"Phenomenal displacement" in delayed auditory feedback: I. Disparate inter-aural intensities

Julian Hochberg and Martin J. Berko
CORNELL UNIVERSITY

Abstract

College undergraduates were required to read standardized passages twice under a condition of delayed auditory feedback (DAF) in which the intensity of the fed-back input to each ear was equal, and once under DAF with highly disparate inter-aural intensities. Reading under the latter condition showed a highly significant reduction in the speech disruptive effect of DAF.

Problem

Speech disruption by delayed auditory feedback (DAF) has been explained in terms of specifiable servosystems (Fairbanks, 1954). The fact, however, that Ss adapt more readily during prolonged exposure to DAF if trained "not to listen to it" (Goldiamond et al, 1962) suggests to us a "phenomenal basis" for speech-programming confusion, at present specifiable in terms of perceptual response but not in terms of known physiological structure. By the latter hypothesis, conditions which displace the apparent source of the DAF from the speaker's "ego center" should reduce DAF's disruptive effects.

Method

Ten Ss (all with normal measured hearing in both ears) received DAF (delay = 0.25 sec.) via a tape loop and a Warren D-1 2-channel power amplifier and high-fidelity headphones with independent intensity controls for each ear, while reading aloud three passages (134 syllables each) under three test conditions: (A) 60 db in each ear; (B) 40 db in right ear, 80 db in left ear (a setting found with 10 pretest Ss to produce "phenomenal localization" at the left ear); (C) repetition of Condition

A. Paragraphs were randomized across conditions. Readings were tape recorded.

Results

Recordings of the readings were judged by each of two qualified speech clinicians, who scored an "error" (with exceptionally good agreement, one noting a total of 540 errors, the other, a total of 545 errors, and visual inspection showing virtually no disagreement for each): (a) misarticulation; (b) omission; (c) repetition; or (d) "miscellaneous error," such as laughter or marked distortion of voice quality or control. The averages of two judges' total error scores for 10 Ss on the respective conditions were: A, 242.5; B, 84.0; C, 216.0; and total, 542.5.

One-way analysis of variance yields an F-score of 6.15 ($df = 27/2$, $p < 0.01$). Conditions A and C do not differ significantly ($t = 0.76$); hence, the error-reduction in Condition B is not simply due to adaptation.

Discussion

"Phenomenal displacement" of DAF reduces speech disruption, suggesting that DAF speech disruption depends at least to some extent on the failure of the delayed feedback stimuli to be perceived as "external" to the speaker's "control center."

References

- FAIRBANKS, G. Systematic research in experimental phonetics: A theory of the speech mechanism as a servosystem. *J. speech hear. Disord.*, 1954, 19, 133-139.
- GOLDIAMOND, I., ATKINSON, C., & BILGER, R. Stabilization of behavior and prolonged exposure to delayed auditory feedback. *Science*, 1962, 135, 437-438.

II. High intensity effects

Martin J. Berko
CORNELL UNIVERSITY

Abstract

It was previously demonstrated with 10 Ss that the speech disruptive effect of delayed auditory feedback (DAF) was significantly reduced when there was, instead of equal intensity of fed-back input to each ear, a marked disparity of inter-aural intensity. The findings were interpreted as implying that the disruptive effect of DAF was related to the phenomenal localization of the feedback. It was later suggested that the effect noted might simply reflect a reduction of intensity in one headphone to a degree allowing the Ss to receive some non-delayed feedback. The experiment was redesigned to overcome this objection by achieving dis-

parity of intensities by raising rather than lowering the input to one headphone. The originally reported effect was retained.

Problem

The concept of "phenomenal displacement" of delayed auditory feedback was discussed in a previous article Hochberg & Berko, 1965: Unbalanced auditory intensities between a pair of headphones "phenomenally displaces" the localization of the perceived sound source from "the middle of the head" (for balanced intensity) towards the "louder ear." It was hypothesized that the speech disruptive effects of DAF would be greatest

when the Ss perceived the source of the DAF as originating in the "ego center" of control (the center of the head), and that phenomenal displacement of delayed auditory feedback would sharply reduce the degree of speech disruption. The experiment compared the number of speech errors made by 10 adult Ss reading randomized paragraphs of equal length under various conditions of "balanced" and "phenomenally displaced" DAF. Ss read three equated paragraphs, under auditory feedback delay of 0.25 sec. Experimental conditions were: (A) 60 db in each ear; (B) 40 db in right ear/80 db in left ear, giving "phenomenal localization" at the left ear; and (C) repetition of Condition A.

The paragraph readings were tape recorded and were judged for errors of speech (misarticulations, syllable omissions, involuntary syllabic repetitions, or rate and voice quality distortions) by a panel of trained speech clinicians. Total error scores were tabulated for each of the three conditions. Analysis of variance showed a highly significant decrease of speech errors ($p < .01$) under the "phenomenally displaced delayed feedback condition." T-tests between the two "balanced intensity" conditions showed no significant differences. It was felt that the reduction of errors noted in the "phenomenally displaced" condition was not due simply to "adaptation" and that speech disruption under DAF depends to a great extent upon whether the DAF stimuli are perceived as being "internally" localized, or whether they are perceived as being somewhat external in reference to the speaker's self-perceived "center of control."

The reported findings were criticized by E. C. Nuttall (1965), who pointed out that in the "phenomenally displaced" condition, 40 db was somewhat below normal conversational speech intensity, and that the reduction of errors might be due to the availability of unmasked immediate feedback in the right ear. In order to obviate this possibility, the experiment was repeated.

Method

The overall design was unchanged, but 10 new Ss were used. Instrumentation (tape loop giving 0.25-sec. delay feedback through a Warren D-1 2-channel amplifier

and high-fidelity headphones) was unaltered, and the same materials were read. The only major change was in stimulus intensity levels. Because of Nuttall's criticism, it was our desire to run the second study at maximized intensity levels.

Pretests with taped conversations showed that, starting with balanced intensities of 80 db in each ear, holding the intensity in one ear constant and boosting intensity at the other ear to 120 db, gave total "phenomenal shifting" to the louder ear.

In the present study, conditions tested were: (A) 80 db in each ear; (B) 80 db in right ear/120 in the left ear, giving phenomenal localization "within" the left ear; and (C) same as Condition A. Several of the Ss complained of discomfort or slight pain at the 120 db level, but none reported severe discomfort or unwillingness to continue with the experiment.

Results

In Experiment 1, the error scores for the different conditions were: A, 242.5; B, 84.0; C, 216.0; and total, 542.5. In Experiment 2, the error scores were: A, 281; B, 76.5; C, 245.5; and total, 603.0. Since 10 Ss were used, the mean error scores are 1/10 of these numbers. With 27 and 2 degrees of freedom, the .01 level of significance is 5.49. For Experiment 1, $F = 6.15$; for Experiment 2, $F = 11.19$ and $p < .001$.

Discussion

Nuttall's critique does not appear applicable. As noted in the Results, the use of extreme intensities significantly increases the disparity between the number of errors noted under "balanced intensity" and "phenomenally displaced" DAF conditions. We feel that this is due to the fact that the 120 db level imposed palpable mechanical pressures on the tympanum of the louder ear, and that these pressures tend to enhance the displacement effect.

References

- HOCHBERG, J. E., & BERKO, M. J. "Phenomenal displacement" with delayed auditory feedback: I. Disparate inter-aural intensities. *Psychon. Sci.*, 1965, 2, 389.
- NUTTALL, E. C. Department of Speech and Drama, Cornell University. Personal communication, 1965.