Visual vs. phonemic contributions to the importance of the initial letter in word identification

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A modified Stroop paradigm was used to evaluate the relative contributions of visual and phonemic processing to the importance of initial letters for word identification. Results implicated both types of processing while indicating a stronger role for visual processing. Results are discussed in terms of the typically found importance of the first letter for successful word identification.

A variation of the Stroop color-word interference task (Stroop, 1935) has been used by many investigators (cf. Ehri, 1976; Pace & Golinkoff, 1976; Rosinski, Golinkoff, & Kukish, 1975) to study reading. Such a task is aimed at determining the stages of processing by which readers abstract meaning from printed words. In this task, subjects are presented with line drawings which have superimposed print. They are asked to name the line drawings as quickly as possible. Typically, it has been reported that, when superimposed print is a word other than the picture label, naming times are slower than when the print is a superimposed nonword. Such times are, in turn, slower than when superimposed print matches the picture label.

While the earliest investigators interpreted these findings as indicating that printed words directly access their concepts in semantic memory, the more recent use of this task tachistoscopically has permitted a more powerful specification of the print characteristics which are responsible for the interference generated (cf. Posnansky & Rayner, 1977; Rayner & Posnansky, 1978, in press; Underwood, 1976). For example, Rayner and Posnansky (1978) reported that less interference was generated by superimposed print which maintained the visual features of the picture label than by print which altered visual features such as end letters and word shape. This was especially true early in processing. Later in processing, Rayner and Posnansky (1978) reported that the preservation of the phonemic characteristics of the picture's label reduced

the amount of interference generated. Furthermore, Underwood (1976) has implicated the importance of the semantic relationship between the picture and the print for determining the amount of interference generated. He reported that naming times for line drawings with adjacent related words were longer than when adjacent words were unrelated to the picture label (Experiment 1). In addition, it has typically been found that labeled pictures are named faster than their unlabeled counterparts (Ehri, 1976; Rayner & Posnansky, 1978).

Rayner and Posnansky (1978) and Posnansky and Rayner (1977) found that less interference with picture naming was generated when the print superimposed on the picture maintained the first letter and overall word shape of the label. Traditionally, the first letter of a word has been considered to be very important in word identification for three reasons (cf. Gibson & Levin, 1975; Rayner & Hagelberg, 1975). First, since it is assumed that readers scan from left to right, the salience of the first letter may be attributed to the well-known primacy effect found in many verbal memory studies. Second, the beginning letter is not as susceptible to visual masking from adjacent letters. Third, the initial letter probably conveys more information than middle or end letters because of constraints in the English language; once a reader knows the beginning of a word, the remainder of the word becomes more predictable. The extent to which each of these explanations is viable may depend upon the relative contribution of visual and phonemic processing of the first letter of a word. That is, it is unclear whether the importance of the first letter results from some priority of visual processing or because the first letter is rapidly recoded from its visual form into a phonemic representation. The experiment reported here utilized the picture-word interference task to examine the relative contribution of visual processing and phonemic recoding in determining the importance of the first letter in word identification.

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METHOD

Subjects

Ten members of the University of Rochester community were paid \$2.50/h for their participation. All of them had normal or corrected vision.

Materials and Apparatus

Nine black and white line drawings which could be labeled with four- or five-letter frequent words were prepared. The drawings were mounted on 4 x 6 in. index cards for tachistoscopic exposure. Each drawing was mounted on five cards so that five different experimental conditions could be created by superimposing various types of print on the drawing.

In the label condition, the drawing's label was centered on the picture. In the visual condition, another noun matched in length and frequency to the drawing's label and beginning with the same letter was superimposed on the line drawing. In the phonemic condition, the superimposed noun preserved the initial phoneme of the drawing's label although the first letter was changed. In the totally different condition, both the first letter and the first phoneme were changed. The final condition, the drawing-only condition, consisted of a drawing with no superimposed print. (See Figure 1 for examples.)

In addition to the stimulus cards prepared, a visual mask made up of superimposed Xs, Is, and Os was also prepared. The mask covered the area of visual angle occupied by the drawings.

A Gerbrands three-channel tachistoscope (Model T-3B-1C with lamp drivers, Model 400-3) was used to present the stimuli. The channels of the tachistoscope were equated at approximately 2 mV. Viewing distance was 86 cm and viewing was binocular. A digital timer accurate to 1 msec began with the onset of the stimulus presentation and was used to record naming times for line drawings. The digital timer was stopped when the subject spoke into a voice-activated microphone.

