1972

Post-Exposural Eye Movements and Lateral Differences in Tachistoscopic Recognition

R. Cameron McRae

Wilfrid Laurier University

POST-EXPOSURAL EYE MOVEMENTS

AND

LATERAL DIFFERENCES IN TACHISTOSCOPIC RECOGNITION

by

R. Cameron McRae

A Thesis
Submitted to the Department of Psychology
in Partial Fulfilment of the Requirements
for the Degree
Master of Arts

Waterloo Lutheran University

Waterloo, Ontario

Canada

May, 1972

Acknowledgements

The author wishes to express his appreciation to Dr. Janet Hay, whose enthusiasm for research, and whose interest in visual perception has provided the inspiration for a life's work. Also, to the members of the committee, Dr. Vernon Schaefer, Mr. Marc Barnes, and particularly to Dr. Mary Kay Lane, supervisor, whose astute criticism and creative data skills were invaluable. Special appreciation is due Mr. Gerard Blom of the University of Waterloo for his assistance in constructing the apparatus. The contributions of Diana McRae, my wife, ranged from preparation of the figures, to the continued support and counsel for which thanks are merely inadequate.

Abstract

Left-right differences in visual field accuracy obtained in studies of tachistoscopic recognition have been typically discussed in terms of a covert post exposure scanning process derived from the horizontal eye movements (EM) habitually used in reading. Further, some evidence exists that indicates the occurrence of EM concomitant with the recognition process. By monitoring EM during a representative recognition task, the present study attempted to establish the relation between overt EM elicited by the task, and response accuracy. Using a projection tachistoscope (duration 100 msec.), 8 female Ss were presented with a random trial series of 8-element letter, number, and symbol arrays exposed bilaterally, and 4 letter arrays exposed unilaterally. In a second trial series, bilateral and unilateral letter arrays were presented at a 1 sec. duration. A high resolution corneal reflection technique was used to detect the latency and direction of EM. The pattern of recognition accuracy for alphanumeric stimuli generally conformed to the results of previous investigations based on grouped data. Marked individual variation was noted in the present results, suggesting a source of variability worthy of analysis. Response accuracy obtained for symbol arrays was highly variable and demonstrated a lack of lateral disparity, indicating an unstructured encoding process for this material. The post exposure EM was established as a reliable phenomenon, identical in topography to the EM evoked with the stimulus present. However, the EM behaviour did not relate to recognition accuracy, a result that does not limit the use of reading EM as a model for the scanning process. Rather, the lack of relation does indicate that overt EM are not involved in that process. Further implications of the EM and recognition results for theory and future research are discussed in detail.

Table of Contents

Tables

Figures

Figure		Page

Introduction

The study of visual processing of symbolic information has long been an important area of interest to psychologists. Typified by reading, the process involves a sophisticated amalgam of perception, sensory-motor skill and cognitive function. Contour discrimination, eye movements and memory, for example, all play a role in this complex behaviour, perhaps the highest order of perceptuo-cognitive behaviour available to the scientist for experimental scrutiny.

Typical methodology used in the study of visual information processing has been the tachistoscopic recognition task, a procedure designed to discern, as George Sperling (1960) has stated: "The Information Available in Brief Visual Presentations." A large number of tachistoscopic recognition studies are reported in the literature and a body of sophisticated theory has been generated. Although the theory attempts to integrate perceptual, physiological and cognitive parameters, there is a conspicuous omission of data collection that might provide empirical support for this integration. It is within this context that the present experiment explores the relation between eye movement behaviour elicited by tachistoscopic exposure of alphanumeric stimuli and accuracy of report for that material.

Review of the Literature

In general, when a horizontal row of stimulus elements, centred at fixation, is presented tachistoscopically, the elements to the left of fixation are identified more accurately than those to the right. In contrast, when stimulus elements are exposed successively to one side of fixation or the other, accuracy is higher for elements in the right visual field (RVF) than for those in the left visual field (LVF).

The lateral disparity produced by bilateral presentation, that is, a row of elements centred on fixation, half in the LVF, half in the RVF, was observed in early "range of attention" experiments. For example, Glanville and Dallenbach (1929), exposing two rows of letters across the visual field, found that letters to the left of the upper row are most accurately perceived. Similarly, Crosland (1931) has shown that when an array of randomly selected letters is exposed in the centre of the field, letters in the LVF are more accurately reported than those in the RVF.

Successive, or unilateral presentation, was first utilized by Mishkin and Forgays (1952) in an experiment designed to determine whether constant involvement of a select neural organization would result in more efficient use of that organization. Arguing within a Hebbian framework (Hebb, 1949), Mishkin and Forgays reasoned that, in reading English text, the persistent presentation of elements in the RVF would lead to more efficient tachistoscopic recognition for that field. The results of that experiment indicated a consistent, significant, RVF superiority.

Since Mishkin and Forgays' (1952) initial demonstration, other researchers have attempted to analyze the phenomenon and explain its relation to the data obtained for bilateral presentation.

Heron (1957) completed an extensive investigation dealing with both modes of presentation. The results of his experiments with letter material corroborate those of earlier investigations. However, two experiments using nonsense forms and familiar forms as stimuli provided data indicating that the differential effects of visual field position are limited to alphabetical material.

Further, both the objective scores and Ss' report indicated that the letter material is processed after the brief exposure (100 msec.) via the same attentional sequence used in reading. The Ss reported that ". . . it seemed to them they were attending to each of the letters in turn, starting with those at the left." In Heron's interpretation: "Letters which would tend to be fixated first under normal reading conditions have their [associated neurological activity] 'scanned' first." This information led Heron to reject the postulates of Mishkin and Forgays and to suggest a "post-exposural process" contingent on perceptual discrimination of the stimulus.

In other words, with an exposure so brief as to disallow recognition of stimuli within its duration, recognition occurs after the exposure, derived from after-stimulation remaining in the visual system. The post-exposural perception of letter stimuli is uniquely bound to the objective qualities of this material. Heron proposed that the eye-movement (EM) characteristic of reading English determines how the post-exposural process operates.

Carmichael and Dearborn (1947) had found two main types of reading EM. The first is a series of short saccades from left to right along a line of print; the second consists of a sweep from right to left at the end of each line. In terms of the post-exposural process this form of scanning provides "a temporal distribution of attention across the persisting [neurological activity initiated by] the stimulus elements" (Harcum and Finkel, 1963).

Heron conceptualized the after-stimulation as having motor components related to the control of EM. Activity in the frontal oculomotor areas of the cerebral cortex, present when an observer is reading and necessarily preceding the overt EM, was posited to provide facilitation to the persisting stimulation, allowing more efficient recall. The sequence of letter processing are proposed to be identical to that which would occur given sufficient exposure duration for overt EM.

The results obtained with the two modes of presentation were explained within this framework as follows:

> . . . the fluent English-reader presumably has two tendencies established; faced with a line of print there is one tendency to fixate near the beginning of the line and another to move the eyes along it from left to right.
>
> When alphabetical material is exposed in the right field alone, the two tendencies would be acting together. When, however, it is exposed in the left field alone, the tendency to move the eyes to the beginning of the line (presumably the dominant one) would be in conflict with the tendency to move the eyes from left to right. Under conditions of successive presentation we should therefore expect that more letters would be recognized in the right field. When exposure occurs simultaneously in both fields, on the other hand, the dominant tendency to move the eyes to the beginning of the line would result in more letters being recognized in the left field. Familiar and unfamiliar forms would be recognized equally easily in both fields, since, as one does not usually read lines of nonsense figures or geometrical forms there would not be the same tendencies toward eye-movement established for figures as there are for letters.
>
> (Heron, 1957, pp. 46-47)

Fudin (1969) has reinterpreted the Heron model, suggesting that the EM's are evoked in sequence rather than in concert. The initial movement is a sweep, usually leftward, to the starting point (SP) of a line of print. The second EM is from left to right; a movement concerned exclusively with the encoding of the stimulus materials.

On this view, conflict of EM cannot account for the LVF inferiority obtained with unilateral presentation. Rather, the time required to accomplish this sequence is considered the major factor. Information from the after-stimulation must be encoded from left to right before this activity fades below the threshold necessary for a response. The delay encountered in reaching the SP of material exposed in the LVF is sufficient to allow the loss of some of the material.

The lateral disparity encountered with bilateral presentation is subject to a similar interpretation. As the after-stimulation dissipates, scanning proceeds left from fixation to the SP and then processes the material from left to right. The temporal sequence favours the elements first processed, i.e., there is a "primacy" effect for elements in the LVF (Anderson and Crosland, 1933; Harcum and Jones, 1962).

Although in essential agreement, Heron and Fudin differ primarily on the issue of EM conflict. Although at present there are no empirical data bearing directly on this issue, investigation of EM latency for unilateral stimuli may prove informative. If, as postulated by Fudin, EM tendencies are not in conflict, latencies for the two fields would be approximately equal. If, however, Heron's EM conflict does occur with LVF presentation, then latencies will be longer to the LVF than to the RVF.

That the lateral disparity effect is a function of reading experience has been experimentally investigated. Forgays (1952) conducted a study relating school grade level to hemifield differences for words presented unilaterally No significant differences in field accuracy were demonstrated below the seventh grade. Graphical analysis of the recognition data demonstrated an increase in overall accuracy as a function of grade level and significant difference in field accuracy beyond grade seven.

Hay and McRae (1969) replicated Forgays' (1952) study, substituting three-letter random arrays for the words and including a random selection of single forms as a control for set as suggested by Terrace (1959). The results of this study corroborate those of Forgays with the exception that significant RVF superiority occurred in grade five.

The shift to a lower grade is an important finding as many modifications have been introduced to elementary school reading programs in the seventeen years separating the two investigations. Not the least of these is the use of prose material selected from or closely approximating the material encountered in publications for adults. The visual habits postulated by Heron (1957) and Fudin (1969) may receive more efficient training under these conditions than with the over-simplified primary readers previously used.

Recently, Peters (1970) succeeded in training young Ss with a rapid sentence scanning task. Sampled from the same school population used by Hay and McRae, the grade four Ss were pretested on unilateral letter arrays. No significant field superiority was found. After training, however, the scores revealed significantly better accuracy for the RVF, a result similar to that obtained for an untrained grade five sample (Hay and McRae, 1969).

