3 stages of phonological development

1. Prelinguistic vocal behaviors
2. Phonology of the first 50 words
3. Emergence of rules

Prelinguistic vocal behaviors

- Reflexive/vegetative sounds (birth-1 month)
- Cooing (2-3 months)
- Vocal play (4-6 months)
- Reduplicated babbling (7-9 months)
- Variegated babbling (10 months-1 year)
- Jargon (12-18 months)

Stage 1 (birth-1 month)

- reflexive sounds: crying, fussing
- vegetative sounds: burping, swallowing, spitting up

Stage 2 (2-3 months)

- "cooing" stage
- productions are acoustically similar to velars
- CV timing not yet adult-like

Stage 3 (4-6 months)

- "vocal play"
- experimentation with nonsegmental features: pitch, loudness, rhythm, vocal register
- experimentation with articulators: raspberries, tongue clicks, trills
- CV timing still not adult-like

Stage 4 (7-9 months)

- "reduplicated" babbling
- CV timing approximates that of adult speech
- limited phonetic repertoire
  - lax vowels [ɪ, ɛ, ʌ] predominate
  - stops, nasals, and glides most common consonants
  - alveolars replace velars as most frequent place of articulation; bilabials also increase

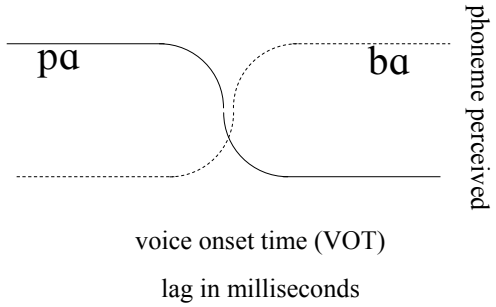
Stage 5 (10 months-1 year)

- "variegated" babbling
- variety of consonants and vowels can co-occur, e.g. [bæwidə]
- consonant repertoire increases substantially but stops, nasals, and glides are still most frequent
- adult-like intonation patterns occur

Jargon (12-18 months)

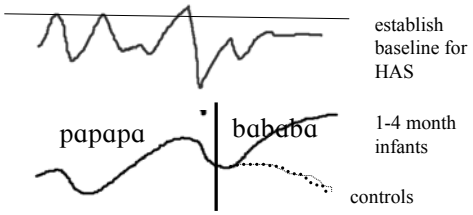
- longer syllabic strings
- more varied intonation patterns
- overlap with child's true first words

Categorical perception



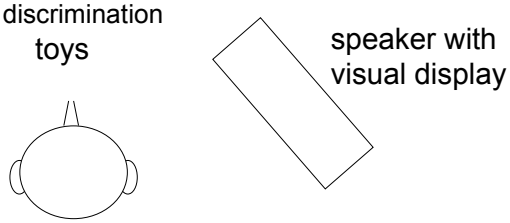
Techniques for studying speech perception

- high amplitude sucking



- limitation: doesn't work with breastfed babies, limiting pool of study participants

- heart rate
  - works similarly to high amplitude sucking
  - not as effective
- visually reinforced speech discrimination



Categorical Perception

- Using "preferential sucking rate" measures, infants as young as 1 month of age appear able to discriminate [p] from [b] based on Voice Onset Time (VOT)
- Place and manner of articulation differences can be detected by age 3 months

Discrimination of Non-native Sounds

- Up to approximately 6-8 months of age, infants can discriminate among sounds that they had not been exposed to, then the ability is lost.
- Suggests that discrimination ability in something we are born with.
- Language experience may cause us to ignore differences that are not functional.

