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Notes and Comment

Multidimensional letter similarity: A reply to Mewhort and Dow

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Gilmore, Hersh, Caramazza, and Griffin (1979) reported a confusion matrix for uppercase letters presented on the screen of a cathode-ray tube. Mewhort and Dow (1979) recently have questioned the validity of this matrix and the indices of letter similarity derived from it. They apparently raised their objection because of the low correlation between the diagonal entries of the matrices reported by Gilmore et al. (1979) and Townsend (1971), who generated a confusion matrix using a conventional tachistoscope. There are several reasons why this low correlation could occur. The most obvious explanation, which the authors mention and dismiss, is the difference in type fonts used in the studies. Another possible source of the difference is that the values reported in one of the studies may be unreliable or confounded by another variable. Since the confusion matrix reported by Gilmore et al. (1979) was based on eight times as many stimulus trials as that reported by Townsend (1971), one might question the reliability of Townsend's matrix. However, Mewhort and Dow (1979) choose to argue that the method used by Gilmore et al. (1979) in presenting the stimuli is the source of the difference and, furthermore, that this confounding factor leaves the value of the confusion matrix questionable.

The argument presented by Mewhort and Dow (1979) to support this conclusion seems to be a convincing one. The weakness of the presentation, however, is that it is based on inferences about the stimulus presentation method and not facts. The authors infer that a low-intensity level was employed, since Gilmore et al. (1979) were able to achieve a 51% level of accuracy with a mean stimulus duration of 33 msec. This first inference is, indeed, correct. We regret that the stimulus luminance level was not reported, but we were not able to obtain an instrument which could reliably measure the luminance. Reporting the luminance level, however, would not have forestalled the major objections raised by Mewhort and Dow (1979). First of all, they question the stability of the equipment for displaying dots at a low-intensity level. Rather than rely on speculation, we checked this point with the manufacturer of the equipment, Digitial Equipment Corporation, and were assured that there is no reason to suspect a stability problem (Rupp, Note 1). The second objection raised by Mewhort and Dow (1979) concerns the dot-brightening algorithm used in generating the letters. They contend that it may have been very slow and that letters containing few dots may have been brighter than those composed of more dots. The algorithm employed has been described by Schwartz (1978) and is not considered slow, since a dot is refreshed approximately every 25 μsec. Furthermore, while the displayed dots were continuously refreshed, possible brightness differences among letters composed of an unequal number of dots were controlled for by presenting an appropriate number of extra dots at a nonvisible portion of the screen. That is to say, the same number of dots were generated and brightened regardless of the letter displayed. This should have been an effective brightness control. Indeed, when our subjects were questioned, none of them reported noting any brightness differences among the letters. The subjects did note that some letters, such as I and T, were easier to identify than others, but they attributed this to the fact that there were few letters shaped as these letters.

Since the brightness of the letters was controlled, how can one then account for the high correlation ($r = -.873$) between the number of dots in a letter and its identification accuracy? One reasonable interpretation is that the letters with few dots are simple figures composed of relatively few features. In a limited-capacity system, simple letters would have an advantage over more complex ones at an encoding level. Another interpretation, suggested by our subjects, is that the simpler letters are relatively unique in their shape, thereby placing less processing demands on the observer. Based on an inspection of the letters used by Gilmore et al. (1979, Figure 1), one can see that the set of letters potentially confusable with the letter L is much smaller than the set potentially confusable with the letter M.

This conclusion is supported by a recent study by Podgorny and Garner (1979). In an investigation of inter- and intraletter similarity, they have reported that in a "same-different" task there are significant differences in "same" reaction times among letters. For instance, it takes much longer for a subject to respond "same" to a pair of Ms than to a pair

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of Ls. Podgorny and Garner (1979) also have interpreted these differences as due to either more efficient encoding of certain letters, such as L, or a low level of confusability of these letters with the other letters of the alphabet.

The major point raised by Mewhort and Dow (1979) was that the confusion matrix reported by Gilmore et al. (1979) lacks validity because of a confounding of letter structure with brightness. Yet, as we have stated, the procedures and equipment used in generating the letters controlled for potentially confounding brightness differences among the letters. We must conclude therefore that the differences in level of identification accuracy among the letters reliably reflects true processing differences and that the confusion matrix can be used by investigators as a reliable and valid instrument.

REFERENCE NOTE

1. Rupp, C. Personal communication, August 1979.

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