Acquisition of Phonology

Major concerns:

First, **production/perception asymmetries**, true of all language acquisition;

Second, specific to phonology: early phonological production/perception is a prelinguistic phenomenon (if we define language as sign-referent correlation), **infant - to - child continuity/discontinuity**.

Also to be borne in mind are **the methodological issues** relating to these concerns: what is the nature of the experimental data?

General Issues:

1) Place of built in and experiential factors in the acquisition of phonology

2) Levels of phonological analysis: Segmental phonology/suprasegmental phonology
Are the phonological representations segmental or suprasegmental?

3) Role of suprasegmental features in language acquisition: Extreme sensitivity to suprasegmentals, is there a relation beween suprasegmental features and syntactic and morphological patterns -- lg learner's use of suprasegmental patterns for acquisition of morphology and syntax. An alternative to semantic bootstrapping – prosodic cues employed to arrive at syntactic and morphological structure.

4)Individual Variations in phonological acquistion

I Segmental phonology

Adult metalinguistic ability to have access to segments, or featural contrasts (reflected most commonly in sound to grapheme mapping).

Several possible featural analyses:

C/V: Constriction in the oral tract
Consonants:
Manner in which the air flow is constricted and released: stop, nasal, fricative, affricate, liquid, and others
Place in the mouth where the air is constricted: labial, dental, alveolar, palatal, velar, uvular, glottal
Voicing: whether vocal cords are vibrating
Coarticulations: aspiration, palatalization

V: back, height, rounding
(sounds differ in terms of features: kg/ td/ pb in English: phonemic contrasts)

Segmental phonology: issues

1. Children learning segmental phonology are learning phonemic contrasts:

    a) relation between early (prelinguistic) speech perception and later production of first words
    b) development of phonological representations

2. How children's early words deviate from the adult forms, and from the child's intended forms.

Prelinguistic development:

Defining the boundaries: birth to onset of first words

The lower bound: Birth represents the infant readiness to begin the experiences we normally associate with human development. Issues concerning prenatal development: auditory and vocal apparatus; possible effects of in utero auditory experiences. Not touched upon here.

The upper boundary: narrowing down what we mean by the acquisition of the first word – defining this milestone is no easy matter. Is it first word in comprehension or production? The first auditory word/the first recognizable meaningful word?

Infant speech perception: perceiving linguistic stimuli – perceiving speech before the recognition that such speech conveys a meaning. To be distinguished from child speech perception: perception of linguistic sign as a meaning bearing element, begins with single word utterances. Similarly, infant speech production: speech like vocalizations before any meaning is given to them. To be distinguished from child speech production, production of meaningful speech in the adult world.

Precursor to Segmental Phonology: Infant Speech Perception:

Perceive: perceive phonemic or featural contrasts

Leading Conceptual Paradigms

(a)Perceptual Learning theory
Behaviourist -- underdeveloped perception at birth, infant experience with auditory input leading him to recognize speech sounds. Prediction: young infant is poor at speech perception; perceives distinctions only of the language he is learning.

(b)Attunement theory:

Constructionist – the infant born with ability to perceive some of the basic human language sounds, others develop as a result of experience. Predicts three directions: maintenance of early contrasts (if they are present in the target language); loss of early contrasts, if they are unattestedin TL, addition of new contrasts.

Maturational theory:
Innatist: the perceptual ability follows a biologically determined schedule, virtually unaffected by experience.

Hypotheses:

A. Infants are born with limited perceptual ability.
B. Infants are born with ability to perceive most and possibly all speech sounds.

Infant speech perception – methods:

Three procedures to study infant perceptual ability:

High amplitude sucking paradigm: the capacity to discriminate auditory stimuli, and hence, speech sound differences, is inferred from the sucking behaviour, which undergoes a systematic change at the introduction of a new stimulus (Eimas et al, 1971).

Heart rate paradigm: The infant is monitored through the attachment of electrodes which record his heart rate. The heartbeats undergo a deceleration at the introduction of a new auditory stimulus. (Moffit, 1971).

Visually reinforced speech discrimination paradigm: the auditory stimulus is reinforced by a visual stimulus, and the turning of the head at the visual stimulus is a measure of whether the auditory stimulus has been perceived or not (Eilers, 76).

Categorical speech perception in adults: adult listeners presented with a continuum of synthetic speech stimuli. These stimuli have a consonant like burst sound followed by a vowel like steady state sound. The variable of interest is the temporal relation between the burst and the vowel – the voice onset time.

