf. *spoke*)
  – ...

• List 3:
  – 16 monosyllabic regular verbs that resemble irregular past tense forms (shared 1.1 phonemes, e.g. *chew*, cf. *blew*)
  – ...

• Task: produce past tense form as quickly as possible
Results—no marking errors

- shows gang effect of irregular past tense forms on verbs sharing 3 or 2 phonemes
  - suggests irregular past tense forms listed in lexicon

Fig. 6.1: Error rate for verbs in Study 3.

- error rate for verbs like *spank*
- error rate for verbs like *choke*
- error rate for verbs like *chew*
- not significantly different
- significantly different
- to irreg. past tense form

[Graph showing error rate for different verbs with resemblance to irregular past tense forms.]
4. Regular present tense forms

- “If regularly inflected forms are in general in the lexicon, then a gang effect should be present.”
- Compared no-marking error rate on regular present tense forms ending in /s/ or /z/ for
  - verbs resembling regular present tense forms (gaze (cf. lays), coax (cf. pokes), cause (cf. caws), please (cf. pleas))
  - verbs not resembling present tense forms (e.g. buzz, force, race, toss)
- Prediction: should be more no-marking errors on first group (gaze produced instead of gazes) than second (buzz produced instead of buzzes)
## Results

<table>
<thead>
<tr>
<th>Item type</th>
<th>Number of errors</th>
<th>Number of trials</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resemblance</td>
<td>36</td>
<td>900</td>
<td>.040</td>
</tr>
<tr>
<td>No resemblance</td>
<td>32</td>
<td>900</td>
<td>.036</td>
</tr>
</tbody>
</table>

- not significantly different
- no gang effect
- regularly inflected forms not lexically listed
Conclusions

• high-frequency irregular past tense verbs stored in lexicon
  – Study 1: frequency effect
  – Study 3: gang effect
• high-frequency regular past tense inflected forms stored in lexicon
  – Study 2: frequency effect
• regularly inflected present tense forms not stored in lexicon
  – Study 4: gang effect
• Contradiction (study 2 vs. 4 results)?
  – Suggested resolution
    • “low-frequency regularly inflected forms are not stored in the lexicon”
    • “How frequent an inflected form must be before it is stored in the lexicon is unknown...”