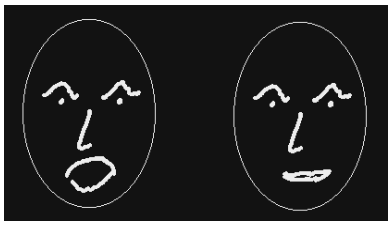
Perceptual Constancy

- The acoustic characteristics of speech sounds produced by speakers of different ages and sexes vary widely.
- As listeners we are able to identify the sound regardless of who the speaker is.
- categorization is possible by 6-8 months

papapa	bababa	papapa
pipopu	bɛbibo	pupepɪ
male	female	child

infants ignore vowel and speaker "noise" and respond to consonant change

Auditory-visual mapping ("speechreading") in infants



infants detect mismatched auditory-visual stimuli

[ɑ] [i]

- progressive idioms
  - their disappearance gives the appearance of regression
  - down [dɑʊn] → [nɑʊn]
  - stone [don] → [non]
  - beans [biz] → [minz]
- canonical forms
  - CVʃ e.g. beans [biʃ] stone [doʃ]
  - ŋVŋV e.g. balloon [ŋoŋo] cookie [ŋʊŋʊ]

Phonology of the first 50 words

- Preference for some sounds and avoidance of others
  - bilabial preference: *bubble, bottle, baby*
  - avoidance of [u]: no *juice, shoe, moo*
  - not evidenced in all children
  - short-lived

Early Segmental Development

- Some generalizations from several studies:
  - CV, VC & CVC syllable shapes most common.
  - Greater variety of sounds in initial position.
  - Voiced sounds more common in initial position (voiceless in final).
  - Up to 70% of consonants attempted are correctly produced (may be choosing words containing consonants they are able to produce).

Phonetic inventory of toddlers Initial Position

Age	Mean Size	Phones in 50% of kids
15 mos	3.4 (2-5)	b d h
18 mos	6.3 (2-10)	b d m n h w
21 mos	6.7 (2-13)	b t d m n h
24 mos	9.5 (4-16)	b t d k g m n h w f s

Phonetic inventory of toddlers Final Position

Age	Mean Size	Phones in 50% of kids
15 mos	0.6 (0-2)	(none)
18 mos	2.8 (0-6)	t
21 mos	3.6 (0-7)	t n
24 mos	5.7 (0-11)	p t k n r s

Linguistic Perception

- Requirements of the child - a speech stimulus must be
  - heard
  - registered
  - interpreted
- Distinction between sensory capacity and use of that capacity to distinguish among words

What counts as evidence of linguistic perception?

- a behavioral response (pointing, picking up object, etc.)
- an unambiguous response
- a response within the child's repertoire

Perceptual Difficulties

- Confusion among fricatives and liquids may persist
- May be partly responsible for persistence of errors within these classes

Internal Representations

- These are the "blueprints" for phonological structures that reside in a child's brain
- They cannot be observed directly but must be inferred from limited perceptual evidence as well as evidence from children's immature productions

Internal Representations

- most methods of phonological analysis and intervention assume adult-like representations
- available evidence suggests
  - word shapes are represented earlier
  - immature representations may persist for clusters, fricatives, liquids
- a child with adult-like representations may still have production errors because of a lack of self-monitoring

Emergence of rules

- beyond the single-word period, we begin to see consistency and regularity in children's renditions of adult words
- phonological process = *a systematic sound change that affects classes of sounds or sound sequences*

Adult vs. Child Speech

- Young typically-developing children produce segmental errors.
- Children articulate the segments at a slower rate than adults.
- Children's speech may be more variable than adult speech.
- Children anticipate upcoming segments less than adults (less coarticulation).

Preschool Phonological Development

- Largest gains in phonological development occur between 1;6 and 5;0 for most children.
- Accompanied by many gains in other aspects of language development (especially semantics and syntax).

The Preschool Child

- At the appearance of two-word combinations (when the lexicon is about 50 words), the child still has limited inventories (both phonemes and syllable shapes).
- Still quite unintelligible; unfamiliar listeners typically understand < 50% of what they say.

Vowel Development

- Has not been examined very well.
  - Problems with vowel transcription.
  - Vowels rarely a problem clinically.
    - major exceptions = [ɝ] and [ɚ].
    - Can be a problem for children with obvious speech motor problems (e.g., cerebral palsy).
  - Data suggest that 70% of children have mastered all the vowels by about age 3;0.

Consonant Development

- Much more research done here.
  - Consonants more of a clinical issue than vowels.
- Most studies are cross-sectional.
  - Look at several age groups at the same time.
  - Cohort problem: Did the oldest children previously perform like the youngest children do now and will the youngest children perform in the future like the oldest do now?