All stimuli in which the V occurs 25ms or more after the burst are perceived as /pa/ (vl consonant) all others are perceived as /ba/ (vd consonant) -(Lisker and Abramson, 1964)

English speaking Adults unable to distinguish two stimuli from within the same phonemic category but able to differentiate stimuli exhibiting an equivalent acoustic difference when these stimuli come from different catgories (Liberman et al., 1967).

Infant speech perception (Eimas et al., 1971)
Eimas: Sucking rate habituation expts
Three phases: acquisition phase, habituation phase and dehabituation phase.
Two groups: control group and experimental group

The infant is given a pacifier which contains a wire attached the computer that measures the infant sucking rate. As the infant sucks the pacifier, he hears the auditory stimuli in the form of syllables.

In the acquisition phase, the infant learns that he may increase the amplitude of the auditory stimulus by increasing the sucking rate. When the increased rate of sucking occurs, the infant enters the habituation phase of the experiment. After hearing the same stimulus for several minutes, the infant gets used to or habituates to the sound and decreases the rate of sucking. When this happens, the infant is presented with one of the two conditions:

If the infant is in the control Group, he continues to hear the same stimulus item while his sucking rate is recorded.

If the infant is in the experimental group, however, he will be presented with a new stimulus, and when the new stimulus is perceived, he will increase the sucking rate to make the stimulus more audible. The new stimulus interrupts the habituation to the old stimulus, and hence marks the appearance of the dehabituation phase of the experiment. If the rate of sucking in the experimental group is significantly greater than that of the control group at this point, then it is concluded that the infant perceived the difference between the stimuli.

These studies set of a volley of experiments testing infant perceptions of a wide range of C/V discriminations – the studies demonstrated that from early in life, English-learning infants are able to discriminate most English sound classes – voicing among stops, place of articulation of stops, vowels, and liquids. Discrimination of fricative appears difficult, suggesting some role for maturation.

Debates in the Journal of Child Language: controversy both on method and interpretation.

Parallel research calling into question this interpretation of the early infant speech perception data.

One group of studies demonstrated categorical perception for non-speech stimuli (e.g., two short tones varying in their temporal relation to each other), suggesting that this mode of perception is not specific to language (Pissoni 1977).

Others demonstrated the categorical perception of human speech in nonhuman mammals, casting further doubt on the linguistic basis of the phenomenon - Kuhl and Miller (1976) on chinchillas (appeared in Science, 190: 69-72)

Regardless of whether infant categorical perception abilities are language specific or they are a consequence of general auditory mechanisms, it is clear that these abilities are crucial to phonological development in that they change with exposure to the target lg.

Infant speech perception research also focuses on the issue of how infants and children learn which of the early (innate) perceptual distinctions are relevant to the TL. Researchers have examined the infant ability to discriminate sounds that are not relevant to the TL, and the course of development of these discriminations: the ability to perceive foreign language contrasts diminishes and disappears with age – 6 to 12 months. (Werker and Tees, 1984 – Course File).

General remarks

Infant phonological representations and how they develop: Not very well understood – not clear what kind of representations prompt the infant to stabilize the TL-relevant contrasts, and ignore the non-relevant contrasts. Is it that referential properties of words have begun to be understood?

Holistic properties such as the overall acoustic shape or the prosodic structure characterize early PF representations. The adult like segmental representations develop only later when the size of the lexicon grows and it is no longer possible to rely on the prosodic/acoustic properties. Or because segmental representation is more conducive to speech production.

Infant Production:

Prelinguistic speech perception

Babbling as the next precursor to segmental phonology:

Five stages in infant vocalizations before the onset of the first word.

First three may accidentally produce sounds that resemble speech. However only the fourth and the fifth stages are referred to as "babbling".

Babbling: elements are obviously repeated and the timing properties resemble those in speech (Oller, 1986). Two major subtypes: reduplicated babble, variegated babble, the former is a single CV type (ba) concentrated upon for some time and then a switching over to another, the latter has strings of different syllables, different stress and intonation patterns, with a sentence like quality to the production.

First words – first utterances that are clearly meaning bearing – child renditions of adult words, or protowords, the latter idionsyncratic forms with referential status for the child.

Does the transition from babbling to speech reflect a continuous process, or are these discrete developmental stages?