Other researchers, beginning with Mishkin and Forgays (1952), have been concerned with the contribution of cerebral dominance to these phenomena. As stated by Barton, Goodglass and Shai (1965) an "overwhelming quantity" of clinical data support the notion that one cerebral hemisphere, usually the left, is dominant for the processing of language. The cerebral dominance hypothesis suggests that information received from the RVF in unilateral presentation is processed by the left, more efficient hemisphere. Thus, superior accuracy is obtained for RVF stimuli.

In order to explore this possibility, three investigations compared visual field accuracy in bilingual readers of English and Yiddish. Since Yiddish is read from right to left, expectations concerning recognition accuracy based on cerebral dominance are opposite to those based on a process dependent on directional scanning tendencies. All three studies presented the stimuli unilaterally.

Mishkin and Forgays (1952) found that Yiddish readers demonstrated LVF superiority for Yiddish words but the inter-field difference was not significant ($p < .10$). Orbach (1953) re-evaluated this effect using Ss for whom Yiddish was the first learned reading language. Significant LVF superiority was obtained for those Ss, supporting the hypothesis which attributes ". . . the recognition differential to early visual training which contributes to the perceptual organization of maturity" (Orbach, 1953).

Barton, Goodglass and Shai (1965) tested bilingual Israeli _S_s utilizing a method devised by Goodglass and Barton (1963) who had argued that horizontal presentation of the letter material will inevitably result in horizontal scanning as the dominant effect.

With _S_s selected for handedness as a predicator of cerebral dominance, Goodglass and Barton (1963) had attempted to circumvent the scanning tendency with words printed in a vertical orientation. Contrary to prediction, both right and left handers demonstrated RVF superiority.

Barton, Goodglass and Shai (1965), however, demonstrated RVF superiority in both American and Israeli _S_s for letters printed in the vertical orientation. This result implies the effects of a language dominant left occipital cortex.

While primarily designed as investigations of the contribution of cerebral dominance, these studies also provide support for a scanning mechanism. Their results are indicative of a perceptual process operative only when the letter elements to be identified are in the normal prose orientation. This phenomenon would be predicted if one assumes, as Heron (1957) and Fudin (1969) have, that the process is the result of highly developed horizontal EM habits, established through reading training.

Bryden (1964a; 1964b; 1966) has also carried out a series of experiments investigating the relation of cerebral dominance to right-left differences in recognition scores. The impetus behind Bryden's work can be found in the discovery by Kimura (1961) that right ear superiority on a dichotic listening task is correlated with left cerebral dominance. The discovery of such a relation in the auditory modality prompted Bryden to seek a possible counterpart in vision.

The first paper (Bryden, 1964a) was a simple summary of data from experiments with unilateral presentation previously completed in his laboratory. The data were re-analyzed in terms of the handedness of the Ss. Percentages of left-handers demonstrating superior recognition in the RVF were shown to be low relative to percentages of right-handers superior in that field. The results suggested a factor, perhaps cerebral dominance, operating differentially for the two groups.

In the second experiment (Bryden, 1964b), left and right-handed Ss were tested on both the dichotic listening task and unilateral presentation of single letters. On both tests, right-handers were significantly more accurate in identifying material presented to the right side, while left-handers failed to show any consistent left-right differences. No correlation was found between the two experimental tasks.

When right-handed Ss attempted recognition of both single and multiple letter stimuli (Bryden, 1966) they were again more efficient for material in the RVF. Right visual field superiority on the two tasks, however, was not correlated ($r = -.01$) indicating the operation of separate processes. Indeed, in the first paper, Bryden (1964a) concluded:

> While these data are not conclusive, they do support the notion that tachistoscopically-presented verbal material is more readily analyzed in the hemisphere in which speech is represented. When multiple-letter stimuli are presented, however, highly learned directional reading habits seem to override the effect of cerebral dominance.

Bryden (Bryden, 1960; Bryden and Rainey, 1963) has also provided us with an extension of Heron's conclusions regarding non-alphabetical material. Reasoning that if the phenomena of tachistoscopic recognition are directly related to the EM specific to reading, Bryden suggested that presentation of non-alphabetical material should result in different effects.

Bryden (1960) presented eight geometric forms arrayed across fixation and observed a significant LVF recognition superiority. With groups of three forms presented unilaterally, however, there were no significant right-left differences.

In 1963, Bryden and Rainey compared three types of material: letters, geometric forms and outline drawings of familiar objects. Bilateral presentation resulted in higher LVF scores for all three stimuli. With unilateral presentation an RVF superiority was found for letters.

An LVF superiority has also been demonstrated for six-digit number sequences presented in the bilateral mode (Bryden, Dick and Mewhort, 1968).

Apparently, horizontal arrays presented bilaterally result in primacy for elements in the LVF regardless of the type of stimuli. With unilateral presentation the effect is restricted to letters.

Harcum (e.g., Harcum and Dyer, 1960; Ayres and Harcum, 1962; Harcum, 1964) has conducted a series of experiments dealing with differences in bilateral recognition for binary patterns. An array of these patterns consists of a row of open and filled circles (Figure 1). Concurring with the suggestion that the direction and sequence of perceptual processing is a result of reading habits, Harcum also concludes that laterality differences are produced by scanning of the pattern from end to end causing one end to be favoured by the primacy effect (Harcum, 1969).

Two experiments (Harcum, 1964; Harcum, 1969) have employed a novel procedure that sheds light on the primacy effect and provides evidence for Fudin's (1969) conception of the "starting point" (SP). In an attempt to eliminate end to end scanning,the 1964 study involved presentation of 17 elements across 7.9^{o} of visual space. The left most element was accurately reproduced, but scores for the other positions were generally poor. With the wide array, only the element at the SP was available for a response.

In 1969 the experiment was repeated with a 28 element 13.4° array, wide enough to place the ends beyond the range of effective vision. Under these conditions only those elements close to fixation were reported accurately, suggesting that elimination of the SP disrupted the scanning process.

Although all stimuli studied result in LVF superiority for bilateral presentation, there is evidence to suggest that the attentional process, having its root in a linguistic skill is also prepotent for linguistic material. Bryden (Bryden, Dick and Mewhort, 1968) in comparing data obtained for letters, numbers and geometric forms stated that the processing of numbers is more flexible than that of letters but less flexible than that of forms. This conclusion was based on experimental manipulations of the Ss' order of report.

Observing that left to right reporting was used almost exclusively, Bryden (1960) instructed Ss to respond in the opposite sequence. The results indicated that the Ss could report in a right to left direction more easily for forms than for letters. Bryden, Dick and Mewhort (1968) demonstrated that processing of numbers can be reversed but that right to left report results in less efficient recall.

That forced changes in the order of report will modify recall of forms more than numbers and numbers more than letters is indicative of the fact that non-linguistic stimuli are not inherent to the process as is the case with letters. Although read in a left to right sequence, numbers are not regulated by stable sequential contingencies as are English letters (Dick and Mewhort, 1967).

The strategy employed by a S for perception and response of all horizontal stimulus arrays is based on the horizontally distributed attentional process developed for reading. Highly overlearned, the strategy is operative in varying degrees in a variety of situations. Indeed, even within the range of language material as defined by order of approximation to English, the effect of hemifield differences becomes more pronounced as the material more closely approximates its textual form (Dornbush and Winnick, 1965).

The experiments reviewed above demonstrate that right-left differences in tachistoscopic recognition are primarily operative in tasks using linguistic material and are produced by extensive experience with this material. The post-exposural process postulated by Heron (1957) and reinterpreted by Fudin (1969) is the only mechanism so far proposed that successfully accounts for the majority of experimental data.

As a neurological rather than a behavioural event, the process is hidden from scientific scrutiny, with technology lagging behind theory. However, investigations of objective EM have demonstrated the occurrence of post-exposural movement with direction congruent with the locus of recognition (Bryden, 1960; Crovitz and Daves, 1962). Apparently, the motor component of the after-stimulation results in an overt EM. Crovitz and Daves (1962) suggest that the post-exposural ". . . neural state tending to produce an eye movement will be called a 'tendency to eye movement.'"

In a tachistoscopic recognition task the duration of the exposure is, by definition, extremely brief; on the order of 150 msec. or less, usually in the 30 to 100 msec. range. These durations are much shorter than those recently reported for EM latencies, which are on the order of 200-300 msec. (e.g., White, Eason and Bartlett, 1961). Crovitz and Daves (1962) reasoned that with the difference between exposure duration and latency, nothing remains in the objective field to induce an eye movement. They state: "The first eye movement which occurs must be the result of the tendency to eye movement existing at the initiation of the movement." For Heron (1957) and Fudin (1969) the characteristics of this tendency are determined by the characteristics of the stimulation.

Although both investigations (Bryden, 1960; Crovitz and Daves, 1962) are subject to criticism on procedural or methodological grounds, the use of apparatus to detect overt post-exposural EM was successful. Bryden (1960) used the contact lens method (Ditchburn and Ginsborg, 1953) for recording EM, a technique which provides excellent sensitivity.

However, it is expensive in terms of both time and money as each S must be individually fitted with a special contact lens. This consideration limited Bryden's sample to five Ss.

Sixteen six-element rows of letters or familiar geometrical forms were presented centred on fixation. The responses were scored for "mean locus of recognition." That is, each element was sequentially assigned a value from one to six. The score for each trial consisted of the mean of the values for the correctly recognized objects. A product-moment correlation between first EM direction and mean locus of recognition was computed for each S and for both types of material.

For individual Ss three demonstrated significant correlations between initial EM direction and locus of recognition with letter material ($p < .05$). With forms all correlations were within chance. For the combined data, however, significant correlations were obtained for both letters ($r = + .44$; $p < .01$) and forms ($r = + .31$; $p < .02$). No attempt was made to ascertain visual field superiority. However, a cursory check of the published data provides an indication that the normally predicted LVF superiority for bilateral presentation was achieved.

These results notwithstanding, Bryden's procedure casts doubts on any generalizations that might evolve from the study, as his stimuli were not directly comparable to those used in the majority of previous investigations. The stimulus elements and total array subtended visual angles respectively three and five times larger than those generally utilized (Table 1). Such a large array might possibly bias EM effects in the direction predicted.

Crovitz and Daves (1962) also presented their stimuli in a manner that disallows comparisons with previous work. Six numerals were displayed in the bilateral mode. The visual angles subtended by the elements were within the accepted range (Table 1), but the individual elements were spaced 3°, 5° and 7° from fixation. Thus, this array subtends the large visual angle of 14°. Further, wide spacing between elements has been shown to depress the lateral disparity effect (Bryden, 1966a). Presumably, scanning or EM may be affected by the conditions chosen by Crovitz and Daves.

