Laterality effects in perceptual matching*

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Two experiments are reported in which Ss had to indicate whether pairs of simple geometric forms were "same" or "different." In Experiment 1 the two forms were either both in the left visual hemifield or both in the right hemifield. Reaction times were unaffected by the locus of the stimuli. In Experiment 2, in addition to left and right pairs, there were pairs in which one of the stimuli was on the left and the other was on the right. Under these conditions, reaction times were faster for pairs totally on the left than for pairs totally on the right. The data support the notion that implicit scanning patterns are important in determining laterality differences. When such scanning is not involved and when simple nonverbal stimuli and responses are employed, laterality differences are eliminated.

The analysis of laterality effects in perception has potentially important implications for fields of research as diverse as perception, psycholinguistics, and physiological psychology. The present studies are specifically concerned with laterality effects in visual perception, a field that has recently been reviewed in detail by White (1969).

As White pointed out, differences in perceptual performance between the left and right visual hemifields have been investigated with two different kinds of stimulus presentation. In one, material is presented *bilaterally*, i.e., simultaneously on both the left and right sides of the visual midline. In the other mode (*unilateral*), material is presented on one side or the other (but not both) of the midline. Most data are consistent with the following generalization: With bilateral presentations there is a left-field visual superiority; with unilateral presentations there is a performance differential in favor of the right field. The exceptions to this generalization are as interesting as the rule itself. For example, when Hebrew-speaking Ss are presented with Hebrew alphabetic characters (ordinarily read from right to left), recall is better for items shown unilaterally in the left visual field than in the right (Orbach, 1952). In sum, the data suggest that early visual training is an important determinant of adult laterality differences. Such training, as in learning to read one's native language, presumably has a permanent effect via a hypothesized "postexposural trace-scanning mechanism" [White, 1969, p. 395].

One of the problems with the research on which these conclusions are based is that too often it is rather clear that memory is heavily involved in the

"perceptual" tasks selected for use. For example, a string of letters may be presented, and the S asked to recall it. Although such studies are interesting in their own right, they should not be mistaken for studies of perception.

Of course, it is not impossible to design a study of laterality effects that eliminates or greatly reduces the involvement of memorial factors. White (1970) presented hemifield displays of four letters at a brief exposure. The Ss simply had to decide whether or not a particular probe letter was present on each trial. Analysis in terms of signal detection theory showed no sensitivity difference between the left and right hemifields. These data suggest that laterality effects, when they obtain, may be due more to memory or learning than to perceptual processes.

The present research is designed to explore laterality differences in a task designed to go even further than White's in the elimination of memory requirements. To this end, Ss were shown pairs of simple geometric forms and asked to indicate if they were "same" or "different." The dependent variable was response latency.

EXPERIMENT 1

Method

Subjects. Thirty-six right-handed male students at the Johns Hopkins University served as paid volunteers in a single session lasting about 20 min.

Stimuli. Pairs of solid black figures were prepared on white cards. Squares and circles were used; the squares were 4.5 mm on a side, and the circles were 5 mm in diam. The two figures used on each card were positioned at corners of an imaginary square, 2.5 cm on a side, that was centered at the fixation point of the visual field. In this experiment the figures were both on the left or both on the right of fixation, their locus varying randomly from trial to trial. In other words, on each trial two forms were presented, one above the other,

separated by a vertical distance of 2.5 cm. These stimuli were viewed at a distance of 83 cm.

On each trial the two forms were either the same (two circles or two squares) or different (circle above a square or square above a circle). Thirty-two cards were prepared, 16 "same" and 16 "different." The order of presentation was randomized for each S.

Apparatus. To avoid eye movements, stimuli were displayed for .10 sec in a Scientific Prototype two-channel tachistoscope. The Ss responded by depressing a sensitive telegraph key. Response latency was measured between the onset of the display and the depression of the key.

A small dot was presented between trials at the center of the viewing area. The Ss were instructed to fixate this point before each trial.

Procedure. Half of the Ss responded with the index finger of their right hand and half with the index finger of their left hand. Half of each of these groups of Ss responded only when the stimuli were "same" and half only when the stimuli were "different." Several warm-up trials were given before the test series was started.

Results

Table 1 presents arithmetic mean reaction times for all conditions. Error trials were infrequent and were excluded from analysis. It should be noted that left field vs right field is a within-S comparison but that left hand vs right hand and "same" vs "different" are between-Ss comparisons.

An analysis of variance performed on these data indicated *no* significant main effects or interactions. The Fs did not even approach significance.