Consonant Development

- Biggest problems with comparing the studies:
  - Different definition of "mastery":
    - 50%, 75% or 90% of children?
    - Mastery at initial and final position?
  - Word positions included:
    - Did they examine intervocalic position?
    - Did they test clusters?

Consonant Clusters

- Usually later developing than singleton consonants.
- A frequent therapy target; a problem for some second language learners .
- Suggests that they may be more difficult to produce than singletons.

Consonant Clusters

- Sampling mode may be crucial.
- A recent study suggests that omission of one element of a cluster is more likely in conversational speech than in single word tests.
- Single word tests may be less likely to identify a problem with clusters.

Consonant Clusters

- McLeod, van Doorn & Reed (2001) concluded:
  - 1. Word-final clusters probably are acquired earlier than word-initial clusters.
    - Acquisition is probably aided by the emergence of grammatical morphemes (plurals, past tense, etc.).
  - 2. Two element clusters (e.g., /st /, /bl/, /tr/) are generally acquired before three element clusters (e.g., /str/, /skl/).

Consonant Clusters

- 3. Children acquire word-initial sequence in a typical sequence:
  - 1. Omit one member "blue" /blu/ → [bu]
  - 2. Substitute for one member "blue" /blu/ → [bu]
  - 3. Produce it fully correctly.
- 4. Less consistency in the pattern of acquisition of word-final clusters.

Universal Order?

- Shriberg has proposed we group the 24 English consonants into "developmental sound classes":
  - Early 8: /m, b, j, n, w, d, p, h/
  - Middle 8: /t, ŋ, k, g, f, v, tʃ , dʒ/
  - Late 8: /ʃ, θ, s, z, ð, l, r, ʒ/
- Not everyone would agree even on this division.

Suppression of Processes

- A different overall perspective is to look at how natural phonological processes are suppressed over time by children.
- If “phonological processes” are truly natural, and development involves the suppression of them, we should see a pattern across children.

Errors and Development

- Normative Data from Photo Articulation Test

Age	Boys	Girls
3;0	25 +/ - 13	20 +/ - 10
3;6	16 +/ - 10	15 +/ - 12
4;0	16 +/ - 14	14 +/ - 11
4;6	14 +/ - 11	11 +/ - 10
5;0	9 +/ - 11	9 +/ - 10
5;6	7 +/ - 7	7 +/ - 8
6;0	6 +/ - 6	5 +/ - 8

Whole-Word Accuracy and Development

- From Schmitt, Howard, & Schmitt (1983)

Age	% Words fully correct
3;0	68.5 +/- 10.3
3;6	76.4 +/- 10.7
4;0	80.0 +/- 10.3
4;6	83.8 +/- 5.5
5;0	88.0 +/- 6.0
5;5	88.7 +/- 7.8
6;0	91.9 +/- 4.9
7;0	95.4 +/- 2.1

Intelligibility and Development

- From Weiss, Gordon & Lillywhite (1987)

Age (months)	% Intelligible
18	25%
24	50%
30	64%
36	80%
42	92%
48	100%

Intelligibility and Development

- Caplan & Gleason surveyed parents of 235 children asking how much strangers understood of their child’s speech.
- Used the data to create clinical cutoffs of the age when 90% of children reached particular milestones.

Intelligibility and Development

- Understand 50%? 22 months
- Understand 75% 37 months
- Understand 100% 47 months
- Closely agree with Weiss et al data.

Intelligibility and Development

- Useful approximate index:
- Expected % intelligible =
  - Age in years divided by 4.

The School-Age Child

- Much less studied than the preschool period.
- Most of the data comes from normative studies for the published single-word articulation tests (e.g., PAT).
- These data and the cross-sectional studies all suggest that the period of normal speech-sound acquisition ends at around 9;0 (may still see problems with clusters).

The School-Age Child

- Very little is known about the acquisition of other aspects of phonology though much of it appears to be mastered during the school-age period.
  - Allophonic rules.
  - Morphophonemic rules.
  - N-V alternations, vowel shifts etc.