Using electro-oculography (Ford and Leonard, 1958; Shackel, 1967) with fourteen _S_s, Crovitz and Daves did demonstrate that: ". . . a congruence in direction exists between the initial postexposure eye movement and the more accurate field." In terms of left-right differences in hemifield accuracy, no consistent results were obtained.

A finding incidental to the main body of their work may be of more lasting importance. It was discovered that congruence occurred on 85 per cent of the trials in which latency of the initial EM was from 150 to 175 msec. These short latencies are in disagreement with results obtained

TABLE 1

COMPARISON OF STIMULUS ELEMENT AND ARRAY SIZES

Author(s)	Number & Type of Element	Total Angle Subtended	Element Width	Element Height
Bryden (1961)*	6 letters	18°36'	1°28'	1°41'
Crovitz & Daves (1962)*	6 numbers	14°	30'	28'
Bryden (1959)	8 letters	3°7'	n/a	n/a
Bryden (1968)	6 letters	3°36'	23'	30'
Bryden, Dick & Mewhort (1968)	6 numbers	3°36'	23'	30'
Dick & Mewhort (1967)	8 letters	4°	18'	37'
Dick & Mewhort (1967)	8 numbers	4°	18'	37'
Harcum & Filion (1963)	8 letters	3°20'	12'	16'

*Objective EM studies.

with non-meaningful material, i.e., lights. For example, White, Eason and Bartlett (1961) describe eye movement reaction time as requiring durations of 200 to 300 msec. Data obtained by Bartz (1962) with numerical stimuli, however, corroborate those of Crovitz and Daves (1962). Bartz (1962) obtained average reaction time of approximately 200 msec. This information suggests that horizontal EM reaction time is also facilitated by tendencies to EM for alphanumeric material.

Confidence in the analysis of the EM directions and latencies described by Crovitz and Daves (1962) is limited by the low sensitivity of the electro-oculographic technique. Crovitz and Daves' equipment provided an oscillograph pen movement of 5 mm. for an EM to the 7° limit of the array. Thus, an EM through 1° 25' of arc was resolved by only one mm. of pen deflection. Further, the records were subject to artifact from the GSR, as well as EMG and EEG potentials (Crovitz and Daves, 1962; Shackel, 1967).

There are no data to suggest that an EM should occur on each trial. For example, Bryden's data obtained with a sensitive EM detector, included no moves (NM) on 22.6% of trials. Crovitz and Daves report 30% NM. Although the figures are roughly comparable, Bryden's result is likely the more accurate of the two.

The difficulties inherent in the methods of Bryden (1960) and Crovitz and Daves (1962) force one to conclude that the post-exposural EM requires further objective study. The conditions of further investigation must meet the criterion of comparability with prior work. The choice of stimulus elements, their visual size, the mode of presentation, the number of trials and the size of the sample must be determined by the procedures of previous investigation. The EM detection apparatus must be sensitive, relatively free from confounding artifact and provide economy of application. In addition, further study must attend more closely to the lateral disparity phenomena uniquely demonstrated by the recognition tasks in question.

Statement of Purpose

It was the purpose of the present study to attempt an investigation of objective EM satisfying the above criteria within the limitations imposed by practical considerations and statistical design. Three types of stimulus materials were chosen--letters, numbers, and a modification of the binary patterns used by Harcum and his associates (e.g., Harcum and Dyer, 1960).

Harcum's investigations of tachistoscopic recognition typically used rows of the patterns with the two states arrayed randomly (Figure 1). However, in a preliminary investigation the present author discovered a marked practice effect. When questioned, the pilot Ss suggested that not only did recognition become easier over trials but that they began to complete their responses by high probability guessing (i.e., at least $p = .50$).

Therefore, for the present study, nine symbols were designed with a circle as base (Figure 1). Pilot work with these figures demonstrated the effects usually associated with bilateral and unilateral presentation of non-linguistic material and showed negligible practice effect. Visual size of the symbolic elements was approximately equal to that of letters and numbers.

To ensure comparability with previous investigations

FIG. 1. Examples of a binary figure array and the nine symbols designed for the present study.

both bilateral and unilateral presentations were used. The bilateral mode (i.e., eight element arrays centred on fixation) was used for all three types of stimulus material. Letter material was presented unilaterally in four element arrays.

In addition to the tachistoscopic presentation of the arrays described above, a control condition not present in previous studies was incorporated into the design. For these trials all cue and fixation conditions remained unchanged but no stimuli appeared on the screen. Although pilot investigation indicated zero EM response to this stimulation, the blanks were included as a check on spontaneous EM.

In a separate series of trials, alphabetical arrays were presented in the bilateral and unilateral modes with the exposure duration extended to one second. The one second duration was chosen in order to allow recording of EM evoked with the letter stimuli present in the exposure field.

Recent technology was utilized in an attempt to gain data more susceptible to analysis and interpretation. An instrument designed by Gaarder et al. (1967) was used to detect the EM. This apparatus provides excellent sensitivity, (adjusted for the present study to 10'EM/1 mm. of pen movement), and is relatively simple and economical in use.

In order to avoid the confounding effect of variations in chart speed, and the poor response encountered with electromechanical event markers and recorder pens, photography of a CRT display was used to evaluate EM latencies below 250 msec.

Statement of Hypotheses

The research design may be considered as two experiments run in combination. Hypotheses and analysis were essentially independent for bilateral and unilateral presentation but with the intention that cautious cross comparisons could be discussed.

Given bilateral presentation of eight element groups, it was hypothesized that:

(a) recognition scores for the LVF would be higher than scores for the RVF;

(b) the difference in recognition scores would be greater for letters than for numbers and greater for numbers than for symbols;

(c) a significant correlation would obtain between direction of first EM and locus of recognition;

(d) the number of first EM made to the LVF would be greater than that made to the RVF;

(e) EM latency to letters and numbers would be less than EM latency to symbols.

Given unilateral presentation of four letter groups, it was hypothesized that:

(a) recognition scores would be higher for the RVF than for the LVF;

(b) a significant correlation would obtain between direction of first EM and locus of recognition;

(c) the number of first EM made to the RVF would be greater than that made to the LVF;

(d) EM latency to the two fields would be approximately equal.

The separate one-second exposure trials were intended to provide a demonstration of intra-exposure EM phenomena, thereby allowing a descriptive comparison with EM occurring in response to sublatency stimulation.

Method

Subjects

A random sample of eight Ss was recruited from the Women's Residence at Waterloo Lutheran University during the university summer session. Female Ss were used as pilot work indicated that their written responses were more legible than those of male Ss.

Prospective Ss were given a brief description of the experiment and were informed of the time required (one hour) and the possibly fatiguing nature of the task. Subjects for selection were screened for uncorrected normal vision and right handedness. As a more formal check, the tentative sample was tested on the Crovitz and Zener (1962) handedness questionnaire (all were exclusively right-handed) and the Ss were required to read the "twenty" line on the Snellen chart without error. Subjects were paid two dollars for participating.

Apparatus

One channel of a Lafayette T-2K tachistoscope was used to project the stimulus material on a 60 cm. by 30 cm. reverse projection screen positioned 180 cm. from the Ss viewing position. The Prontor-Press shutter was modified to provide exposure durations of approximately 100 msec. and 1 sec. The central fixation point consisted of a 3 mm. dot of light projected by a miniature spotlight mounted on the frame of the screen.

The corneal-reflection technique was used for detection of the eye-movements. Adapted from apparatus designed by Gaarder et al. (1967), the device incorporates an optical system (L_1, L_2: Figure 2) which focusses the heat filtered infra-red image of the filament of a No. 2331 bulb on the corneal-scleral margin of the eye.

> The cornea backed by the iris reflects less light than the white sclera, so as the eye moves the amount of infra-red light reflected from the eye changes. The reflected light is collected by the same optical system and reflected by a beam splitter [Figure 2] to be focused by L_3 [Figure 2] on a phototube [Figure 2].
> Gaarder et al., 1967, p. 475

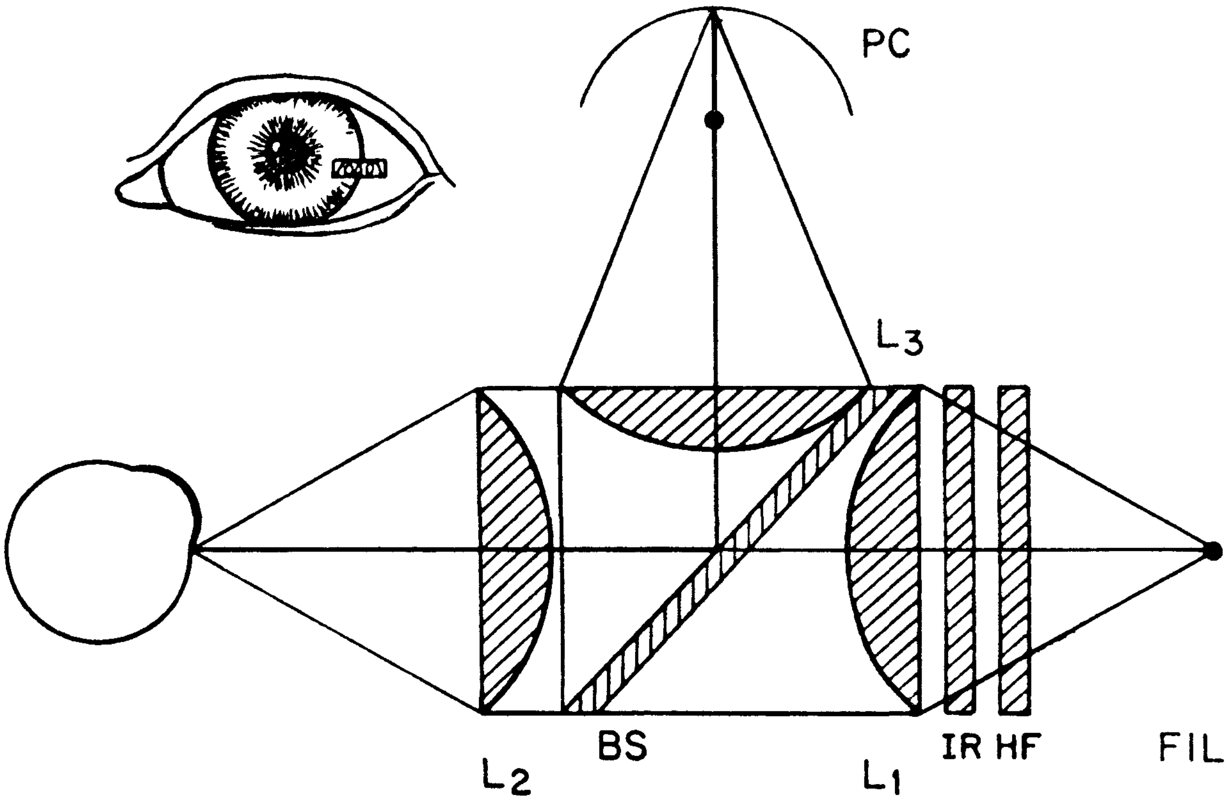
The electrical output of the phototube varies with the amount of light falling on it. Thus, variation of the tube's output is contingent on the eye's movement and proportional to it.

