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Word length and "knowing that you know" in perceptual recognition

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"Response conditional" confidence rating accuracy (Type II d') was examined as 19 subjects listened to a list of monosyllable and trisyllable words masked by white noise. Word length added significantly to d' ($p < .001$) and also improved probability correct ($p < .001$). The interpretation that the two dependent variables (d' and probability correct) reflect independent psychological processes was supported by Experiment II ($n = 20$), which substituted visual for auditory presentation but maintained the confidence rating procedure. In the case of visual presentation, long words showed a strong d' advantage over short words ($p < .001$), but only a mild advantage over short words in terms of probability correct ($p > .05$). Overall, the effect of word length on "knowing that you know" (d') appears to operate through the mechanism of selection constraints placed on the number of perceptual alternatives.

By means of confidence ratings, observers are able to provide independent, supplementary information concerning the accuracy of their perceptual reports (e.g., Pollack & Decker, 1958). In the auditory word perception task of Pollack and Decker, confidence rating accuracy (d′) was directly related to the speech-to-noise ratio, yet was unaffected by successive repetitions of the same message. In a similar experiment, Hochhaus and Antes (1973) found confidence rating accuracy was greater when all words were drawn from the same organizational category (food words), a result which led them to the hypothesis that the confidence ratings of words are affected by the context in which the words appear.

According to the context hypothesis, important "feelings of knowing" arise from comparison of individual words against the perceived selection constraints of other words in the series. The context hypothesis further predicts that, if the reported word fits the overall context of other words, confidence ratings increase, and that, if the reported word does not match the context, confidence is undermined. The total effect of contextual constraint, therefore, is to improve the accuracy of confidence ratings (d′). To summarize, the confidence with which a word is perceived depends upon the listener's broader knowledge that the word fits the matrix of expectancies created by immediately preceding perceptions.

In the present paper it is argued that selection constraints occur within word units as well as between them. Perception of a part of a word may be evaluated on the basis of its fit with other parts of the same word. Selection constraints on letters, phonemes, or syllables are expected to be greater for long words than short ones, given that other parts of the word have been well perceived (cf. Shannon & Weaver, 1949). For example, if the listener was presented the word ART, he or she might perceive it as "cart," but the addition of the letters IFICIAL, making the word ARTIFICIAL, places a constraint upon the perceptual alternatives of the first part of the word. Therefore, it was hypothesized that confidence rating accuracy, measured by d′, is greater for long words than for short words.

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EXPERIMENT I

This experiment tested the hypothesis that confidence rating accuracy (d′) is greater for trisyllable words than for monosyllable words. It should be pointed out that d′, based on the confidence ratings of word responses, measures discrimination between correct and incorrect message receptions and, therefore, is a Type II detectability measure (Clarke, Birdsall, & Tanner, 1959). Type II confidence judgments are ratings of responses, not stimuli. In signal detection theory terms, "hit" and "false alarm" rates are determined when confidence ratings are conditionalized, respectively, upon correct and incorrect responses (Green & Swets, 1966). The metaconfidence nature of the Type II ratings led Hochhaus and Antes (1973) to refer to the judgment process as "knowing that you know." The Type II distinction applies to all discussion of d′ in the present report.

Method

Subjects. The subjects were 19 students enrolled in psychology courses at Oklahoma State University. Subjects received extra credit for their help. Seven males and 12 females participated.

Materials. Eighty monosyllable and 80 trisyllable words were matched word for word for initial phoneme and for frequency of occurrence by the Thorndike-Lorge (1944) G list. The range of frequency for all words was from 10 to 50 occur-

rences per million word sample. The 160 words were recorded in a random order at a constant level of speech at 10-sec intervals onto one track of a stereo tape recorder. White noise was recorded on the other track and the sound levels were adjusted to about 50% intelligibility for three-trial subjects. This recording was then transcribed onto a monaural tape recorder. Instructions to the subjects preceded the list of words in the final monaural recording.

Procedure. In groups of three to six, subjects were seated at an equal distance from the tape recorder speaker. Instructions requested the subjects to write down each word they heard on a prepared sheet and to rate their confidence in each response on a 4-point rating scale. Each subject was given a card describing the confidence scale. Confidence categories were adapted from the scale used by Pollack and Decker (1958). Guessing was strongly encouraged, but blank responses were permitted when the subject had absolutely no response. Such omissions were scored as incorrect message receptions of lowest confidence.

Results

Separate receiver operating characteristic (ROC) curves were constructed for monosyllable and trisyllable words on normal-normal graph paper (Codex 41,453). Inspections of the functions revealed the data were reasonably well fit by straight lines of unit slope, as predicted by signal detection theory (e.g., Green & Swets, 1966). Graphical estimates of d' were .99 and 1.81 for monosyllables and trisyllables, respectively. The G test of Gourevitch and Galanter (1967) showed the difference in d' was highly significant ($G = 7.69$, $p < .001$). The data support the hypothesis that confidence rating accuracy ("knowing that you know") is greater for long words than for short words. Direct analysis of confidence ratings revealed that the effect of length on d' was achieved by both an increase in mean confidence for incorrect trisyllables and a decrease in mean confidence for incorrect monosyllables.

