Factors that Influence Speech Acquisition: Treatment Planning

Martha S. Burns, Ph.D.

References

References (continued)


References (continued)

References (continued)

• Martin, D. (1979) Some Objections to the term Apraxia of Speech. *Journal of Speech and Hearing Disorders* 39, 53-64

References (continued)

What we know from perceptual studies and fMRI research

- Kuhl’s landmark infant perception studies
- Hickock and Poeppel – neurolinguistic perspectives
- Genetic causes – Fox P2
Kuhl, 2008 Phases in early perceptual/production

- **Phase 1** - infants begin life with a capacity to discriminate the acoustic cues that code differences among phonetic units. The ability to discriminate the sounds, albeit crudely, assists development in phase 2.

- **Phase 2** – two aspects of environmental input—*exaggerated acoustics (motherese) and distributional properties*—interact to support infants’ perception of categories infants’ sensitivity to categories
  - Learning occurs earlier for vowels than consonants which could reflect the availability of exaggerated cues in ID speech (consonants are not as easily exaggerated as vowels, because exaggeration can change the category, e.g. stretching the formant transitions of /b/ produces /w/).
  - Alternatively, there may be differences in the availability and/or prominence of distributional differences for consonants (e.g. consonants like /th/ occur in function words, which are lower in energy and do not capture infant attention, see Sundara et al. 2006).
Organization of cortical responses to spoken language in 3 m old infants.

Kuhl, 2007

- Acoustic stretching of phonetic cues in ID speech
- would be expected to exaggerate the distributional cues
- to phonetic units, and there is some evidence to validate
- this (Werker et al. 2007). Computer-learning models
- also indicate that ID speech improves the robustness of
- category learning achieved over that obtained with AD
- speech (de Boer & Kuhl 2003). In order for ID speech
- to support phonetic learning, infants have to be
- interested in listening to it. Studies of typically
- developing infants, even newborns, suggest a preference
- for speech, and especially ID speech (Fernald
- 1984; Fernald & Kuhl 1987; Vouloumanos & Werker
- 2004). And when a social interest in speech is absent, as
- is the case for children with autism, our tests show that
- non-speech analogue signals are preferred over ID
- speech, and that the strength of preference for nonspeech
- predicts severity of autism symptoms as well as
- the degree to which neural responses to speech are
- aberrant (Kuhl et al. 2005a). Thus, research on both
- typical children and those with developmental disabilities
- suggest that social factors play an important
- role in the earliest phases of language acquisition.
Kuhl NLM continued

• By the end of phase 2, infant perception is altered. The detection of native language phonetic cues is enhanced in the process, while detection of non-native-phonetic patterns is reduced.

Who? What? A unified sound wave coming from an unseen talker is analyzed to produce two distinct percepts—Who spoke and What was said.
Kuhl, 2008

• By the end of phase 2, infant perception is altered. The detection of native language phonetic cues is enhanced in the process, while detection of non-native-phonetic patterns is reduced.

Kuhl research on the importance of Social Interaction

Figure 6: Social Interaction Facilitates Foreign Language Learning

The need for social interaction in language acquisition is shown by foreign-language learning experiments. New-birth infant infants experienced in Mandarin phonetic discrimination between natural interaction with a Chinese speaker (left) or the identical linguistic information delivered via television (right) or audiotape (data not shown). (b) Natural interaction resulted in significant learning of Mandarin phonemes when compared to a control group, who participated in television presentation of Mandarin phonic stimuli or audiotaped presentations. Data for age-matched Chinese and American infants learning their native languages are shown for comparison (right panel, from Kuhl et al., 2003).
Kuhl, 2008 (continued)

- Phase 3 - enhanced speech perception abilities improve three independent skills that propel infants towards word acquisition (and predict future language skills):
  - the detection of phonotactic patterns (Friederici & Wessels 1993; Mattys et al. 1999);
  - the detection of transitional probabilities between segments and syllables (Goodsitt et al. 1993; Saffran et al. 1996; Newport & Aslin 2004); and
  - The association between sound patterns and objects (Swingley & Aslin 2002; Werker et al. 2002; Ballem & Plunkett 2005).
Kuhl, 2008 continued

Phase 4—analysis of incoming language has produced relatively stable neural representations—new utterances do not cause shifts in the distributional properties coded neurally.

- In infancy, neural networks are not completely formed and do not restrict learning.
- Infants are thus capable of learning from multiple languages, as shown in everyday life, and also as shown by experimental interventions (Maye et al. 2002; Kuhlet et al. 2003).