The output of the phototube was fed into a Physiograph DMP-4A rectilinear recorder via a Physiograph DC-AC preamplifier. Chart speed for recording was 5 cm./sec.

From the monitor jack provided on the DMP-4A the signal was transferred to one vertical input of a dual-trace triggered-sweep oscilloscope (Advance OS25A).

The second vertical input was connected to a simple pulse circuit switched by the synchronization contacts of the tachistoscope shutter. These contacts were adjusted to trigger the horizontal sweep at the onset of the exposure duration.

FIG. 2. Schematic diagram of the EM recording instrument (from Gaarder *et al*., 1967)


PC
L3
BS
L2
L1
IR
HF
FIL

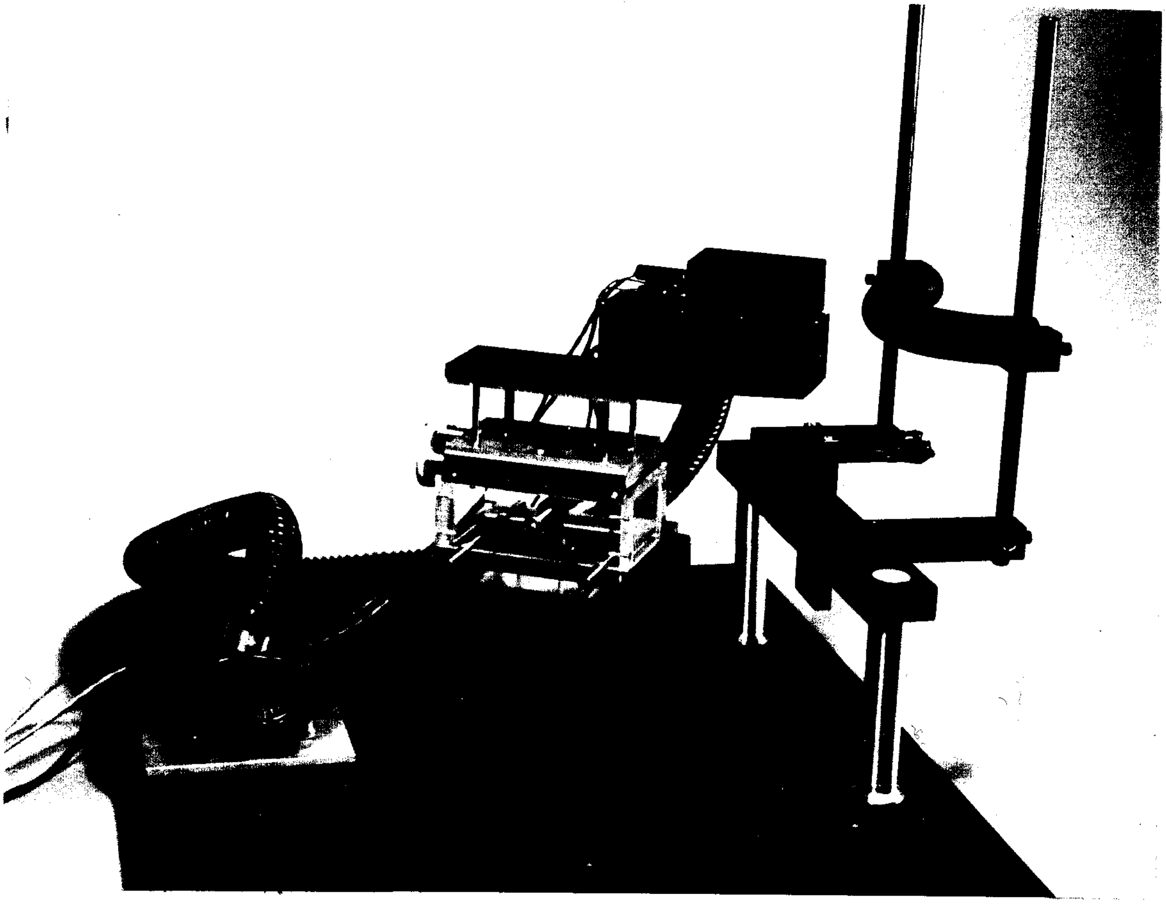
An Asahi Pentax 35 mm. camera with a solenoid operated shutter release was mounted in front of the CRT (Figure 2). Shutter speed was set at 1/2 sec. With the sweep rate of the oscilloscope calibrated at 25 msec./cm. over a sweep width of 10 cm., the camera recorded any EM deflection of the oscilloscope trace for a 250 msec. period. Eye movements with latencies beyond 250 msec. were scored from the Physiograph record.

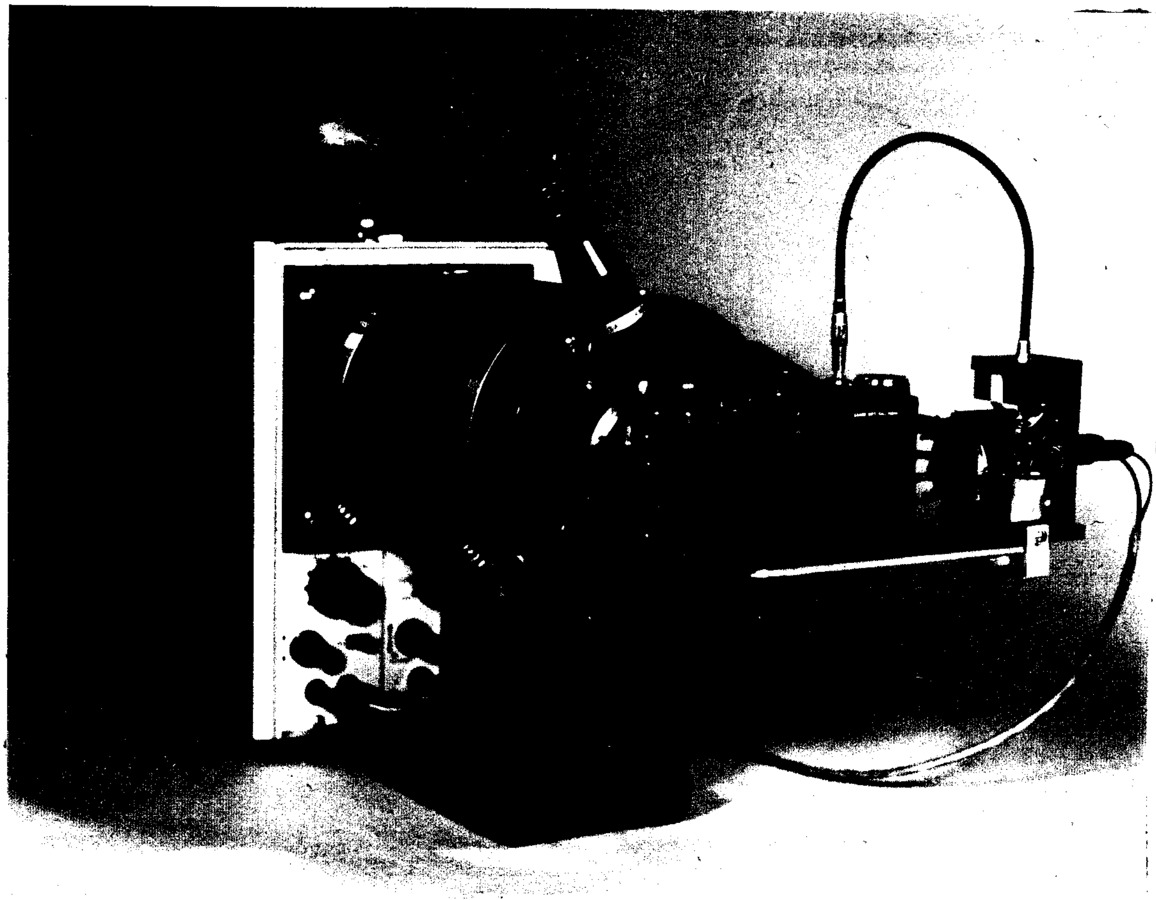
A focussing mount capable of movement in three dimensions is required for the EM detector. Gaarder *et al*. (1967) used a stand designed for the Mackworth camera. For the present experiment a mount was constructed providing increased range of movement, finer adjustment and greater rigidity (Figure 3).

To reduce head movement to a minimum, a fully adjustable but rigid bite plate mount and forehead rest was utilized (Figure 3). The chromed steel bite plates were coated with "Mizzy" dental compound for each *S* and an impression taken at the beginning of the experimental session. The Mizzy compound softens if heated to 50° C. but hardens quickly at body temperature. If the *S* became fatigued, she could disengage herself from the apparatus for a brief rest period. With careful replacement of the teeth in the original impression, minimal loss of calibration occurred.

The head brace and the focussing mount were positioned on a heavy wood base 90 cm. by 60 cm. This, in turn, was

FIG. 3. (Upper) EM recording device, forehead rest and biteboard. (Lower) Instrumentation for CRT photography.





clamped to a sturdy table.

The _S_ sat on an adjustable stool. To her right and at desk height was a horizontal panel 25 cm. by 42 cm. Resting her arm on the panel, the _S_ wrote her recognition responses on a strip of paper exposed in a 5 cm. by 18 cm. opening. The paper was part of a motor driven continuous roll advanced by the _E_ prior to each trial.

A foot switch, operated by _E_, controlled the initiation of an exposure sequence programmed on standard 28V electromechanical modules. At the beginning of a trial the _E_ said "ready," engaged the Physiograph chart drive, and then closed the switch resulting in the simultaneous onset of the fixation light and a 50 msec. 2800 H_Z tone.