Word length also affected message reception. Mean number of correct responses was 13.05 for monosyllables and 40.77 for trisyllables; the advantage of long words was revealed in each of the 19 subjects tested, and a t test confirmed the effect as highly significant ($t = 4.10$, $df = 18$, $p < .001$).

Discussion

The observation that in auditory perception long words are more intelligible than short words has been reported elsewhere and must be tempered by the fact that presentation time is necessarily confounded with word length in an auditory task (cf. Rosenzweig & Postman, 1958). This methodological issue is relevant to the interpretation of d' changes as well.

While d' is defined to be mathematically independent of message reception scores, the empirical separation of the two dependent variables is not so clear. In word perception tasks, d' and mean correct receptions have at times shown covariation (Hochhaus & Antes, 1973; Pollack & Decker, 1958); yet, in the case of recall memory, variables which affect retention, such as repetition and serial position, do not appear to affect Type II confidence rating accuracy (e.g., Bernbach, 1967). Because presentation times differed for monosyllables and trisyllables and because the empirical independence of d' and word recognition accuracy is not immediately apparent, a second experiment was carried out to safeguard the conclusion that the two measures ("knowing" and "knowing that you know") reflect independent psychological processes.

EXPERIMENT II

One way to reverse the relationship between word length and message recognition scores is to shift from auditory to visual presentations (Rosenzweig & Postman, 1958). Therefore, the essential procedures of Experiment I were repeated, substituting brief tachistoscopic projection for the earlier listening situation.

Method

Subjects. The 20 subjects used in Experiment II were drawn from the same pool and circumstances as described in Experiment I. Ten subjects were male and 10 were female.

Materials. Forty monosyllables and 40 trisyllable words were resampled from the Thorndike-Lorge (1944) norms. As in Experiment I, the monosyllable and trisyllable words were matched for initial letter and for language frequency in the range 10-50 per million word sample. These words were typed on an IBM electric typewriter and were copied by the diazachrome method. Individual words were then mounted on slides for presentation via a Kodak projection tachistoscope.

The 80 slides were randomly arranged in a single Carousel slide tray, the activation of which was controlled by a slide-synchronizing monaural tape recorder to provide one slide presentation every 10 sec. Tape recorded instructions preceded the slides, and a verbal ready signal ("trial number X," where X was a number from 1 to 80) preceded each slide activation by 1 sec). The minimum tachistoscopic setting (6.67 msec) was used and, by control of the light-intensity aperture, intelligibility was adjusted to roughly 50% for six-trial subjects.

Procedure. In groups of three, subjects were seated an equal distance from the viewing screen. Except that the task was one of looking at words rather than listening to them, the procedures, instructions, confidence scale, and scoring system of Experiment II were identical to those of Experiment I.

Results

By means of the graphical and statistical procedures of Experiment I, estimates of d' were 1.66 and 1.06 for trisyllables and monosyllables, respectively. The difference in d' was found to be highly significant ($G = 4.39$, $p < .001$). The data support the hypothesis that confidence rating accuracy in visual word perception is greater for long words than short words. Mean number of correct responses was 19.2 for monosyllables and 21.2 for trisyllables; the difference falls just short of statistical significance ($t = 2.04$, $df = 19$, $p > .05$).

Discussion

The method of visual presentation was not entirely successful in eliminating the recognition advantage of long relative to short words. This result does not agree with earlier reports summarized by Rosenzweig and Postman (1958). Pilot data collected prior to Experiment II at a slower presentation rate (20 msec), however, showed greater parity for monosyllable recognition. It is suggested that the disagreement might be resolved by parametric investigation of the rate variable.

The difference in d' scores, however, is about the same as that observed in Experiment I. It appears that the advantage of trisyllables relative to monosyllables in d' is not changed by the visual presentation method, a procedure which did alter the relative advantage of trisyllables in base recognition scores.

GENERAL DISCUSSION

The data of Experiment II make it easier to accept the conclusion that d′ scores are empirically, as well as mathematically, independent of changes in word recognition. A few prior outcomes in word perception tasks support this interpretation as well. Both Hochhaus and Antes (1973) and Pollack and Decker (1958) found repeated presentations of the same word improved identification scores, but had no effect on confidence rating accuracy (d′).

Overall, the conclusion that d′ changes cannot be explained in terms of changes in word recognition scores is supported by three lines of argument: (1) Covariation in d′ and word recognition scores is less than perfect in the present series of experiments; (2) in earlier work, d′ changes have been observed in the absence of noticeable changes in word recognition; (3) in the computation of d′, hit and false alarm rates are probabilities which are conditionalized, respectively, upon correct and incorrect recognitions; this procedure provides mathematical independence between d′ and word recognition scores.

The findings of the present experiments add support to the impression that the parts or subunits of trisyllable words are subject to selection constraints not found in monosyllable words and that the resulting restriction in the number of perceptual alternatives within long words provides "feelings of knowing" which lead to significantly greater d′ values. Therefore, it appears correct that feedback is operating between the parts of long word units and provides a basis for "knowing that you know."

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