Fig. 1 (A) Mean voice-recognition performance of dyslexic and control listeners (error bars indicate SEM).
Clinical Import of Kuhl research for FFWD interventions – bilingual infants

• Infants learning two first languages simultaneously might reach the developmental change in perception at a later point in development than infants learning either language monolingually (see Bosch & Sebastià-n-Galle’s 2003a,b).

• Bilingual infants could remain in phase 2 for a longer period of time because it takes longer for sufficient data from both languages to be experienced and to reach sufficient stability:
  – Could depend on factors such as the number of people in the infants’ environment producing the two languages in speech directed towards the child and the amount of input they provide.
  – Since neural commitment in the early period is incomplete, a second language introduced during infancy does not encounter as much ‘interference’ from commitment to the features of the first language as a second language introduced at a later point in life.

• DUAL Mapping - The phonetic features of each language could be mapped onto separate perceptual spaces because their acoustic and statistical properties are sufficiently distinct.
Learning a second language after the critical period

Kuhl research (continued)
Intracranial electrophysiology (ICE) (Sahin, et al., 2009)

- Recorded local field potentials from populations of neurons using electrodes implanted in language-related brain regions while people read words verbatim or grammatically inflected them (present/past or singular/plural)
- Neighboring probes within Broca’s area revealed distinct neuronal activity for lexical (~200 milliseconds), grammatical (~320 milliseconds), and phonological (~450 milliseconds) processing, identically for nouns and verbs, in a region activated in the same patients and task in functional magnetic resonance imaging
Fig. 1 Experimental design

Fig. 2 (A) Main results: sequential processing of lexical, grammatical, and phonological information in overlapping circuits


Published by AAAS
Categorical speech representation in human superior temporal gyrus

Edward F Chang, Jochem W Rieger, Keith Johnson, Mitchel S Berger, Nicholas M Barbaro & Robert T Knight

Nature Neuroscience
VOLUME 13 | NUMBER 11 | NOVEMBER 2010
Assessment of Apraxia

• Liepmann’s model
  – Kinetic apraxia
  – Ideokinetic apraxia
  – Ideational apraxia
• Limb apraxias
• Oral buccal apraxia
• Apraxia of Speech
Research Findings - Speech characteristics in children

- Delayed and deviant patterns
- Vowels are often impaired as severely as consonants
- Problems with phonetic synthesis
- Decreased phonetic repertoire
- Automatic speech is better than purposeful
- Errors tend toward simplification
- eg. dudi for cookie; glottal stops for final consonants, imploded final stops, etc.

Research Findings - History

- Feeding problems
- Little or no early vocal behavior
- Non-informative crying
- Family history speech, language, LD problems
- Neurological soft signs
- Inability to imitate oral postures and facial expression
Research Findings - Nonspeech deficits

- Auditory processing
- Oral perception
- Oral Apraxia
- Poor self monitoring
- Limb apraxia (gross motor abnormalities)

Summary

- Apraxia is a motor speech disturbance that affects articulation (production) of phonemes and grammatical formulation
- Phonological processing disorders in children and literal paraphasia in adults represent problems with perception, phonological organization, linguistic representation
- Many children exhibit components of each
What is Childhood Apraxia of Speech?

• Diagnostic criteria are all over the place
  – ASHA website and position papers essentially include all problems with speech production saying more research is necessary
• Shriberg et al have been studying CAS from production characteristics to genetics (FOX P2)

![Diagram](image)

From Hosum, Shriberg and Green, 2004
Video

• Fox P2 characteristics

Newer research

• Links perception to production (see especially Pulvermueller and Fadiga, 2010)
  – Reviving the motor theory of speech perception – notably that speech production enhances perception
  – See also newer research by DeHaene, Dec. 2010 showing that perceptual skills are even enhanced by reading
But Turken and Dronkers, in press take it further to processing tracts

- Differentiating
  - Speech, Grammar and Fluency pathways
  - Differentiating underlying auditory speech processing
  - With semantics overlying everything
Turken and Dronkers (2011 in press) speech, fluency and grammar pathways

![Image 1](image1.png)

Figure 8. Pathways associated with the BA47 ROI (left, blue). Streamline tractography results from two subjects are presented as examples. The inferior occipito-frontal fasciculus as well as a group of IOFF fibers associated with the posterior MTG ROI were identified.

