Psych229: Language Acquisition

Lecture 12
Word Forms

Werker & Yeung 2005
Word learning: mapping among concept, word, and word’s variable acoustic signal

Important ability: “bootstrapping”
= using existing knowledge to facilitate acquisition
(use existing perceptual knowledge to learn words)

Werker & Yeung 2005
Perceptual system plays a significant role; perceptual units change throughout word learning (facilitate)

Werker & Yeung 2005
Bootstrapping:
- initial perceptual biases enable infants to initially extract early word forms (yields more precise knowledge of acoustic and phonetic properties of the native language)
- once linked with concepts, infants realize different sounds yield different word meanings and phonological representations is “bootstrapped” from existing perceptual system (phonological system online ~ 18-20 months)

Neonate (and fetus) perceptual biases:
prefer mother’s voice, stories & songs in native language

Werker & Yeung 2005
Perceptual biases shared with other animals:
- discriminate native language rhythm only when played forward, not backward
- categorical discrimination of some contrasts (ex: voice onset time “d” vs. “t”)

60 msec

Werker & Yeung 2005
Perceptual biases possibly shared with other animals:
- preference for speech over acoustically matched non-speech
- sensitivity to phonetic cues that indicate word boundaries
- (from cognitive neuroscience studies): unique cortical activation to forward speech vs. backward speech, phonetic vs. non-phonetic attributes

The effect of early exposure: links with later language proficiency
- vowel discrimination at 6 months predicts vocabulary size at 13-24 months
- reading proficiency correlated with phonetic discrimination as neonate
- word-object association ability delayed if ear infections/initially deaf
- bilingual evidence: don’t have true bilingual phonetic discrimination if exposed to sound system at 3-4 years of age
Werker & Yeung 2005

**Time course of speech perception: functional reorganization**

Functional reorganization of the brain due to statistical learning

Life’s easier when the distribution is bimodal, though

Werker & Yeung 2005

**Word segmentation**

- first segmentation at 7-8 months
- recognize familiar words, words with trochaic bias (if English)
- 10 months: recognize iambic words (guITAR), using phonetic & phonotactic cues

Strategies:

- language-specific: trochaic/iambic bias, phonotactic cues, familiar words
- language-independent: transitional probabilities

Question: which cues take precedence when both are available?

Johnson & Jusczyk (2001): 8-month olds prefer prosodic information over statistical information

Thiessen & Saffran (2003): 6-month olds prefer statistics to prosody

Werker & Yeung 2005

**Word forms**

- 5-6 months: encode phonetic detail ("tup" vs. "cup") and indexical detail (speaker identity & emotional affect); don’t generalize if indexical details are changed (no recognition)

<table>
<thead>
<tr>
<th>Age</th>
<th>Description</th>
<th>Phonetic detail</th>
<th>Indexical detail</th>
<th>Phonotactic cues</th>
<th>Familiar words</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-6 months</td>
<td>Cup</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7-8 months</td>
<td>guITAR</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
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</tbody>
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Werker & Yeung 2005

**Word forms**

- 10-11 months: recognition of word form even if indexical details are altered… but still treat mispronounced words as real words when differences are “perceptually confusable”

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<tbody>
<tr>
<td>10-11 months</td>
<td>Cup</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
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Werker & Yeung 2005

**Word form-object pairings**

- 14 months: can learn novel word-object pairings, but phonetic detail is fuzzy till about 17 months
- younger infants can learn (8-12 months), but only if synchrony between word presentation and movement of object; also require perceptual/social cues like visual salience and eye gaze

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<td>Cup</td>
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Werker & Yeung 2005

**Word form-object pairings**

The “Switch” Task (presentation of word 7-10 times while object moved)

Preferential Looking Task (word recognition)
Swingley & Aslin 2002: Word Representation

Word form representation:
- Children must encode sound forms... but different instances may have different acoustic properties (speaker voice, rate of speaker, word context)
- Word recognition: attend to linguistically relevant distinctions in the language (Swingley, Swingley, & Werker 2007: English tam ≠ taam; Dutch tam ≠ taan)
- By 12 months, infants seem to know which sounds are linguistically relevant — this is right at the beginning of the word learning phase