Procedure

Subjects were tested individually in single sessions lasting approximately 1 h. Prior to presenting the stimulus cards in the experimental trials, subjects participated in two warm-up tasks. In Task 1, subjects were shown sheets of paper which contained the nine line drawings. Subjects were asked to name the drawings to ensure correct identification. In cases where the subject mislabeled a drawing, the experimenter corrected the subject and retested that item. In Task 2, subjects were shown different drawings in the tachistoscope at exposures beginning with 200 msec on the first trial and decreasing with successive trials until a threshold (T) for line-drawing identification was determined.

Following the two warm-up tasks, subjects participated in 180 experimental trials. For each trial, subjects were asked to fixate on a cross in the center of the visual field and acknowledge that they were ready for the stimulus presentation. A stimulus drawing was then exposed. The stimulus presentation was fol-

PICTURE

CONDITION LABEL	SUPERIMPOSED PRINT	CHARACTERISTICS	$\bar{X}$ RT FOR PICTURE NAMING			
			T+20 msec	T+40 msec	T+80 msec	T+160 msec
Drawing Only			700.7	678.4	690.9	675.8
Label	giant	the drawing's label	684.4	662.4	640.8	670.0
Visual	gamut	preserves the label's initial letter	716.7	695.0	711.6	742.1
Phonemic	jewel	preserves the label's initial phoneme	718.6	714.6	737.4	786.0
Totally Different	paint	preserves neither the initial phoneme nor letter of the label	716.9	737.8	762.4	818.3

Figure 1. Examples of stimuli: mean picture-naming times as a function of experimental condition and exposure duration. Note that all print preserves the overall word shape of the drawing's label.

lowed by the presentation of the mask for 300 msec. In the stimulus presentation, the print on the drawing was .25 deg above where the fixation cross had been. The print was centered with regard to the fixation point and a five-letter word occupied approximately 1 deg of visual angle. Forty-five trials (nine trials blocked in each of five conditions) occurred with each of the following four stimulus exposure durations: T + 20 msec, T + 40 msec, T + 80 msec, and T + 160 msec. The mean T value was 18 msec. The orderings of exposure duration times and experimental conditions within an exposure duration were counterbalanced in Latin-square fashion.

RESULTS AND DISCUSSION

A 4 (stimulus exposure duration) by 5 (experimental condition) repeated-measures analysis of variance was performed on reaction times for successfully naming each drawing. Both subjects and drawings were treated as random variables and quasi-F ratios are reported where appropriate. Alpha levels are $\leq .05$.

The main effect of experimental condition reached significance [$F'(14,79) = 9.84$]. Mean naming times for the five conditions can be found in Figure 1. A Newman-Keuls test on these means indicated that all three expected interference conditions resulted in slower naming times than the drawing-only and label conditions, which did not differ from each other. Naming times in the visual conditions were significantly shorter than in the phonemic or totally different conditions. Although the main effect of exposure duration did not reach significance, the interaction of experimental condition and exposure duration was significant [$F'(13,128) = 2.12$]. This interaction can be attributed to the fact that no differences in naming times occurred among the experimental conditions with the very brief (T + 20 msec) exposure duration, while clear differences emerged with longer exposure durations. This replicates the previously reported finding of Rayner and Posnansky (1978). The amount of interference generated by a word which preserved neither the visual nor phonemic first-letter features of the drawing label (i.e., the difference in naming times between the totally different and label conditions) was greater than the interference generated in either the visual or phonemic conditions. Importantly, the amount of interference was considerably less (average = 50% reduction when compared to the totally different condition) in the visual than in the phonemic condition (24% reduction) at all exposure durations longer than T + 20 msec.

The results of this experiment make it possible to better evaluate the relative visual and phonemic feature contribution to the importance of a word's first letter

for the identification of that word. Clearly, the size of the interference reduction under the visual condition indicates that the first letter is important because of its visual characteristics rather than its phonemic characteristics. It should also be noted, however, that phonemic features of the first letter are of some use since phonemic condition resulted in less interference than the totally different condition. The relatively small reduction in interference given the preservation of the phonemic characteristics of the label's first letter in the superimposed print may initially appear to differ from Rayner and Posnansky's (1978) earlier finding that letter strings which were phonemic matches for the drawing's label resulted in significantly less interference than strings which were not. These larger effects were reported only for relatively long stimulus exposure durations. Thus, the smaller effects from the present study may reflect the fact that only the first letter was matched phonemically, whereas in the earlier study the entire string was a phonemic match with the label.

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