After 1.5 sec. from initiation, the camera shutter solenoid was energized. The camera's synchronization contact completed a control circuit which simultaneously tripped the tachistoscope shutter, turned off the fixation light and delivered an event pulse to the Physiograph. One second following the offset of the exposure, a 50 msec. 2800 H_Z tone signalled the subject to respond.

Circuit reset, including slide advance and the advancement of the written response paper was controlled via a momentary contact toggle switch. This switch, along with a reset indicator lamp, was mounted on the camera as a reminder to _E_ to advance the film for each trial.

The experimental setting consisted of two adjacent rooms with an opening in the wall between them. The reverse projection screen was positioned in the opening. All programming, projection and recording equipment was situated in the E's room with the S in the other. The opening allowed efficient communication between E and S.

Stimulus Materials

The numerical and letter arrays were typed using IBM Selectric 12-point, upper case gothic type face. The symbols were inked using a Staedtler 700 technical pen with a 0.2 mm. stroke width.

Preliminary testing demonstrated that white stimuli on a dark neutral background produced fewest blink responses in Ss. This agrees with suggestions supplied by Gould and Schaffer (1965) in a discussion of problems encountered with EM recording. Further, this form of presentation produced zero artifact in the EM detection system. Therefore, the prepared material was photographed on 35 mm. Kodalith Ortho Type 3 film and the negatives mounted for projection.

The four categories of stimulus complex used were: (a) four-letter groups presented unilaterally; (b) eight-letter groups exposed bilaterally; (c) eight-number groups exposed bilaterally; and (d) eight-symbol groups exposed bilaterally.

The no-stimulus exposure consisted of a black slide; auditory cues and temporal sequence were unchanged. Similarly, no change in procedure was adopted for the one second exposure trial series.

The four-element groups were centred 3° 30' from fixation, the eight-element groups were centred on fixation and subtended a total visual angle of approximately 3° 20'. Individual elements subtended a vertical angle of approximately 22' and a horizontal angle of approximately 14'.

The number sequences utilized all ten digits selected randomly. Letter material was selected at random from the full alphabet with the restriction that chance formations of an English word be rejected. The symbol arrays were randomized from the nine designs.

One hundred and twenty-four slides were used. The 10 practice slides consisted of a random series of: 2 eight-letter slides, 2 eight-number slides and 2 eight-pattern slides. Two four-letter arrays are presented in the LVF and 2 in the RVF. No blank slides were shown.

For the 100 msec. exposures the experimental arrays consisted of: 16 eight-letter groups; 16 eight-number groups; 16 eight-symbol groups and 32 four-letter groups, 16 exposed to the left of fixation and 16 exposed to the right. Eight blank slides were exposed for this duration.

At the one second exposure duration the stimuli used were: 6 eight-letter groups exposed across fixation and 12 four-letter groups, 6 to the left and 6 to the right of fixation.

Procedure

On her arrival at the experimental setting the S was seated in front of the apparatus and given an informal explanation of the task and the use of the equipment. The complicated process of establishing the S in the apparatus coupled with the novelty of the task did not allow easy interjection of a set of formal instructions. Instead, all instruction was given in conversation as an integral part of the procedure. A list of the instructions in point form was available for the E's reference. Prior to running experimental Ss, the pre-trial instruction sequence was tested and rehearsed.

After the dental impression was taken, the chair height, bite board height and forehead-rest position were adjusted. Coarse alignment and focussing of the EM detector was completed. With the S still in the apparatus the E demonstrated the temporal sequence involved and had the S print her last name in the response space. This allowed practice on the response task and provided a record of the S.

The S was then allowed to relax as the E explained the symbol material, presenting the symbols drawn on a card and demonstrating the most efficient way of transcribing them.

With the S re-established in the apparatus, the E made an initial fine adjustment of the EM detector and began the series of ten practice trials at 100 msec.

On completion of these trials the _E_ checked the _S_'s response sheet and asked her if she was comfortable and understood the task. After a final check of the programming functions, recording equipment, and the focus and positioning of the EM detector, the experimental trials began. If she became fatigued, the _S_ could interrupt the trials for a brief rest.

Before attempting the one second exposures the _S_ was encouraged to relax, stretch and blink her eyes. The rest period lasted for approximately five minutes during which the _E_ informed the _S_ of the longer duration, emphasizing that no other changes would occur.

Scoring

Recognition For bilateral stimuli the array was dichotomized at fixation, i.e. between elements 4 and 5. Subject scores consisted of sums of correctly reported elements from each visual hemifield. Similarly, scores for unilateral presentation consisted of sums of correctly reported letters from arrays exposed in the RVF or LVF.

Eye movement An abrupt deflection characteristic of saccadic movement was required; slow drifts were not included in the data. Minimum scorable EM was defined as that resulting in at least 1 mm. of pen movement on the Physiograph.

The Physiograph record was scored directly with a finely divided (0.5 mm.) metric ruler. The photographic negatives of the CRT trace were projected on a screen 125 cm. in height, ruled in 1 cm. divisions. The projector was positioned so that the image filled the screen exactly, allowing accurate elapsed time measurements.

EM direction was classified as right move (RM), left move (LM), or no move (NM), and the number of EM's summed for each category. Eyeblinks were included in the NM total.

EM latency over 250 msec. was scored to the nearest 10 msec. Those within 250 msec. were scored to the nearest 5 msec.

Scoring for EM at the one second duration was extended to include the direction and latency of both the first and second movement after initiation of a trial.

Analysis

The formal statistical analyses dictated by the hypotheses are outlined below. The outcome of these analyses constitutes part I of the Results section; part II is devoted to descriptive analysis.

Recognition scores   Repeated-measures analysis of variance was computed on the sums of correctly reported elements. Bilateral and unilateral data were analyzed separately.

Individual planned comparisons were conducted with Sandler's *A* (Runyon and Haber, 1967). The Newman-Keuls test (Winer, 1962) was utilized for multiple comparisons and *a posteriori* investigation.

EM direction LM and RM scores for the three types of bilateral stimuli were compared in a repeated-measures analysis of variance. An ANOVA was conducted comparing LM and RM scores for left and right unilateral presentation.

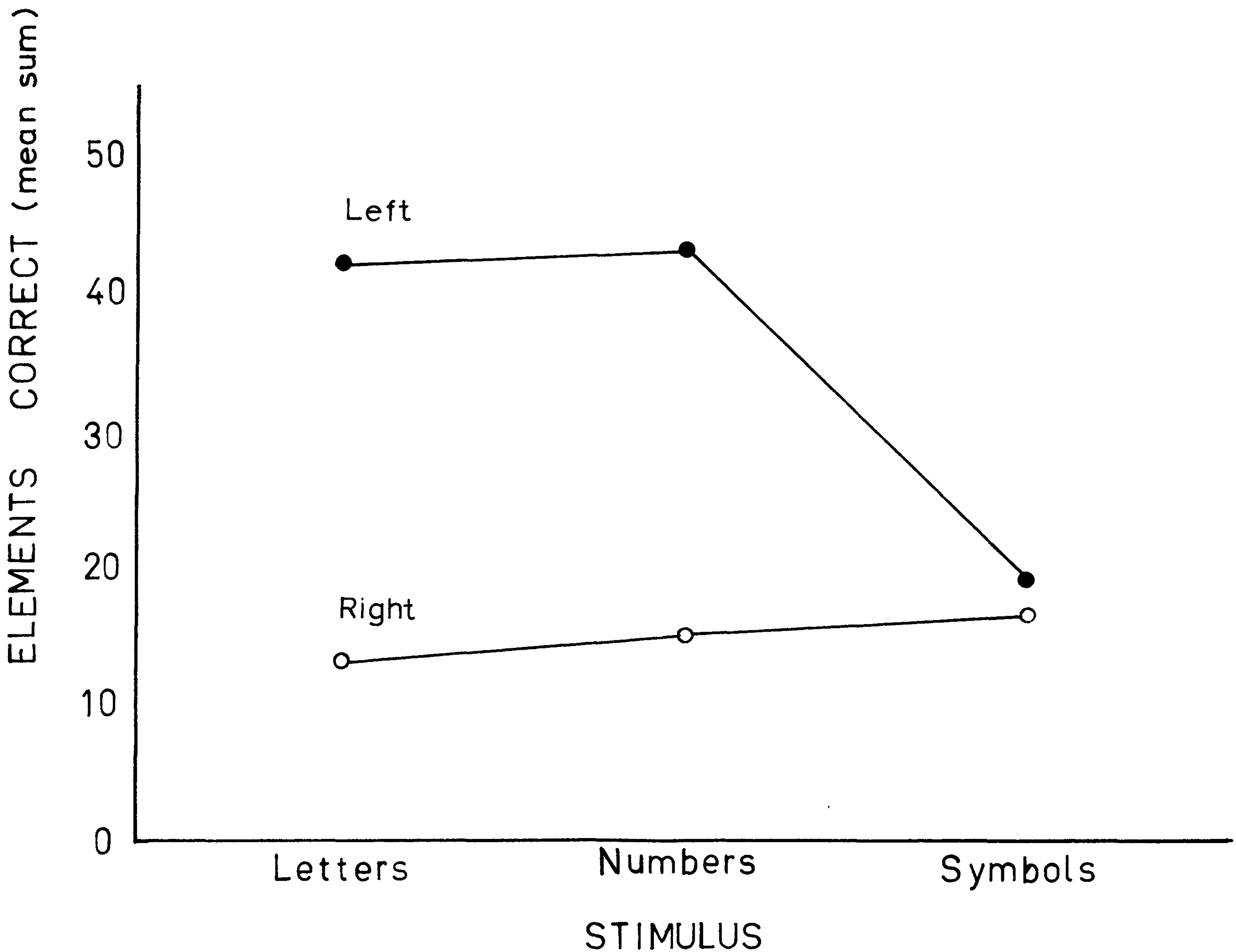
Using the Pearson *r*, the relation of EM direction and accuracy of recognition for bilateral stimuli was explored within each stimulus category. Data for the three types of stimuli was also combined in order to obtain an indication of general relations. A similar correlational analysis was undertaken for first EM and recognition scores from unilateral exposures.

EM latency Mean EM latencies were compared in repeated measures analyses computed separately for the bilateral and unilateral conditions.

Although not indicated by the hypotheses, a correlational analysis of EM latency and hemifield accuracy was conducted.

Note: CV Wherever pertinent, the coefficient of variation (*CV*) is reported. Derived by the formula $CV = \frac{\sigma}{\bar{X}} \times 100$, the *CV* denotes that proportion the standard deviation is of the mean, expressed as a percentage (Guilford, 1942). As such, the statistic is a useful descriptive indicator of variability.

