VOWEL-CONSONANT RELATIONS IN BABBLING

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ABSTRACT

Early babbling is apparently based on syllabic "Frames" produced by mandibular oscillation. Thus, reduplicated babbling with cooccurring labials and central vowels is "Pure Frames" produced only by mandibular oscillation. Reduplicated babbling with cooccurring tongue front consonants and front vowels is "Fronted Frames". Variegated babbling may initially be produced primarily by "Frame Modulation" - variations in the amplitude of mandibular oscillation (related to stress variation in English).

1. INTRODUCTION

At an earlier Congress of this society, the suspicion was voiced [6] that, counter to the then-prevailing views of Jakobson [2] and Lenneberg, [4] there may be a close relation between the production of babbling and the production of the first words. In the intervening years this suspicion has been abundantly confirmed (e.g. [5], [15]). Both segmental preferences and syllable structure preferences have been found to be virtually identical in first words and concurrent babbling. Consequently, babbling is of prime importance in attempts to understand the acquisition of speech. The question raised in this paper is, what are the organizational principles underlying babbling, and, therefore underlying early speech production? The answer will include the novel conclusion that there are extremely close relationships between early consonantal and vocalic components of babbling. (We will call these two components consonants and vowels for convenience, though this should not be taken to mean that we regard them as independent control units in babbling.)

2. THE CONCEPT OF "FRAMES" FOR BABBLING

Babbling is defined as a relatively rhythmic alternation between an open and a closed vocal tract configuration accompanied by normal phonation. This alternation is produced primarily by oscillation of the mandible. The main thesis of the present paper is that these mandibular oscillations literally provide a "Frame" for the earliest attempts at true speech. It is claimed that much of what happens in the articulatory domain during the entire prespeech babbling period -typically a 6 month period beginning at about 7 months of age - can be understood in terms of cycles of mandibular oscillation alone. If this is true, then it follows that the best way to understand the eventual acquisition of speech production is in terms of modifications of this basic frame structure. Speech acquisition may be largely a matter of "Frames, then Content" [8].

Multisyllabic babbling can be divided into reduplicated babbling, in which the same syllable-like component (typically consonant followed by vowel) is repeated, and variegated babbling, in which changes occur from syllable to syllable. The present claim is that there are two main kinds of reduplicated babbling. In one, particular labial closing phases - most often phases heard as labial stops - alternate with particular opening phases heard as central vowels. Both closing and opening phases are considered to be entirely produced by mandibular movement. Consequently these are termed "Pure Frames". The labial closures, and tongue positions during opening are considered to be purely passive effects of mandibular oscillation. It is suggested that the vowel configurations are passive because there is no other reason for these particular vowels to preferentially cooccur with these consonants. In the other main type of reduplicated babbling, closing phases involving the tongue front region alternate with front vowels. These are termed "Fronted Frames". Manibular action in these cases is considered to be basically identical to that in pure frames, but superimposed on it throughout an utterance is a fronted tongue position that is adopted before the utterance becomes audible ("Pre-Utterance Fronting"). In this case, cooccurrence constraints between vowels and consonants result from the presence of a single non- resting tongue configuration.

It is also claimed that much variegated babbling is produced by the frame component. It may be produced by variation in the amplitude of the mandibular cycle, with the consequence that most vowel variation within a single utterance is in tongue height, and most consonant variation is in amount of vocal tract constriction, not place of constriction. This process is termed "Frame Modulation". It is also claimed that, in languages in which stress is prominent (e.g. English), attempts to produce differences in stress play an important role in frame modulation because the amplitude of the mandibular oscillation cycle will be positively related to stress level. In particular, more stressed syllables will have more open vowels. In the remainder of this paper, the evidence that led to these claims will be summarized and the validity of the claims will be assessed in a quantitative case study of the babbling of one infant in an English-speaking community.

3. EVIDENCE FOR A FRAME/CONTENT VIEW OF SPEECH

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The necessity for considering the ontogeny of speech in terms of Frame structures with developing Content elements arises when the organization of adult speech is investigated. Segmental serial ordering errors, such as spoonerisms, show that segments (Content elements) are independent units. And syllable position constraints on segmental movement, whereby misplaced segments must retain the position in the syllable which they should have had, if produced correctly, show the existence of syllable Frames at a premotor level of organization [7], [12]. Thus, an important question about speech acquisition becomes, how does this Frame/Content structure develop.

The mandibular oscillation cycle of babbling tells us that the basic temporospatial structure underlying the syllable, the unit which plays a Frame role in adults, is typically present from the age of 7 months onward. The rhythmic continuity of multisyllabic babbling tells us that this embryonic syllable places tight constraints on the structure of speechlike vocalization from the moment of its inception. What are these constraints? Studies of relative frequencies of consonant-like sounds (summarized in [5]) and vowel-like sounds (summarized in [9]) are in good agreement about the features of the closed and open phases of the mandibular cycle of babbling in a handful of languages. Sounds accompanying the mandibular closing phase fall into two main categories; 1. Labials, particularly labial stops, and, to a lesser degree nasals and glides, and 2. Tongue front sounds, particularly stops, and, to a lesser degree, nasals and glides. Tongue back closures tend to develop later. Favored sounds of the opening phase are in the mid and low, front and central regions of the vowel space. High and back vowels are rare.