Does perceptual input from the target language influence the repertoire of production, or does babbling reflect the independent development of the production system?

The first Q has its origins in early suggestions by Roman Jakobson(1941/1968) that some children's transition from babbling to words is marked by silent period., and that the babbling repertoire draws from the set of possible sounds (all human lgs is how he put it.), while the repertoire of contrasts used in early words represents a subset of contrasts present in the TL.

Research in child lg phonology inconsistent with these claims:

Protowords or words co-occur with variegated babbling: Early words are embedded in strings of variegated babble.
Contradict the suggestion that they are temporally distinct, discontinuous.

Babbling and early speech draw on the same repertoire of sounds: Vihman's work

Effects of auditory input on infant babbling patterns: In contrast to early claims to the contrary (Lenneberg, 1967), deaf infants produce different babbling patterns than hearing infants, suggesting some role for perception in infant babbling (Oller et al., 1986).
Different babbling patterns from children from different speech communities. (deBoysson-Bardies et al., 89)

deBoysson-Bardies and colleagues examined the vowel productions of 10 month old infants raised in homes where the ambient language was English, French, Cantonese, or Arabic. They found that acoustic characteristics of the vowels exhibited more variation across linguistic communities than within. Further, they found that differences among the average vowel produced by the adult speakers of the four languages were mirrored by the infants. For example, adults and infants from the English speaking community produced vowels with the highest pitch, and those from the Cantonese produced vowels with the lowest pitch. Conclusion: infant babbling is influenced by the TL environment.

Further research – time period during which babbling comes to resemble TL approximates the period when infant lose the ability to make nonnative perceptual contrasts.

Child perception of early words: Shavachkin (1973) taught Russian-learning 10-to-24-month-olds nonsense words that referred to toys. Over a period of several months, each child learned several minimal word pairs (two words differing by only a single phoneme or feature, e.g., vum vs bum). Phoneme discrimination was tested by asking children to find the toy associated with one member of a minimal pair.

Findings: Half the subjects were able to make all the discriminations tested.
Some contrasts were easier than others: Vowel contrasts (pit/pot), or manner contrast (pit/fit).

Eilers and Oller (1976) employing familiar words or combination of nonsense and familiar words reported 36% discrimination errors. Some contrasts easier than others.

General Remarks:

Children between the end of their first year and the beginning of their fifth year learn to distinguish among words that differ in only a single segment.

Estimates about when children are able to make all of the linguistically relevant contrasts differ across studies – due probably to the differences in the discrimination criteria employed, or to how well children knew the words that were being used as test items.

Children are not able to directly apply the decontextualised perceptual abilities demonstrated by infants in associating a sound with its referent. Even children who previously knew both words in the Barton study made 11% discrimination errors.

Order of acquisition—vowel contrasts before consonant contrasts, manner before voicing in stops. Contrasts among fricatives appear to be discriminated later (don't show up in infants either).

Regression in speech perception abilities, and why?

The experimental task used to test discrimination ability in children is more demanding then the task used with infants. For the infant, to be credited with perception of a particular contrast, he only needs to perceive the distinction between two stimuli, the old and the new. In contrast in case of children, the task requires them to match an acoustic string with its referent. Therefore children's performance reflects not only their perceptual abilities but also the ability to recall the referent of an auditory stimulus. The fact that children perform significantly better when both words of a minimal pair are well known suggests that the referential component of the task contributes to the poor performance.

Early word representations may not be in terms of individual segments but in terms of holistic properties like prosodic structure and acoustic shape.

If the above explanation is correct, then what causes them to abandon these representations in favour of segmental ones?

With a larger lexicon, differentiation based on acoustic properties based will not be adequate, and therefore a segmental reorganization of the lexicon would be needed for a more effective recognition. Estimates of how dense a lexicon should be so that the reorganization takes place vary from 50 words (Menyuk and Menn, 1979) to the early school years (Walley, 1993).

A second motivation for abandoning holistic represenations in favour of segmental ones: articulatory demands, need to consistently produce words, requires a careful timing of a

sequence of articulations, and therefore entails a sequentially ordered representation of the sounds in a word.

Alternatively, perception and production representations might develop independently-- the two lexicon hypothesis: the perception lexicon might remain relatively more holistic and less detailed for an extended period. In contrast the production lexicon must be sequentially and segmentally specified at a much earlier point.

