What does it take to learn a new word?

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MERGING WORD RECOGNITION WITH WORD LEARNING

Stimulus Input

Acoustic Phonetic Pattern Activation

Lexical Processing (Neighborhood Activation)

Higher Level Lexical Information

Known

Recognition

Unknown

Detection

Configuration

Learning
Two-year study funded by the Industry Research Consortium

Overall project goal: Determine the benefits of certain amplification features on auditory tasks that increase in cognitive demand.

Current data analyses: Compare the performance of children and adults who have hearing loss.
PARTICIPANTS

Children: 20 NH (8-12 years)
21 HL (8-12 years)

Adults: 15 NH (50-67 years)
17 HL (52-78 years)
Amplification

1. Standard amplification (4 kHz bandwidth)
2. High-frequency amplification (10 kHz bandwidth)
   - Extended bandwidth
   - or Non-linear frequency compression

Best performance with either type of amplification was included in the analyses.
BINAURAL AIDED HEARING THRESHOLDS
CHILDREN

STANDARD

FREQUENCY (Hz)
250  500  1000  2000  4000  8000

HEARING LEVEL (dB)
-20  0  20  40  60  80  100  120

Aided

Unaided

HIGH-FREQUENCY

FREQUENCY (Hz)
250  500  1000  2000  4000  8000

HEARING LEVEL (dB)
-20  0  20  40  60  80  100  120

Aided

Unaided
BINAURAL AIDED HEARING THRESHOLDS
ADULTS

**STANDARD**

**HIGH-FREQUENCY**

![Graph showing hearing thresholds for adults with and without aids for standard and high-frequency conditions.](image-url)
BINAURAL AIDED HEARING THRESHOLDS
ADULTS VS. CHILDREN

STANDARD

HIGH-FREQUENCY
TEST PARAMETERS

Testing
- 53 dB SPL in quiet
- 0° azimuth

Data collection
- Computer interface
- Digital audio recordings

Sessions
- 1 Unaided
- 1-2 Aided
Non-linear frequency compression
Wide-band amplification

Word Recognition: Best Performance

High-Frequency Amplification (% correct) vs. Standard Amplification (% correct)

- ▲ Non-linear frequency compression
- ● Wide-band amplification
WORD RECOGNITION RESULTS

### Performance (% Correct)

<table>
<thead>
<tr>
<th>Listening Condition</th>
<th>Children</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unaided</td>
<td>30</td>
<td>41</td>
</tr>
<tr>
<td>Aided</td>
<td>85</td>
<td>76</td>
</tr>
</tbody>
</table>

- **p = .29** for Unaided condition
- **p = .051** for Aided condition
Recognition of familiar words was the same in these children and adults with hearing loss.

Are they able to detect and learn new words equally well?
AUDITORY LEXICAL DECISION

Stimulus Input → Acoustic Phonetic Pattern Activation → Lexical Processing (Neighborhood Activation) → Higher Level Lexical Information → Known

Configuration

Detection

Unknown

baby
soovie
doppers
only
grandma
torses
before
taybe
outside
stoobi
AUDITORY LEXICAL DECISION
AUDITORY LEXICAL DECISION
BEST PERFORMANCE

Non-linear frequency compression
Wide-band amplification
AUDITORY LEXICAL DECISION RESULTS

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<td>33</td>
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<tr>
<td>Aided</td>
<td>83</td>
<td>65</td>
</tr>
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</table>

p = .76

p < .01
RESPONSE ANALYSIS

Stimulus

Real

"cat"

Not Real

"glug"

Not Real

Real

"glug"

Not Real

Real

Accurate

"cat"

Inaccurate

"fat"

Inaccurate

"mat"

Inaccurate

"gat"

Inaccurate

"plug"

Inaccurate

"plug"
AUDITORY LEXICAL DECISION RESULTS

Performance (% Correct)

Listening Condition

Unaided

Aided

Children

Adults

Real

Nonsense

0 10 20 30 40 50 60 70 80 90 100
Children are better than adults at identifying words they do and do not know when they occur in isolation.