FIG. 4. Recognition scores for bilateral presentation.


ELEMENTS CORRECT (mean sum)
50
40
30
20
10
0
Left
Right
Letters
Numbers
Symbols
STIMULUS

Results I

Recognition Scores

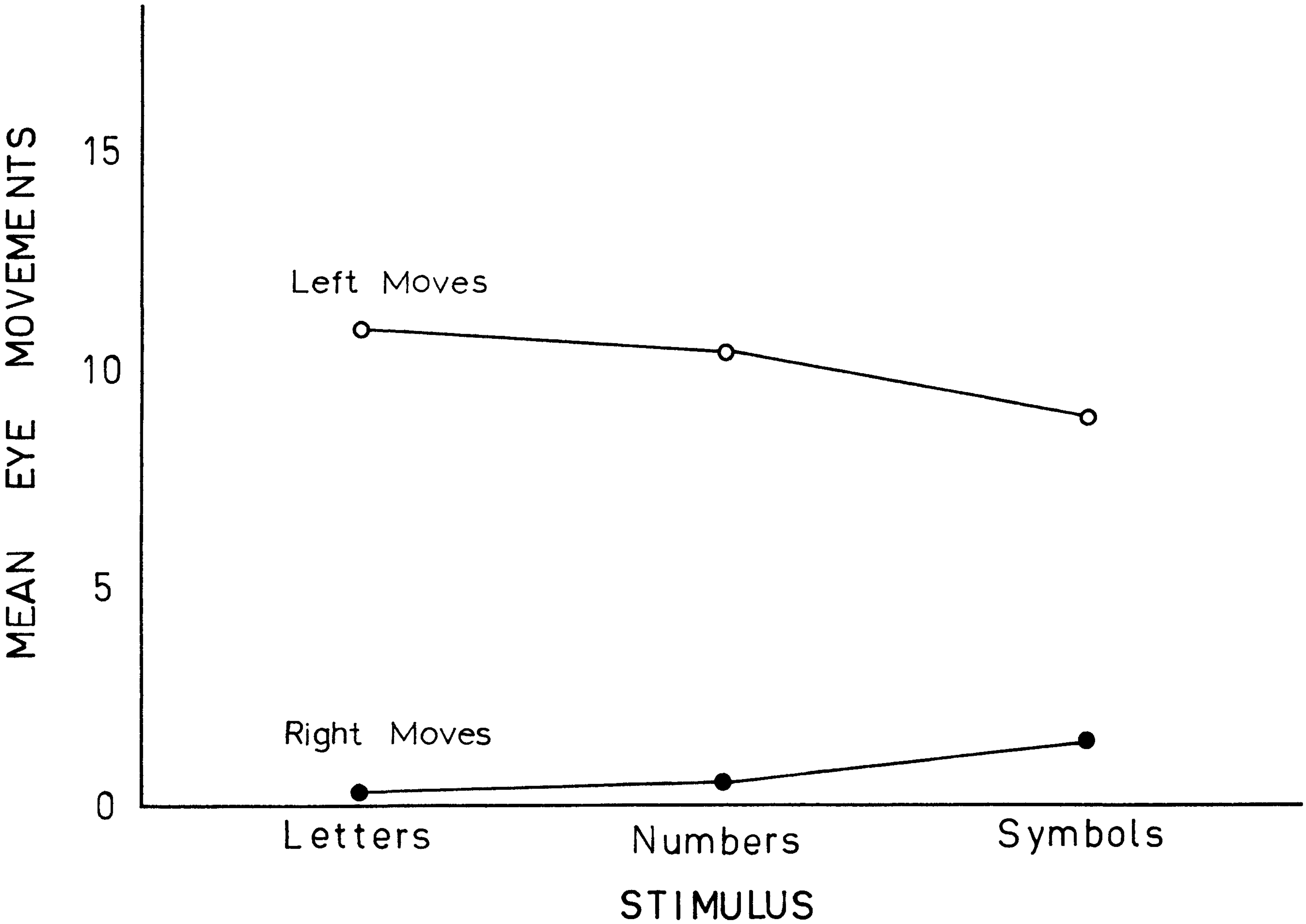
Bilateral presentation   Analysis of variance (Appendix A) for sums of correctly reported elements indicated an overall LVF superiority ($p<.01$), significant differences among types of stimulus element ($p<.01$), and an interaction between element type and field locus ($p<.05$).

Despite the overall LVF superiority obtained, the source of significance was not attributable to symbolic stimuli. Scores for symbolic material did not demonstrate LVF superiority ($p>.05$) and were significantly lower ($p<.05$) than those recorded for alphanumeric material. Equivalent performance was attained for letters and numbers.

Figure 4 portrays the superior LVF recognition obtained with alphanumeric stimuli. The interaction is evident here as a strong depression of LVF accuracy and a slight elevation in RVF accuracy for symbols.

Unilateral Presentation   Analysis of variance (Appendix A) of sums of correctly reported letters indicated superior RVF accuracy ($p<.01$). Mean sum correct elements for the LVF was $\bar{x} = 18.6$ versus $\bar{x} = 38.5$ for the RVF out of a possible total of 54 for each field.

FIG. 5. EM data for bilateral presentation.


MEAN EYE MOVEMENTS
15
10
5
0
Left Moves
Right Moves
Letters
Numbers
Symbols
STIMULUS

Eye Movement

Scorable EM as defined in the Method occurred on 79.1% of the trials. The 20.9% no movement (NM) figure compares favourably with Crovitz and Daves (1962) 30% and Bryden's (1960) 22.6%. Eye blink constituted 33% of the NM.

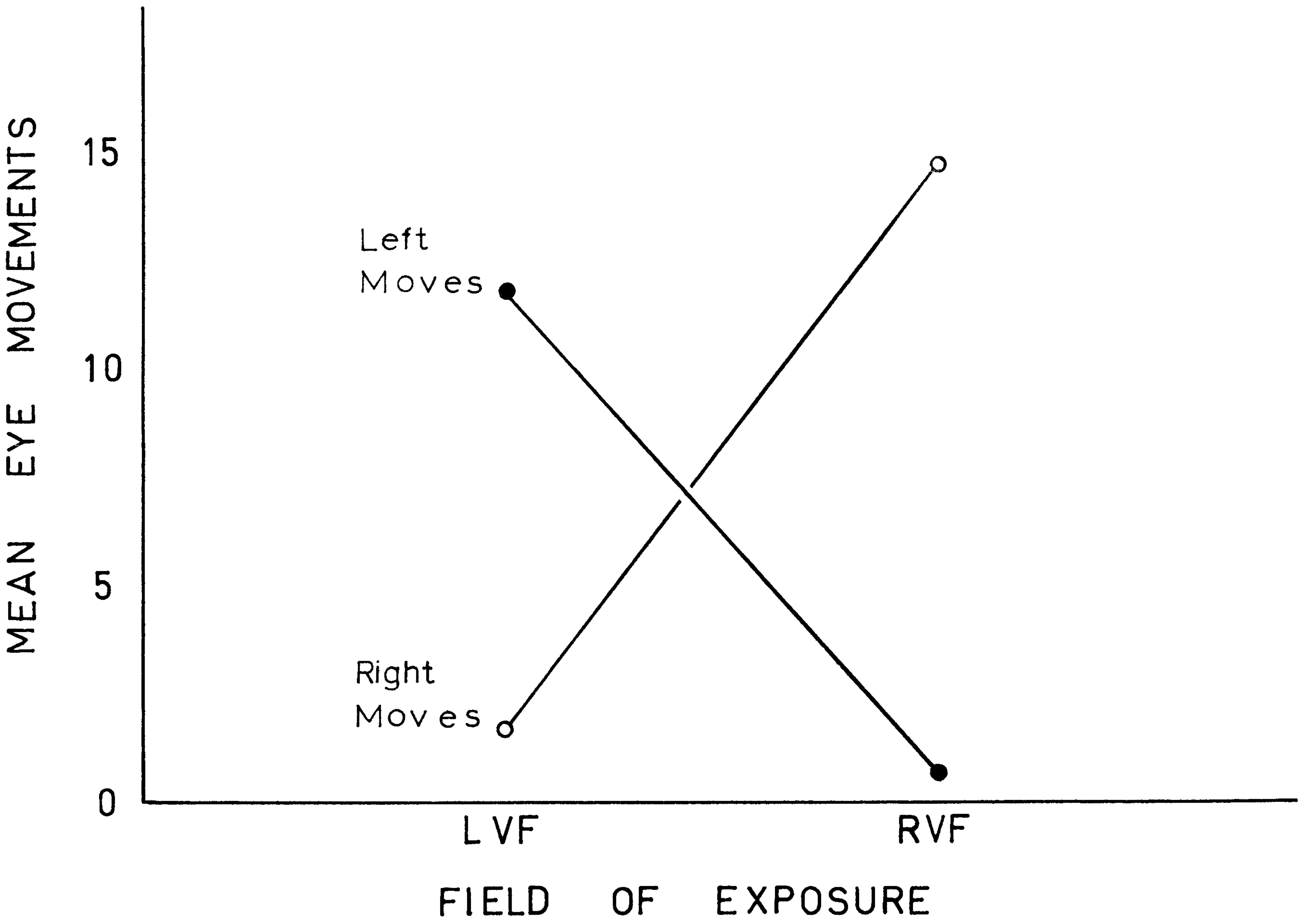
EM direction: bilateral The analysis for EM must be viewed with some caution due to the number of *Ss* with zero EM scores for the right field (letters, 6 *Ss*; numbers, 5 *Ss*; symbols, 1 *S*). With letter and number stimuli the remaining *Ss* made very few right moves (total of 9, $\bar{x} = 1.8$, range 1-4). A total of 17 right moves ($\bar{x} = 2.4$, range 1-5) occurred following symbolic stimuli, approximately twice that evoked by letters and numbers combined.

Zero scores notwithstanding, the ANOVA (Appendix A) in conjunction with Figure 5 does appear to represent the data well. Movements to the LVF predominate ($p < .01$) with no significant differences ($F < 1$) between types of element (see Table 2). An interaction exists between direction of first EM and stimuli.

These relations are depicted in Figure 5. The interaction again arises from a depression of LVF scores and an increase in RVF scores for symbols. To a lesser and not significant extent, a similar shift occurs for numbers.

