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Redundancy in the full-report procedure*

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Redundancy was varied in the tachistoscopic full-report procedure. Unlike previous experiments using the detection paradigm, redundancy led to a detriment in performance. Evidence is presented that response bias was not the cause of the detriment.

Redundancy is generally considered an important variable in visual information processing. Most of the evidence for its importance comes from the manipulation of redundancy in detection tasks (Estes, 1972; Wolford, Wessel, & Estes, 1968). The detection procedure is one in which a S is asked to indicate which of a previously defined set of targets appeared in the display. Increased redundancy leads to an increase in the probability of correctly identifying the target. Redundancy has rarely, if ever, been manipulated as a variable in the full-report procedure. Redundancy in this case would refer to the repetition of some letter in the display. There is no particular target in the full-report procedure, since all letters must be identified if possible. There are at least two reasons why redundancy might not be as effective in the full-report procedure as it is in detection tasks. Ss may experience some difficulty in storing both copies of a repeated letter following the identification process, and/or Ss may have a bias against reporting both instances of a repeated letter. We, therefore, designed an experiment to examine the role of redundancy in the full-report procedure. The basic design of the experiment is to present the Ss with some displays containing repeated letters and some without, and to compare the probability of reporting the double letters with the probability of reporting corresponding unique letters from the control displays. We also varied instructions in an attempt to manipulate any bias for or against reporting double letters.

METHOD

Subjects and Apparatus

Twenty introductory psychology students (10 in each of two groups) received course credit for their participation in the experiment. All had normal or corrected normal vision and none wore contacts.

The stimulus materials were presented in a Scientific Prototype three-channel tachistoscope (Model GA) that was modified with a rapid card changer. Character strings were presented along the horizontal median of a lighted rectangular field which subtended a visual angle of 7.82 deg in width and 1.68 deg in height. One field (the fixation field) contained a circular black dot measuring 0.073 deg in diam centered with respect to the rectangle described above. The luminance of all of the fields was adjusted to 10 fL. The fixation field was visible at all times except for the presentation of the stimulus field and a 10-sec period subsequent to the stimulus which was filled with a lighted field without a fixation point. The total illumination in the laboratory was provided by two 7-W bulbs shielded from the Ss. The responses of the Ss were typed by the E onto a portable teletypewriter which was connected to a time-sharing system.

Stimulus Materials

Seventy-five five-letter strings were generated at random without replacement from the 20 consonants (excluding Y). In 25 of the displays, the third letter was replaced with a repetition of the second letter, and in 25 different displays, the fourth letter was replaced with a repetition of the third letter. The character strings were typed in Royal Bulletin typeface on white notecards. The characters subtended a visual angle of 0.29 deg in height and 0.14 deg in width. The intercharacter space was 0.073 deg, and the entire five-letter array subtended an angle of 1.07 deg. The arrays were positioned so that the leftmost letter appeared 0.073 deg to the right of the fixation point.

Design and Procedure

Each S received a presentation of the 75 stimulus displays in a different random order. The S was instructed to begin each trial by fixation on the black dot. When the dot was in focus, he was to initiate a 50-msec exposure of the display with a hand-held microswitch. The task was to report as many of the letters as possible in a left-right order. Feedback regarding his overall proportion of correct letters was given to the S after every 15 trials.

The Ss were divided into two groups. One group (aware) was informed about the existence of repeated letters in some of the displays and encouraged to report as many such occurrences as possible. The other group (unaware) received no information about the construction of the stimulus displays.

RESULTS AND DISCUSSION

In analyzing the data, the letters did not have to be output in the correct serial order to scored as correct. The serial position curves for the three display types are presented in Table 1. These data have been collapsed across instructional condition. The displays without repeated letters are clearly superior to those with repeated letters at the middle serial positions.

To determine the statistical effect of redundancy, we analyzed the data in two ways. We first wanted to see how often both instances of the repeated letters were reported compared to how often two corresponding

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Table 1
The Serial Position Curves as a Function of Display Type

Display Type		Serial Position 1	2	3	4	5
Unique		93	86	76	42	48
Redundant	2 and 3	88	74	46	40	53
Redundant	3 and 4	90	75	56	37	51

Table 2
The Probabilities of Getting Both Letters Correct

Group	Position	Display Type: Unique	Redundant
Aware	2 and 3	58	51
Aware	3 and 4	32	30
Unaware	2 and 3	50	20
Unaware	3 and 4	21	10

Table 3
The Probabilities of Getting at Least One Letter Correct

Group	Position	Display Type: Unique	Redundant
Aware	2 and 3	92	90
Aware	3 and 4	80	75
Unaware	2 and 3	88	78
Unaware	3 and 4	77	70

letters from the control displays were reported. To do this, we computed the probability of getting both letters correct as a function of three variables: redundancy, string position (2 and 3 vs 3 and 4), and instructional condition (aware vs unaware). The means from this analysis are presented in Table 2. The main effect of string position was significant [$F(1,18) = 76.87$, $p < .05$]; the main effect of redundancy was significant [$F(1,18) = 7.78$, $p < .05$]; and the interaction of Position by Instructional Condition was also significant [$F(1,18) = 5.82$, $p < .05$]. None of the other effects was significant. The significant main effect of string position is to be expected on the basis of both retinal locus and report order. The main effect of redundancy indicates that two adjacent letters are more likely to be reported if they are unique.

Our second analysis examined the probability of reporting at least one instance of a repeated letter, compared to the probability of reporting at least one of two corresponding unique letters from the control displays. The same three variables as in the previous analysis were used. The means from this analysis are presented in Table 3. The main effect of string position was significant [$F(1,18) = 31.82$, $p < .05$]; and the main effect of redundancy was also significant [$F(1,18) = 13.76$, $p < .05$). None of the other effects was significant. Once again, redundancy was detrimental to performance.

Several facets of the data argue against a response bias interpretation of the detrimental effect of redundancy. A response bias explanation would be consistent with the data in Tables 1 and 2 but would not explain why Ss were less likely to get at least one of the letters correct. Furthermore, the interaction of redundancy and instructional condition did not approach significance in either analysis.

As an additional check on the issue of response bias, a signal detection analysis was carried out on the data. A hit was defined as the report of a double letter from a double letter display. A false alarm was defined as the report of a double letter from a control display. It should be noted that a false alarm is not the complement of a correct response for the control displays. Even if a S didn't report a double letter on a control stimulus, he may not have correctly identified the appropriate letters. The aware group had a mean d' of 1.6 and a false alarm rate of .03, and the unaware group had a mean d' of 1.1 and a false alarm rate of .02. So, while the aware group did have higher d', the false alarm rates of the two groups were essentially identical. The equality of the false alarm rates would tend to indicate that the two groups did not use different criteria in identifying double letters.

It would appear, then, that either the instructional conditions had no effect on response bias or, more likely given the rest of the data, response bias did not produce the detrimental effect of redundancy. The cause was probably either in the identification or storage process. Whatever the cause, the differential effect of redundancy in detection vs report paradigms is of potential importance. There has been a recent tendency to exclude report tasks as appropriate for the study of visual information processing due to problems of theoretical interpretation (Gardner, 1970). Nevertheless, the report procedure is one step closer than detection to many problems of applied interest such as reading, and variables which operate differently in the two paradigms should not be ignored.

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