Child production of early words:

Deviations from the adult form

Production-perception discrepancy: – some child deviations may be due to perceptual failure, but not all -- fish as fis (The fis phenomenon) -- not due to perceptual failure – the child knows that the correct form is fish – say fis, not fis, he tells the adult who has produced the child form.

Another piece of evidence – children maintain phonetic contrasts in production in a way imperceptible to the adult ear, but detected instrumentally. Children may have access to word representations that are different from the produced forms.

If children's word representations are holistic, as many researchers have suggested, then early deviations may be describable in terms not of segmental features, but *articulatory gestures* required for the whole word, or suprasegmental characteristics such as rhythm or fundamental frequency. Ferguson and Farwell (1975) noted attempts by children to pronounce words such as *pen*. Over several efforts, none of which resembled the adult form in terms of segmental characteristics, most exhibited the proper articulatory gestures required to produce adult forms. The problem was that these gestures were improperly sequenced. Children's early utterances exhibit unclear or variable segments but consistent intonation contours (Peters, 1983).

As the lexicon becomes denser, more detailed word representations come, and the deviations from the adult model might now be describable in terms of segmental errors. At this point deviations also become more systematic. The child who says fis for fish also says dis for dish.

Simplifications: relatively lesser neuromotor control over their articulations.

Simplification strategies

Substitution: the fis phenomenon -- featural overlap between the two sounds – sh and s are both vl fricatives
Deletion: fish >ish
Cluster reduction: spider >pider -- one of the segments is deleted
Metathesis: snow>nos -- order reversal

Assimilation: dog>dod; duck>guck – feature assimilation

More complex relations:

Chain shifts: truck as duck, but also produces duck as guck: substitution+assimilation chain

Avoidance: comprehends the word but avoids it in articulation

Phonological idioms: Child words which do not follow the pattern of sound changes attested elsewhere in the child's productions. Hildegard (Leopold's daughter) correctly produced /pretty/ when she was reducing clusters everywhere else.

Regression: a phonological idiom taking on a less mature form to become consistent with rest of the system.

Recidivisms: a progressive recession of contrasts:

Stage I: side and light both pronounced as dait

Stage II: side pronounced as dait; light pronounced as light

Stage III: both pronounced as lait

Theories:

Class I: Universal perceptual or articulatory constraints prevent the child from producing adult phonemic contrasts (Jakobson).

Class II: Children apply rules to change their perceived form into one they can produce. (Smith, 1978; Kiparsky and Menn, 1977) – deviations are systematic.

Class III: Connectionist approaches: the child deviations from an adult model are not rule based; they are natural accidents of the speech production system (Menn and Mathei, 1992; Stemberger, 1992)

Class I Connecting child phonology with typological universals – Jakobson --one of the earliest accounts of child phonology – the child's task proposed to be learning to produce the phonemic contrasts relevant to his language. fis/fish – the contrast between alveolar and palatal fricative not yet internalized. The order of acquisition mirrors the frequency with which they occur in world languages. Eg, C/V contrast the most frequent one – also the first to be acquired. Orality/nasality contrast among vowels a less frequent one, also acquired relatively late.
Class II: Children's deviations arise from applications of phonological rules to the child's perceived representations of a word. On some accounts, the rules are universal and innate, and the simplifying nature of many of children's deviations arises from

conspiracies among sets of rules. On other accounts, the individual sets of rules are created by each child in response to output constrains which limit the number of producible word forms. Output constraints are most easily illustrated with regard to children's phonological simplifications. Two lexicons.

Class III: Some connectionist models have been developed to account for adult production errors or slips of tongue. Because connectionist models are probabilistic in nature, they can account for the variability in children's productions. They also have the potential to account for systematicity in deviations across words, because activation spreads across the lexicon, causing phonologically similar items to behave similarly. Finally the connectionist models have the potential to deal with the observation that some contrasts appear to be inherently easier for most children; this can result if the initial activation states on some phoneme and feature nodes are set higher than on others.

Suprasegmental phonology: units larger than a single segment, e.g., syllable, stress, intonation contour, pitch etc.

Word level stress, sentence level stress, pausing, intonation.

The focus of developmental suprasegmental phonology on how learners might use suprasegmental structure of their language to cue the locations of syntactically relevant units in the speech stream, including words, phrases and clauses (Gleitman, 1988, Hirsh-Pasek, 1987 among others).