Unilateral presentation No overall differences between field of presentation or direction of first EM were

FIG. 6. EM data for unilateral presentation.


MEAN EYE MOVEMENTS
15
10
5
0
Left
Moves
Right
Moves
LVF
RVF
FIELD OF EXPOSURE

revealed by the ANOVA (Appendix A). the number of zero scores for EM to left field with RVF stimulation coupled with low scores for EM to the right field with LVF stimulation produced a strong interaction ($p < .05$). The interaction between field and direction of first EM (Figure 6) effectively nullified differences within the data. With LVF presentation, *Ss* averaged $\bar{x} = 12.6$ left EM and $\bar{x} = 2.5$ right EM. Presentation in the RVF evoked $\bar{x} = 14.5$ right EM and only $\bar{x} = 1.0$ left EM (see Table 2). Total possible EM score was 16.

First EM and Recognition: Correlation

Bilateral presentation For the combined data of letters, numbers and symbols correlation of sums of elements correctly reported in the LVF with scores for left EM resulted in a coefficient of $r = +.49$ ($p < .01$). Left EM correlated $r = -.14$ ($p > .05$) with RVF recognition.

The absolute value of the coefficient obtained in comparing RVF recognition with EM to the right ($r = +.13$, $p > .05$) is probably spurious due to the large number of zero movement scores (12 with n = 24). The correlation of LVF recognition with right EM ($r = -.50$, $p < .01$) must similarly be viewed with caution. However, the coefficients do appear to accurately reflect the form of the data.

The proportion of EM made to each field is reported in Table 2.

It was intended that individual Pearson Product-Moment

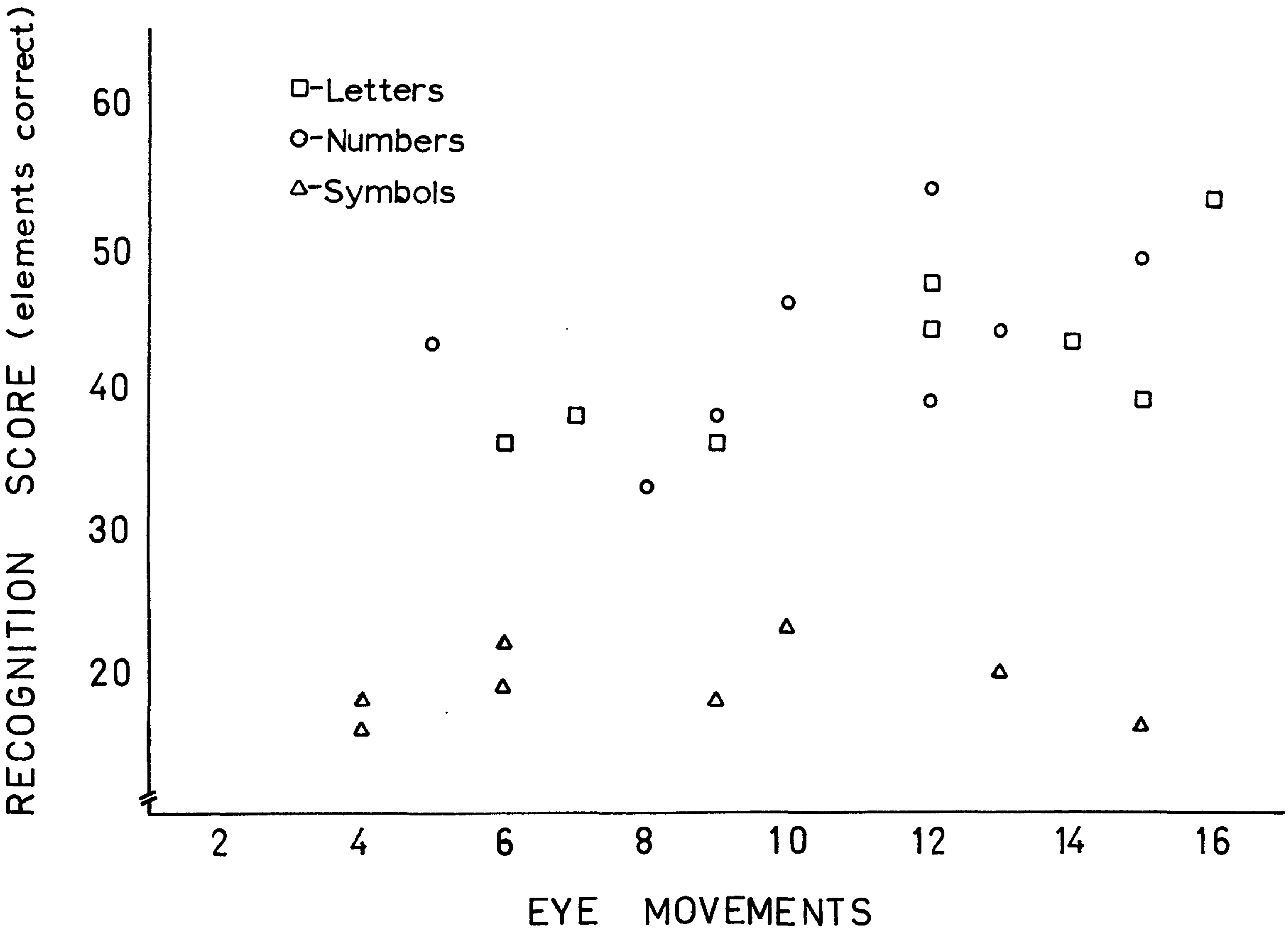
TABLE 2

PROPORTIONS OF OCULOMOTOR RESPONSES

Bilateral Presentation			
	Letters	Numbers	Symbols
Left EM	71.1%	65.6%	52.3%
Right EM	3.1%	4.7%	13.3%
NM	21.9%	22.7%	33.6%
Eye Blink	4.7%	7.0%	1.6%

Unilateral Presentation		
	Left	Right
Left EM	78.9%	6.3%
Right EM	15.6%	90.6%
NM	3.9%	1.6%
Eye Blink	1.6%	1.6%

FIG. 7. Scatterplot of recognition scores versus number of EM: bilateral presentation.



□-Letters
○-Numbers
△-Symbols
RECOGNITION SCORE (elements correct)
60
50
40
30
20
2
4
6
8
10
12
14
16
EYE MOVEMENTS

correlations be reported for all combinations of EM direction and recognition within each element type. For letters and numbers only LVF scores and left EM were validly compared. Again, the large number of zero right EM scores invalidated further comparisons. LVF recognition for letters correlated *r*= + .72 ($p < .05$) with left EM. Left EM was also correlated with LVF recognition for numbers but the relation was not significant (*r*= + .46).

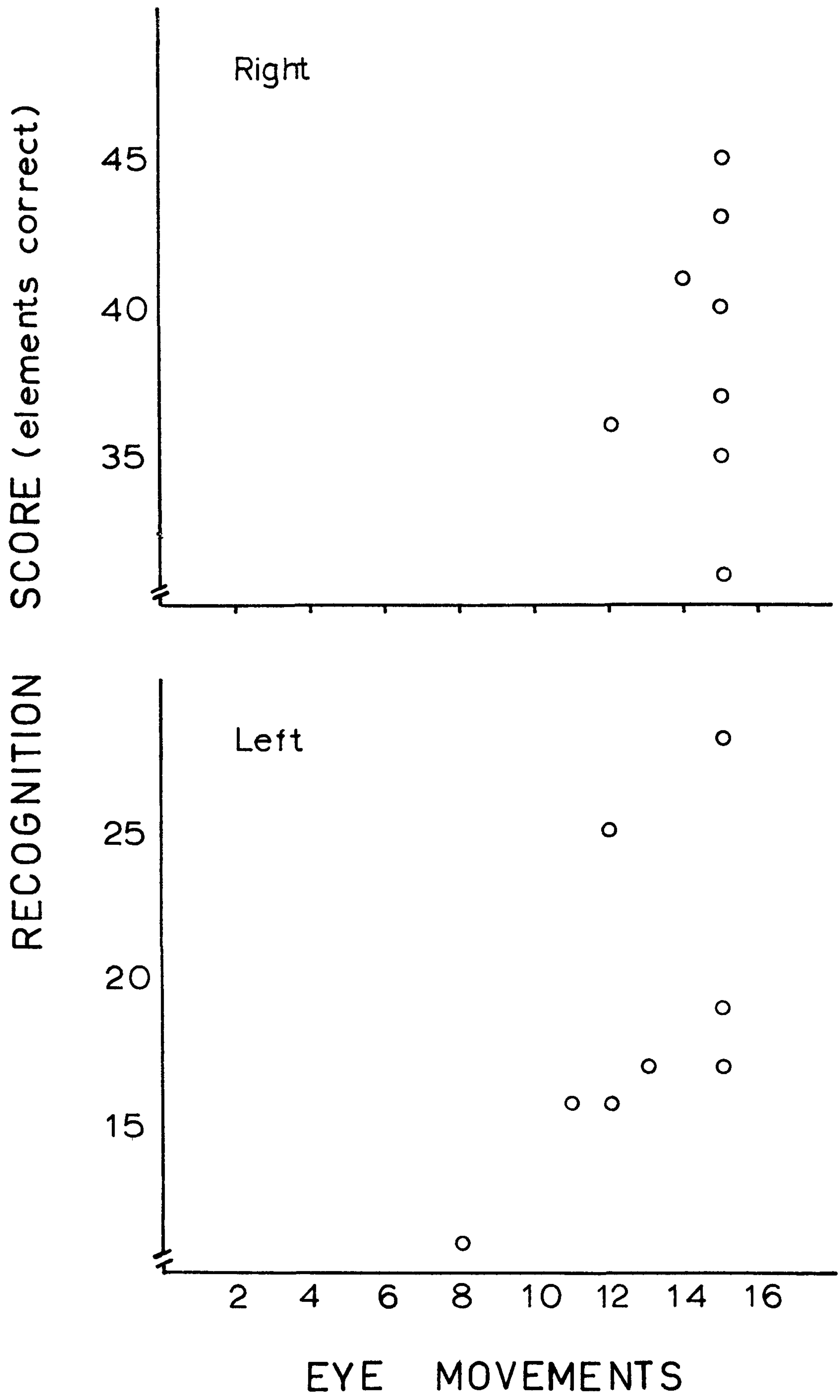
Recognition of symbols in either field is not significantly related to first EM direction. The correlation was *r*= + .014 for the LVF and *r*= + .044 for the RVF.