Turken and Dronkers (2011 in press – White Matter) tracts underlying auditory speech processing

![Image 2](image2.png)

Figure 13. Fiber pathways passing through the white matter underlying the superior temporal sulcus. Five different fiber bundles were found to contribute fibers to this small white matter region (left, green). Direct and indirect segments of the (frontal fasciculi), the (frontal fasciculi), the (pulvinar longitudinal fasciculi) and the tapetum are shown for the two subjects chosen as examples.
So – we should be able to distinguish:

• Children with perceptual problems
• Children with motor speech, grammar, fluency problems (CAS)
• Children with broader problems that effect semantics
Children with severe speech production problems seen for intensive intervention in the Kaufman Clinic during summer 2008

13 Characteristics used characterize children with severe speech disorders

1. **Nasalization due to co articulation with nasal consonants** – (Nasalized vowels or non-nasal consonants) ASHA 2007, Trost and Canter, 1974.

2. **Stopping - Substitution of glottal stops for final tip-alveolar or velar consonants or plosives for fricatives.** (Canter, Trost and Burns, 1984)

3. **Backing - Substitution of blade alveolar or velar placed productions for tip alveolar consonants** (Canter, Trost and Burns, 1984)
Characteristics (2)

4. Absent Frication - Absence of frication or affrication in spontaneous speech productions (Trost and Canter, 1974)
5. Simplification - Simplifies words by replacing difficult sounds with easier ones or by deleting difficult sounds (ASHA 2007)
6. Final Consonant deletion - Imploding or deletion of final consonants (ASHA 2007)
7. Reduced Oral Motor - Problems with oral motor posture imitation (Trost and Canter, 1974)
8. Reduced Fluency - problems combining sounds; may show long pauses between sounds (ASHA 2007; Shriberg, 1993)

Characteristics (3)

9. Reduced phonemic repertoire - spontaneous speech limited to a few different consonant and vowel sounds (ASHA 2007)
10. Low tone - seated slouched in chair, little upper body postural support (Darley, Aronson and Brown, 1975; literature on motor skills maturation, NDT)
11. Reduced bilabial tone - Chronic open-mouth posture and/or excessive drooling (ASHA 2007)
12. Single syllable - Spontaneous speech limited to single-syllable productions (viewed as an extreme form of simplification – ASHA 2007)
13. Reduced Word Repetition - Phonemic repertoire remains reduced on real word and/or non-word repetition on the Kaufman Speech Praxis Test (see also, Shriberg et al, 2009) – divided into simple and complex constructions depending on syllable structure complexity
Table 1. Children determined to exhibit marked Motor-Speech (+CAS) problems [five or more characteristics] and those with possible Motor Speech (?CAS) problems who exhibited four characteristics.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>MAC</th>
<th>CHR</th>
<th>GAR</th>
<th>JAM</th>
<th>LAN</th>
<th>CAR</th>
<th>CAY</th>
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<td>Chronological AGE</td>
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<td>MLU</td>
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<td>G-F score</td>
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<td>71</td>
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Table 2. Children who did not exhibit evidence of motor speech problems per se, with one phonological process (stopping or backing) that might be associated with phonological delay, simplification of phoneme use and/or reduced phonemic repertoire, and/or language production reduced to single syllables with phonemic repertoire consistent with language age.
Children with severe speech production problems seen for intensive intervention in the Kaufman Clinic during summer 2008

Table 3. Seven criteria that differentiated CAS and ?CAS from PPD.

<table>
<thead>
<tr>
<th>MAC CAS</th>
<th>CHR CAS</th>
<th>GAR CAS</th>
<th>JAM CAS</th>
<th>LAN ?CAS</th>
<th>CAR ?CAS</th>
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Results of pre and post Goldman Frisbie 2 testing, organized by ascending age of subject

Goldman Frisbie 2: Pre vs. Post Intervention

- Prep Intervention
- Post Intervention

\[ t \text{ test} = .000241897 \]
Case Study Outcomes

Table 4. Longitudinal case summaries of four children with initial presentation of severe speech sound disorders.
Summary – children with motor speech disorders:

- Can be distinguished from other severe speech problems by seven characteristics
- Do appear to have auditory processing disorders as well as motor speech signs
  - Supported by newer research
  - Lack of self-monitoring
- Are not necessarily more severe to start with but do not show as much improvement with intensive speech/language therapy
- Do benefit from FFWD Language (Literacy) along with speech therapy
- Should receive RAEE as well