Suprasegmentals in the input:

The world's languages exhibit canonical patterns of strong and weak syllables in a word. For example: most Turkish words end in a strongly stressed syllable, while most English words begin with a strongly stressed syllable.

Gleitman and Wanner (82) – strongly stressed syllables are more perceptually salient than others and that young children initially break into the speech stream by identifying meaningful units with these syllables. (CC breaking—unstressed syllable deletion). Data on input to infants and children suggest that stress and rhythmic characteristics of CDS are exaggerated in comparison to adult-directed speech.

Lgs also exhibit suprasegmental cues to phrases and clauses. suprasegmental processes such as pausing, large changes in fundamental frequency, vowel lengthening all tend to coincide with syntactic boundaries. All seen at work in CDS crosslinguistically.

The reasons for suprasegmental features in CDS, important thing to note is that these characteristics are ultimately governed by the grammar. That is, a speaker might employ high pitch excursions to hold the infant' s attention, but these changes are expressed as exaggerations of normal prosody and therefore tend to occur at syntactic boundaries. Place of suprasegmentals in linguistic theory – Chomsky and Halle: they directly reflect syntactic structure. Contested by Grosjean among others:

The man (pause) chased the dog.
He chased (pause) the dog.

Such mismatches between syntax and phonology have been used to support the existence of an intervening module, the prosodic phonology (Inkelas and Zec 1990, etc.)

This view of the syntax/phonology interface suggests that the exaggerated suprasegmental cues in CDS might not directly provide information to learners about the Syntactic structure, but rather about the prosodic structure. Studies show that when prosodic units are different from syntactic units, children are better able to identify prosodic units.

Infant and Child perception of suprasegmental information:

A growing body of research indication the extreme sensitivity of Infant and Child to suprasegmental information in the speech stream.

Three main effects of prosody on infant speech perception. First, several studies have demonstrated that infants discriminate between CDS and ADS.

A second line of research has demonstrated that the infants are sensitive to the suprasegmental features of their native language. Mehler et al. (1988) demonstrated that newborns 'prefer' native lg speech over a foreign lg speech, even when the speech samples are low pass filtered to leave intact only suprasegmental cues. American infants at 6months are able to distinguish between Eng and Norwegian word lists that have been low pass filtered. (Ref: A Precursor to Language Acquisition – Course File)

A third line: infants are sensitive to acoustic cues to syntactic boundaries (See Ann Peters, included in -- Paper Presentation Assignment in the Course)

Production data also confirm sensitivity to suprasegmental information:

deBoysson-Bardies – 8 month old infants exhibit the canonical supraseg patterns of the native lg in their babbling. English and French learners produced different proportions of rising to falling intonation contours, reflecting differences in the predominant intonation contours found in the two target lg.

Gerken data – children group subject NP and the VP in distinct phonological phrases when the subject is a proper or a common noun, and they group the subject and the verb into a distinct phonological phrase when the subject is a pronoun.

Weak syllable omission – reflects children's sensitivity to the stress pattern of their particular lg.

Many characteristics of children's early multiword utterances that have been attributed to morphological or syntactic development are being explained in terms of children's sensitivity to the suprasegmental patterns of their language.

Eg, English speaking children typically omit function morphemes. This late acquisition of morphology has been assumed to reflect an early linguistic organization which is based on words with concrete referents.

Alternatively, it is possible that children's omissions reflect a perception or production bias for strong syllables. The latter view is supported by children learning Quiche Mayan, who preserve strongly stressed verb inflections to the exclusion of verb stems.

Omission of morphology because it is prosodically nonsalient. – metrical template hypothesis.

Individual variations in acquisition of phonology

Most of the research in acquisition of phonology is directed at finding consistent patterns of perception and production across learners - innatist bias in research.

Study of individual variations in acquisition of phonology does not necessarily question/reject innatism, but attempts to look for the processes by which innate and experiential factors may actually interact in acquisition.

Two dimensions (at least) along which children vary in their phonological acquisition patterns:

1) Whether the child's earliest productions are segmentally detailed or whether they are better described as maintaining the suprasegmental pattern of the ambient language at the expense of phonological accuracy.
2) Whether they avoid words which they cannot produce and as a result give relatively accurate renditions of the words they do produce, or whether they attempt many words, resulting in substantial deviations fro the adult forms.

Explaining individual differences:

1) Variability in individual children's perception and production systems leading to differences in what they find salient and easy to produce in TL.
2) Cognitive strategies: Avoidance
3) Input Properties