These patterns, together with the evidence now to be reviewed on consonant-vowel cooccurrence constraints led us to the claims about the organization of babbling made earlier. In a study of the babbling and speech of a child during the period from 14 to 20 months of age,[1] evidence was found for three sets of consonant-vowel cooccurrence constraints; labial consonants with central vowels, tongue front consonants with high front vowels, and tongue back consonants with high back vowels. Vihman [14] for the most part confirmed these trends in an analysis of groups of children around one year of age from four language communities (English, French, Japanese and Swedish) the same groups discussed in another paper in this symposium by de Boysson Bardies. There is also evidence that these patterns may be universal in languages (e.g. [4]). These are the findings

which led us to suggest that there may be cooccurrence constraints between labials and central vowels (Pure Frames), and between tongue front consonants and front vowels (Fronted Frames) in the earliest babbling. One other finding of Vihman [14] added support for one of our claims. She found a cooccurrence constraint between glottal [h] and central vowels. The choice of central vowels to accompany this nonarticulatory segment, as well as the choice of these vowels to accompany labial (nonlingual) segments suggests that these vowels may not be produced with lactive tongue movement.

An additional finding from our case study seemed to have implications for the organization of babbling. A strong tendency was found for more stressed syllables to be accompanied by more open vowels, whether or not these vowels were the ones in the English target word being attempted. Subsequent analysis of English words [1] and words of New Zealand Maori (unpublished obser- vations) showed a strong tendency for more stressed syllables to have more open vowels. This evidence led to our claim that a considerable amount of the variation in variegated babbling may result from variation in the amplitude of the mandibular cycle (Frame Modulation).

4. A CASE STUDY OF BABBLING

To evaluate our claims about the organization of babbling, we conducted a case study (in preparation) in which we recorded the babbling of a child in an English language enironment on 12 occasions evenly spaced from the age of 7 to 12 months. A total of over 400 utterances were phonetically transcribed. Closing and opening phase preferences were, with one exception, quite typical, featuring labial and tongue front stops, with some homorganic nasals and glides in closing phases and mid and low front vowels and mid but not low central vowels in opening phases. In both monosyllables (mostly CV) and disyllabic and multisyllabic reduplicated babbling, there was statistically significant confirmation of the prediction of cooccurrence constraints between labials and central vowels and between tongue front consonants and front vowels. About 75% of vowels in labial environments were central vowels, while about 60% of the vowels in the environment of tongue front consonants were front vowels.

Until recently it had been thought that a phase of reduplicated babbling preceded a phase of variegated babbling in the developmental sequence (e.g. [11]) implying a natural progression in complexity of control. However more recent studies [10], [13] including our own, show instead that variegated babbling often coexists with reduplicated babbling from the very beginning. In the present case study, most instances of variegated babbling only involved variegation in vowels. There was extremely strong confirmation of the prediction that Frame

Modulation would be an important source of variegation, in the case of vowels. In approximately 90% of instances of vowel variegation involving change in stress (assessed perceptually) the more stressed vowel was more open. The pattern in the observed instances of consonant variegation was also consistent with the Frame Modulation prediction, though there were only 11 instances of such variegation. Six instances involved the predicted change in manner of articulation, while only two involved change in place of articulation. The remaining 3 involved use of the glottal [h] as a variant on articulated closures.

In an unexpected finding, much variegation resulted from alternations between front and central vowels. In alveolar environments, front vowels were even more favored in stressed vowels than they were in reduplicated babbling, but not favored at all in unstressed syllables. Conversely in labial environments central vowels were not favored at all in stressed syllables, but more favored in unstressed syllables than in reduplicated babbling. These vowel classes may have had these different roles because front vowels are actively produced, while central vowels are passive resultants of mandibular oscillation.

5.CONCLUSIONS

By use of the concepts of Pure Frames, Fronted Frames and Frame Modulation, a relatively complete account can be provided of the main properties of both reduplicated and variegated babbling in the infant studied here. These concepts are offerred as an attempt to delimit a possible set of core mechanisms of babbling, for evaluation in other infants and languages. It is important to note that this analysis does not include an a priori commitment to any linguistic unit, other than the syllable, as an independent control unit in babbling. The concepts of Segment, Feature, or Gesture are not required. Even the independence of the syllable is limited at this stage. The two most freqently used CV sequences in both reduplicated and variegated babbling were [pʌ] and [tɚ], but there was not a single instance of either the [pʌ tɚ] sequence or the [tɚpʌ] sequence in variegated babbling. The main functional unit of babbling seems to be a cycle of mandibular oscillation, but with severe limitations on its detailed articulatory accompanyments, both when occurring singly and when reiterated.

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