How do they do when the unknown words are embedded in sentences?
NON-WORD DETECTION

Stimulus Input

Acoustic Phonetic Pattern Activation

Lexical Processing (Neighborhood Activation)

Higher Level Lexical Information

Known

Unknown

Detection

Configuration

Stimulus Input
NON-WORD DETECTION

Children (8-12 years)
19 HI Children
29 NH Children

Close all three doors.
Cooks make hot foom.
Overall performance (% correct)

Error analyses

- Under-detect: REPAIR
- Over-detect: MISPERCEPTION
NON-WORD DETECTION
BEST PERFORMANCE

- Non-linear frequency compression
- Wide-band amplification
NON-WORD DETECTION RESULTS

Performance (% Correct)

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</thead>
<tbody>
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<td>41</td>
<td>35</td>
</tr>
<tr>
<td>Aided</td>
<td>68</td>
<td>63</td>
</tr>
</tbody>
</table>

p = .36

p = .27
NON-WORD DETECTION RESULTS

Performance (% Correct)

Listening Condition

Unaided

Aided

Children

Adults

MISPERCEPTION

REPAIR

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CONCLUSIONS

Children and adults are equally good at identifying words they do and do not know when they occur in context. However, children tend to repair nonsense words while adults tend to misperceive real words.

Why?
COMPETING STRATEGIES

If detection of new words is not an issue, how well can adults learn new words compared to children?
RAPID WORD LEARNING

- Stimulus Input
  - Acoustic Phonetic Pattern Activation
    - Lexical Processing (Neighborhood Activation)
      - Known
      - Higher Level Lexical Information
        - Learning Configuration
          - Unknown
RAPID WORD LEARNING
RAPID WORD LEARNING

\[ P_c = 1 - 0.8e^{-n/c} \]
RAPID WORD LEARNING

PERFORMANCE (%) vs. TRIALS

- Averaged Data
- Averaged Fits
Children
26 HI Children
41 NH Children

**WORD LEARNING**

**BEST PERFORMANCE**

High-Freq Amplification (learning speed) vs. Standard Amplification (learning speed)

- ▲ Non-linear frequency compression
- ● Wide-band amplification

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RAPID WORD LEARNING

LEARNING SPEED FOR WORDS ONLY (no PLURALS)

Performance (% Correct)

Trials

Unaided

Aided

p = .31

p = .78

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RAPID WORD LEARNING

LEARNING SPEED FOR WORDS ONLY (with PLURALS)

Performance (% Correct)

Trials

5 15 25 35 45 55 65 75 85 95 105 115

No Plurals
All Words

p<.01
Children and adults are equally good at learning new words when provided with optimal amplification.
Are words learned rapidly retained?
Purpose:
Examine the relationship between performance for the word learning task on one day and the participant’s retention of those words the next day. Manipulated the number of training trials.
Participants:
98 normal-hearing undergraduates (130+ total)

Method:
Day 1: Learned 3 sets of 5 nonsense words
Day 2: Completed an online post-test
WORD LEARNING PARADIGM

Pittman, Wright, Wright & Latto (in progress)
POST TEST

Administered online

Enter (type) the name learned for each image.

The images are randomly distributed.

The word bank contains the 15 words earned as well as 15 orthographic/phonetic foils.

<table>
<thead>
<tr>
<th>Sentop</th>
<th>Nushtul</th>
<th>Pedsof</th>
<th>Homtul</th>
<th>Kaystil</th>
<th>Podtep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dozultil</td>
<td>Stomul</td>
<td>Stomun</td>
<td>Pedton</td>
<td>Doznud</td>
<td>Gaystil</td>
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<tr>
<td>Daystil</td>
<td>Stillmoy</td>
<td>Depton</td>
<td>Smentos</td>
<td>Maystil</td>
<td>Maystil</td>
</tr>
<tr>
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<td>Tayskit</td>
<td>Fosmud</td>
<td>Kensom</td>
<td>Smenkop</td>
<td>Gaysmit</td>
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<tr>
<td>Stomun</td>
<td>Homston</td>
<td>Kitstn</td>
<td>Kentop</td>
<td>Depmost</td>
<td>Kayskim</td>
</tr>
</tbody>
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*Pittman, Wright, Wright & Latto (in progress)*
RELATION BETWEEN LEARNING AND RETENTION

Performance (proportion correct) vs. Time on Task (minutes) and # of Training Trials.

- **Training** (solid blue line and blue dots).
- **Retention** (dotted green line and green dots).

Pittman, Wright, Wright & Latto (in progress)
CONCLUSIONS

Word learning is not a perishable skill, adults can learn as quickly as children.

Hearing loss impairs/slow word learning but normal or near-normal word learning can be achieved with optimal amplification.

Words learned rapidly are retained for at least a day.
Isn’t speech perception enough?
the end