I. INTRODUCTION

The perception of syllable-initial /a/ and /∅/ can be affected by the composition of the preceding syllable (C) and the following syllable (V) [1]. This has been suggested by the observation that certain combinations of CV sequences are more likely to be perceived as a single syllable (CV) than as two separate syllables (CV/CV) [2].

II. EXPERIMENT 1

A 10-step CV series was used to study the effects of CV composition on perception. A male talker produced CV series, with CVs varying in CV onset frequency and CV duration. The CV series were synthesized, with CVs varying in CV onset frequency and CV duration.

Results: Two CVs were matched in the second experiment. One CV was matched in the second experiment. The second CV was matched in the second experiment.

III. EXPERIMENT 2

A 10-step CV series was used to study the effects of CV composition on perception. A male talker produced CV series, with CVs varying in CV onset frequency and CV duration. The CV series were synthesized, with CVs varying in CV onset frequency and CV duration.

Results: Two CVs were matched in the second experiment. One CV was matched in the second experiment. The second CV was matched in the second experiment.

IV. EXPERIMENT 3

A 10-step CV series was used to study the effects of CV composition on perception. A male talker produced CV series, with CVs varying in CV onset frequency and CV duration. The CV series were synthesized, with CVs varying in CV onset frequency and CV duration.

Results: Two CVs were matched in the second experiment. One CV was matched in the second experiment. The second CV was matched in the second experiment.
some special speech mechanism. To address this possibility, simpler constant-frequency tones were used as precursor stimuli for this experiment.

**Figure 2. Identification functions for Experiment 2.**

Stimuli.

Two constant-frequency sine waves with frequencies equal to the offset frequency of F3 for the /al/ and /ar/ speech stimuli were used as precursor stimuli. Sine-wave amplitude was set to the RMS amplitude of the full-syllable male /al/ and /ar/ from Experiment 1. In contrast to the nonspeech stimuli of Experiment 2, these stimuli were not matched to the speech stimuli either in frequency change over time or in amplitude as a function of frequency. The same series of synthetic CV syllables used in Experiments 1 and 2 and varying perceptually from /da/ to /ga/ followed the sine-wave tones.

Procedure.

As in the preceding experiments, subjects (16) responded by pressing 'd' or 'g'.

Results.

Identification functions depicting the results are displayed in Figure 3. The difference in frequency of preceding tones resulted in a shift in identification boundaries despite the fact that the only characteristic the tones shared with /al/ and /ar/ was that they contained substantial energy in the region of F3. Although the context effect of constant-frequency sine waves was not as great as the effect for full spectrum speech /al/ and /ar/ in this experiment, the effect of these nonspeech precursors is of comparable magnitude to Mann's [1] for natural speech stimuli.

**Figure 3. Identification functions for Experiment 3.**

**V. EXPERIMENT 4**

Results from the first three experiments indicate that the original effect of preceding /al/ and /ar/ on perception of following /da/ or /ga/ generalized quite broadly. These findings suggest that the effect could potentially be general to auditory perception. If this is so, similar results should arise when nonhuman animals serve as subjects. In the last experiment, Japanese Quail (Coturnix japonica) were used to test the generality of this effect.

Procedure.

Two Japanese Quail were trained (by operant procedures) to peck a lighted key when presented with either the syllable /da/ or /ga/ and to refrain from pecking it when presented with the alternative syllable (/ga/ or /da/, respectively). After the birds learned to reliably peck differentially to /da/ or /ga/, they were presented with test syllable pairs consisting of the synthesized /al/ or /ar/ followed by one of the ambiguous intermediary members of the /da/-/ga/ series.

Results.

Histograms representing the results of this study are shown in Figure 4. Avian responses evidenced an effect of the preceding syllable such that 'labeling' shifted to more /ga/ responses following /al/. The most parsimonious explanation for this result is that the effect is due to general auditory processes of frequency contrast.

**Figure 4. Histograms of Normalized Peck Rates from Experiment 4.**

**DISCUSSION**

Results from these four experiments suggest that this context effect is not specific to speech in any conspicuous way. At least part of the original effect is likely due to some general property of the auditory system. One potentially could describe this hypothesized general auditory effect as frequency contrast. The data from these experiments are consistent with this description. Following a high tone or glide, the identification boundary shifts toward higher F3 onsets (more are perceived as low, "ga") relative to when the preceding tone is lower.

At this time, the term is not meant to suffice as explanation or to designate a specific process. The point is simply that the effect reported first in Mann [1] and replicated here may be due, at least in part, to general auditory processes. If the effect is of a general nature, then the earlier findings with Japanese listeners [2] and with infants [3] should not be unexpected.

In general, contrast may be useful for many of the acoustic transformations arising from coarticulation. It appears that all coarticulation in speech results in frequency assimilation. Consequently, contrastive perceptual effects between contiguous speech sounds should generally be adaptive.

**V. REFERENCES**


**VI. ACKNOWLEDGMENTS**

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