Ordinarily, when previous research has shown positive results, a complete absence of significant effects may be taken as an indictment of the precision of the experimental procedure. However, there are two reasons for suggesting that this is not the case in the present experiment. First, several other experiments have been performed in the same laboratory using the same equipment, equally short experimental sessions, and even fewer Ss, but with nicely significant results. If there

Table 1
Mean Reaction Times (Msec): Experiment 1

Visual Hemifield	Same		Different	
	Left Hand	Right Hand	Left Hand	Right Hand
Left	619	562	573	580
Right	623	588	597	552

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Table 2
Mean Reaction Times (Msec): Experiment 2

	Same	Different
Left	521	465
Right	587	520
Crossed	552	512

is a lack of power in the present experiment, it is perhaps because the effects being examined are extremely small. Second, the results of Experiment 2 indicated that lack of sensitivity was not the problem.

EXPERIMENT 2

The first experiment suggested a total lack of a laterality effect, as well as an absence of any potentially interesting interactions. The presentations were unilateral. An obvious and necessary extension of the design is to examine performance with bilateral presentations.

Method

Subjects. Twelve right-handed male students served in a single session lasting about 20 min. None had served in the previous experiment.

Stimuli and procedure. The stimuli were the same kind used in Experiment 1, but now horizontal pairs as well as vertical pairs were used. The pairs of elements could appear on any adjacent corners of the imaginary square. As before, half of the stimuli were "same" and half "different," and circles and squares were used equally often. The top, right, bottom, and left of the imaginary square served equally often as the locus of pairs in the series of 32 trials. (In the previous experiment only left and right had been used.) Thus, half of the trials were unilateral (left, right), while half were bilateral (top, bottom).

Since the previous study had shown no effect of the hand used in responding, all of the Ss were instructed to use their right hands. The telegraph key was replaced with another response device, for reasons having nothing to do with the experimental design. The new response key was mounted on a box, and the Ss responded with their thumbs. Any overall reaction time differences between Experiments 1 and 2

can probably be attributed to this equipment and response change. As before, half of the Ss responded "same" and the other half "different." In all other respects the experiments were identical.

Results

Table 2 presents arithmetic mean reaction times for left, right, and bilateral pairs for "same" and "different" Ss.

An analysis of variance performed on these data indicated that stimulus location (left, right, bilateral) was significant, $F(2,20) = 13.33$, $p < .001$. However, "same" vs "different" was insignificant, as was the interaction between location and "same" vs "different." Clearly, the pairs on the left are responded to more quickly than the pairs on the right, by about 60 msec.

GENERAL DISCUSSION

The first experiment failed to yield any laterality difference between the left and right visual fields. Moreover, there was no indication that responding to sameness or difference or with the right or left hand made any difference at all in the speed of response. Experiment 1 invites the conclusion that in the absence of any substantial memory load or apparent scanning strategy, laterality differences evaporate.

By contrast, the second experiment, containing bilateral presentations, yields a clear superiority of the left visual field over the right visual field. This would seem to be consistent with the generalization presented in the introduction, viz, left-field superiority with bilateral presentations. However, these data must be interpreted with great care. The crucial point is that the left and right trials in Experiment 2 are actually unilateral presentations because both elements of the pairs are on the left or both are on the right. The left-right comparison in this experiment is based on exactly the same kind of trials as the left-right comparison of the first experiment. Thus, the existence of bilateral trials induced a laterality difference in what are basically unilateral trials occurring within the same random sequence.

However, this seemingly paradoxical result still seems to be consistent with the postexposural scanning hypothesis if we assume that on a bilateral trial the S attempts to match by scanning (implicitly, not with an eye movement) from the left element to the right element, the scanning direction consistent with long-standing reading habits. Since half of the trials were bilateral, it may be assumed further that the preference for starting the implicit scan at the left is carried over to the unilateral presentations in the same sequence of trials.

Even if the plausibility of this argument is granted, a problem remains. Why did a laterality difference obtain in most previous work using unilateral presentation but not in the present Experiment 1? The answer is not yet clear, but we may tentatively suggest that a right-field superiority results when verbal material or material to be remembered is presented to the right visual field and, hence, to the left cerebral hemisphere which is the locus of the language center (e.g., Gazzaniga, 1967). In Experiment 1 the stimulus material as well as the response were nonverbal, the task was one of simple perceptual comparison, and implicit scanning did not seem to be implicated. In these simplified circumstances no laterality effect occurred. Further research with matching tasks and a variety of stimulus materials may permit the determination of the extent to which the verbal nature of the stimuli may be a determinant of laterality differences.

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