... but several studies show that children of this age don’t seem to encode a lot of phonetic detail
(novel word dak = gak for 2 year olds)

Swingley & Aslin 2002: Word Representation

Word recognition: attend to linguistically relevant distinctions in the language (Swingley, Swingley, & Werker 2007: English tam ≠ taam; Dutch tam ≠ taan)

By 12 months, infants seem to know which sounds are linguistically relevant — this is right at the beginning of the word learning phase

Swingley & Aslin 2002: Word Representation

Why?
- Maybe the task was too demanding for young children. (Learning a new name for an object, and then being asked to give that object to the experimenter.)

Question: Are children’s representations of words adult-like in their level of phonetic detail, or not?

One idea: Encode detail only if necessary

If children have small vocabularies, it may not take so much detail to distinguish one word from another. (baby, cookie, mommy, daddy)

Swingley & Aslin 2002: Word Representation

One idea: Encode detail only if necessary

If children have small vocabularies, it may not take so much detail to distinguish one word from another.

Neighborhood structure idea: When a child knows two words that are acoustically similar, more attention to phonetic detail is required to distinguish them.

Swingley & Aslin 2002: Word Representation

Going with the neighborhood idea, look at Stager & Werker (1997): “bih” and “dih” are too close, and kids don’t know any words close enough to motivate attention to the “b”/”d” difference when word-learning

Follow-up study (Werker et al. 2002): 17-month olds and 20-month olds do notice the “bih”/”dih” switch

Swingley & Aslin 2002: Word Representation

Correctly pronounced words easier to recognize than all mispronounced words (so task is reasonable & infants notice the difference in pronunciation) [p < .001]

But there was no effect for whether it was a close mispronunciation (opple) or a distant mispronunciation (opal) (contrary to prediction of neighborhood)

Swingley & Aslin 2002: Word Representation

Results
Correctly pronounced words easier to recognize than all mispronounced words (so task is reasonable & infants notice the difference in pronunciation) [p < .001]

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Subjects: 50 14-15-month old infants
24: correct vs. distant mispronunciation
26: correct vs. close mispronunciation

Tracking time spent fixated on target picture (367-2000ms after word pronounced)
Swingley & Aslin 2002: Word Representation

Results

Conclusion: Since ability to notice mispronunciations wasn’t dependent on age or vocabulary size, infants (14 month olds) must initially store words with a lot of phonetic detail - it doesn’t matter how many neighbors there are

Idea: Any mispronunciation may be noticeable (so not necessarily a difference between close mispronunciations & distant mispronunciations)

Good thing: If infants initially store words with phonetic detail, they don’t need minimal pairs to force them into noticing more phonetic detail (minimal pair = ball vs. doll, which requires some semantic knowledge to know they’re different)

Swingley & Aslin 2002: Word Representation

Questions

But what about studies with older kids (17-month olds) that had trouble distinguishing mispronunciations of novel words?

Key: novel words

Idea: Maybe phonetic detail involves hearing the word a number of times - get a little more phonetic detail each time

{p/b/d/g} {a/o/u} {l/r} …

{p/b} {a} {l/r} …

{b} {a} {l}

If it’s a novel word, kids haven’t heard it enough yet. (Stager & Werker, 1997 = only 7 times of repetition)

Swingley 2005: Word Representation

(Yes, really, they have phonetic detail)

11-month olds & familiar words

Previous work: Hallé & de Boysson-Bardies 1994 (less phonetic detail)

- infants prefer familiar words even if initial consonant mispronounced (bonjour ~ ponjour)
- infants prefer familiar words even if onset of second syllable mispronounced (bonjour ~ bonjour)
- only if initial onset missing did infants not like mispronounced words (bonjour ~ onjour)

Reconciliation:

Hallé & de Boysson-Bardies 1994: French children don’t notice change if to onset of initial cluster

Vihman et al. 2004: English children don’t notice change if to onset of medial cluster

Combined: children have trouble noticing difference if change is to beginning of unstressed syllable (bonjour vs. bonJOUR, bonGOUR vs. bonJOUR for French)

Swingley 2005: Word Representation

(Yes, really, they have phonetic detail)

The Plan: Dutch 11-month olds

Use least salient phonetic contrast in language - if infants can track this, they can detect more salient changes, too.

Expt 1: Correct pronunciations of familiar words vs. correct pronunciations of unfamiliar or nonce words (baseline)

Expt 2a: mispronounced familiar words vs. unfamiliar words

Expt 2b: familiar words vs. mispronounced familiar words

Expt 3a: mispronounced familiar words (offset) vs. unfamiliar words

Expt 3b: familiar words vs. mispronounced familiar words (offset)
**Experimental Stimuli**

- Swingley 2005: Word Representation (Yes, really, they have phonetic detail)
- Experimental Stimuli

**Procedure**
- 16 test trials per infant
- 24 words per sound file, 1 second pause in between words
- Experimenter gauged infant's looking time
- Infant fixates on flashing green light, which is exp start
- Then, red light flashes. When infant looks, experimenter starts playing sound file. Experimenter keeps playing sound file until infants looks away for 2 consecutive seconds. (Does not play when infant not looking, though, even if less than 2 seconds.)

**Results 1: Familiar vs. Non-Word**
- Familiar: average 9.20 seconds
- Non-word: average 7.39 seconds
- Infants prefer familiar over non-words

**Prediction 2a: Mispronounced familiar vs. Non-word**
- If have phonetic detail, should not have preference
- If don't have phonetic detail, treat mispronounced as familiar and have preference

**Prediction 2b: Mispronounced familiar vs. familiar**
- If have phonetic detail, should have preference for familiar
- If don't have phonetic detail, treat as same and have no preference

**Results 2a:**
- Mispronounced familiar: average 8.91 seconds
- Non-word: average 9.85 seconds
- No preference = phonetic detail

**Results 2b:**
- Mispronounced familiar: average 9.07 seconds
- Familiar: average 10.07 seconds
- Preference for familiar = phonetic detail

**Experiments 3a & 3b:** But what if mispronunciations are in the offset? (Yield: ben ~ den)

**Results 3a:**
- Mispronounced Familiar (offset) vs. Non-Word
  - Average: 8.85 seconds
  - No preference = phonetic detail

**Results 3b:**
- Mispronounced Familiar (offset) vs. Familiar
  - Average: 9.02 seconds
  - No preference = no phonetic detail

*What's going on?*

**Results 3b:** Why infants don't prefer "bem" over "ben"?
- One idea: Maybe they don't notice the offsets period. (Less phonetic detail)
- ...but then why didn't they prefer the mispronunciations over the non-words (expt 3a)?

*Another idea: Infant recognition process is over-eager*
- They start activating "ben" as soon as they hear "be", and can't de-activate it in time to notice the difference between "ben" and "bem". Support for this from ERP studies.

*...but then why didn't infants treat mispronunciations as familiar words in expt 3a?*
Swingley 2005: Word Representation
(Yes, really, they have phonetic detail)

Results 3b: Why infants don't prefer "bem" over "ben"
Offsets forms are more fragile in the infant mind.
- less informative, less salient, etc.

Prediction: Different trajectories for onset vs. offset?
Question: How does this differ from having less phonetic detail for offsets?

Werker & Yeung 2005
What triggers the ability to recognize the important phonetic detail at 17 months?
(tup is a mispronunciation and not an acceptable variation of "cup")

Suggestion (PRIMIR): critical threshold of word-object mappings has been reached.
Infants recognize which phonetic differences signal meaning differences (contrastive phonological categories). Phonological categories are easy cues to differences in meaning - make child’s job easier for subsequent recognition and acquisition of new word-object mappings.

Incremental processing at 24 months and 18-21 months (shift to correct picture even after partial information).

Werker & Yeung 2005
Neurological Data: Brain Activity at 14 months

High negative deflection at 400ms after presentation for incongruous vs. known congruous words (similar to N400 effect in adults)

Effects for known vs. unknown words at 200-600 ms after presentation (word recognition)
- 14 months: even if words are mispronounced ("tup")
- 20 months: only if words are correctly pronounced ("cup")

Shift from bilateral activation at 14 months to left-hemisphere dominant at 20 months.