Data for all comparisons are plotted in Figure 7.

Unilateral presentation The Pearson *r* could not validly be computed for the unilateral condition. With RVF presentation, six of the eight *S*s produced EM to the right on 15 of the 16 trials. The remaining 2 *S*s produced 12 and 14 right EM ($\bar{x}$ = 14.5). First EM was slightly less reliable for LVF presentation ($\bar{x}$ = 12.6 , range 8-15). Scatterplots, (Figure 8) display the close grouping of EM scores for both fields.

The proportions of first EM to each field provide a meaningful description of the results (Table 2). On trials with exposure of letter material in the LVF, approximately 79% of first EM was to the left. Right moves were evoked following approximately 91% of the RVF presentations.

FIG. 8. Scatterplots of recognition scores versus number of EM: unilateral left and right presentation.


Right
Left
RECOGNITION SCORE (elements correct)
45
40
35
25
20
15
2
4
6
8
10
12
14
16
EYE MOVEMENTS

EM Latency

Bilateral presentation Mean EM latencies for the three stimulus types were: letters, $\bar{x}$ = 295.7 msec.; numbers, $\bar{x}$ = 291.8 msec.; symbols, $\bar{x}$ = 397.0 msec. The corresponding coefficients of variation were nearly identical: letters, *CV* = 36.7%; numbers, *CV* = 39.3%; symbols, *CV* = 38.6%. These figures are indicative of a reasonable degree of internal consistency.

The ANOVA (Appendix A) did not indicate any significant differences between types of stimuli. When latencies for symbols were compared (Sandler's *A*) with latencies for either numbers or letters the null result of the ANOVA was verified.

Unilateral presentation Nearly identical mean EM latencies resulted from LVF and RVF presentation (LVF, $\bar{x}$ = 180.32 msec.; RVF, $\bar{x}$ = 182.24 msec.). The *F* derived in the ANOVA was, predictably, less than one.

Coefficients of variation computed for unilateral scores were also relatively low and quite similar (LVF, *CV* = 28.3%; RVF, *CV* = 35.4%).

The brief mean latencies obtained with unilateral presentation are significantly shorter than those evoked by bilateral presentation of letter stimuli (Sandler's *A*, $p < .05$ for either field).

EM latency and recognition Latency did not relate to recognition accuracy for mode of presentation or field.

All correlations of EM latency and accuracy scores were close to zero. Disregarding sign, the average correlation was .055 in a range from *r*= + .016 to *r*= - .14.

Blank Exposures

Out of a total of 64 trials for all *Ss*, 14 EM were made within one second after a blank exposure. Nine movements (64%) were made to the left and 5 (36%) to the right. Four *Ss* made one move, 2 *Ss* made 2 moves and 2 made 3 moves. Mean latency was $\bar{x}$ = 500.7 msec. with a range of 170 msec. to 1,000 msec. and a standard deviation of 298.6. The *CV* was 59.6%.

No written responses were made following blanks.

One Second Exposure

Recognition scores: bilateral   Scores for the LVF were uniformly high for all *Ss* (range 20-24, *CV* = 6.5%) averaging $\bar{x}$ = 22.8 with a possible total of 24. RVF recognition with $\bar{x}$ = 11.8 (range 5-15, *CV* = 27.6%) was significantly lower (Sandler's *A*, two tail test, $p<.01$).

Recognition scores: unilateral   High accuracy was attained for both fields, resulting in means of $\bar{x}$ = 22.6 for the LVF and $\bar{x}$ = 23.4 for the RVF. Scores in the LVF ranged from 19 to 24 (*CV* = 8.2%) and from 22 to 24 in the RVF (*CV* = 3.9%).

EM direction: bilateral   Left moves constituted

95.8% of all initial EM. Only one right move and one NM were recorded.

The second movement occurred to the right on 70.8% (CV = 44.9%) of trials and to the left on 16.7%. There were no second moves on 12.5% of the trials.

EM direction: unilateral Initial EM to the field of exposure occurred on 95.8% of trials for both fields. Two right moves occurred with LVF presentation. One left move and one NM followed RVF exposure.

Second EM to the right followed 70.8% of LVF trials ($\bar{x}$ = 4.5, range 1-6, CV = 44.9%) and 60.4% of RVF trials ($\bar{x}$ = 3.6, range 1-6, CV = 50.9%). No second movement occurred on 12.5% of LVF trials and 22.9% of RVF trials.

Initial EM latency Overall mean latency for bilateral presentation was $\bar{x}$ = 226.4 msec. Subject mean latencies ranged from 169.0 msec. to 290.8 msec. with a CV = 19.8%.

RVF unilateral presentation resulted in an overall mean latency of $\bar{x}$ = 153.0 msec. with a range of S means from 107.5 msec. to 177.0 msec. (CV = 14.2%). The mean for LVF presentation ($\bar{x}$ = 160.3 msec) was not significantly different from the RVF mean. Subject LVF means ranged from 113.3 msec. to 191.9 msec. with a CV = 17.1%.

Unilateral LVF first movement latencies were significantly shorter than the initial EMs following bilateral presentation (Sandler's A, two tail test, $p<.01$).

Second EM latency   Overall mean latencies were similar for both bilateral and unilateral stimuli. The mean for bilateral was $\bar{x}$ = 743.1 msec.; for unilateral RVF, $\bar{x}$ = 699.1 msec.; and for LVF, $\bar{x}$ = 733.6 msec.

Although the direction and number of second EMs were quite variable (reported above) the variability of the latencies recorded was low: bilateral, CV = 14.1%; unilateral RVF, CV = 24.0%; unilateral LVF, CV = 9.3%.

Results II

The published curves for accuracy scores as a function of element position (e.g., Figure 9; Bryden, 1966a) display a characteristic and intriguing shape. If the proposed scanning mechanism does attend to the elements in the array sequentially from right to left, and if lateral differences are based on a trace decay factor, then one might predict a smooth drop-off in accuracy from position 1 to the position furthest right. This is not the case in the published curves.

Thus, by plotting the functions for grouped data we may look to see if the pattern of accuracy obtained by prior investigations prevails for the present study. In addition, we may discern the extent to which the function is typical for the individual S.

The curve derived from group data for letters

FIG. 9. Typical field position recognition curves for bilateral stimuli (derived from Bryden, 1966a) and unilateral stimuli (derived from Bryden, 1966b).

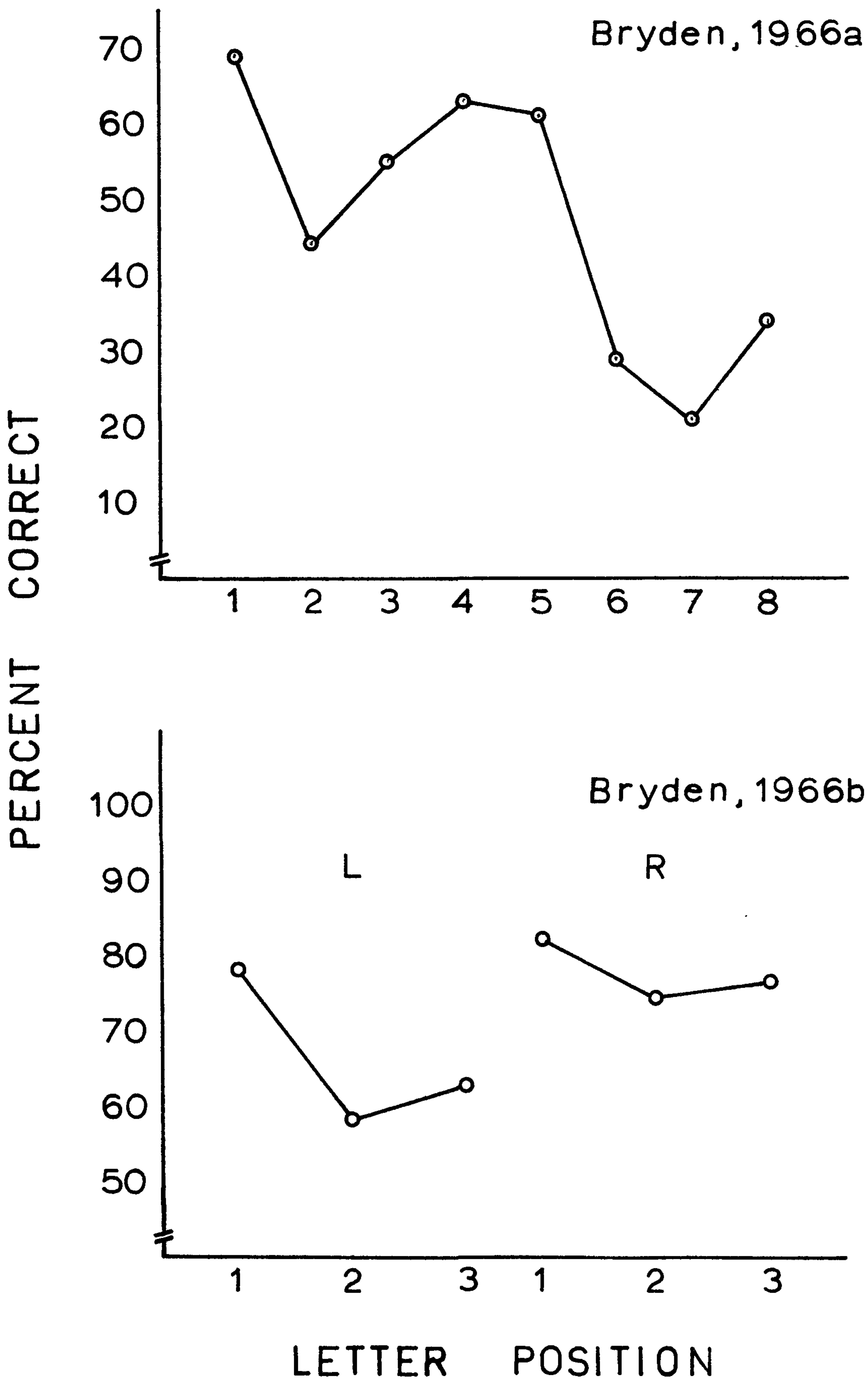

Bryden, 1966a
70
60
50
40
30
20
10
1 2 3 4 5 6 7 8
PERCENT CORRECT
Bryden, 1966b
100
90
80
70
60
50
L
R
1 2 3 1 2 3
LETTER POSITION

FIG. 10. Field position recognition curve for bilateral letters based on group data.

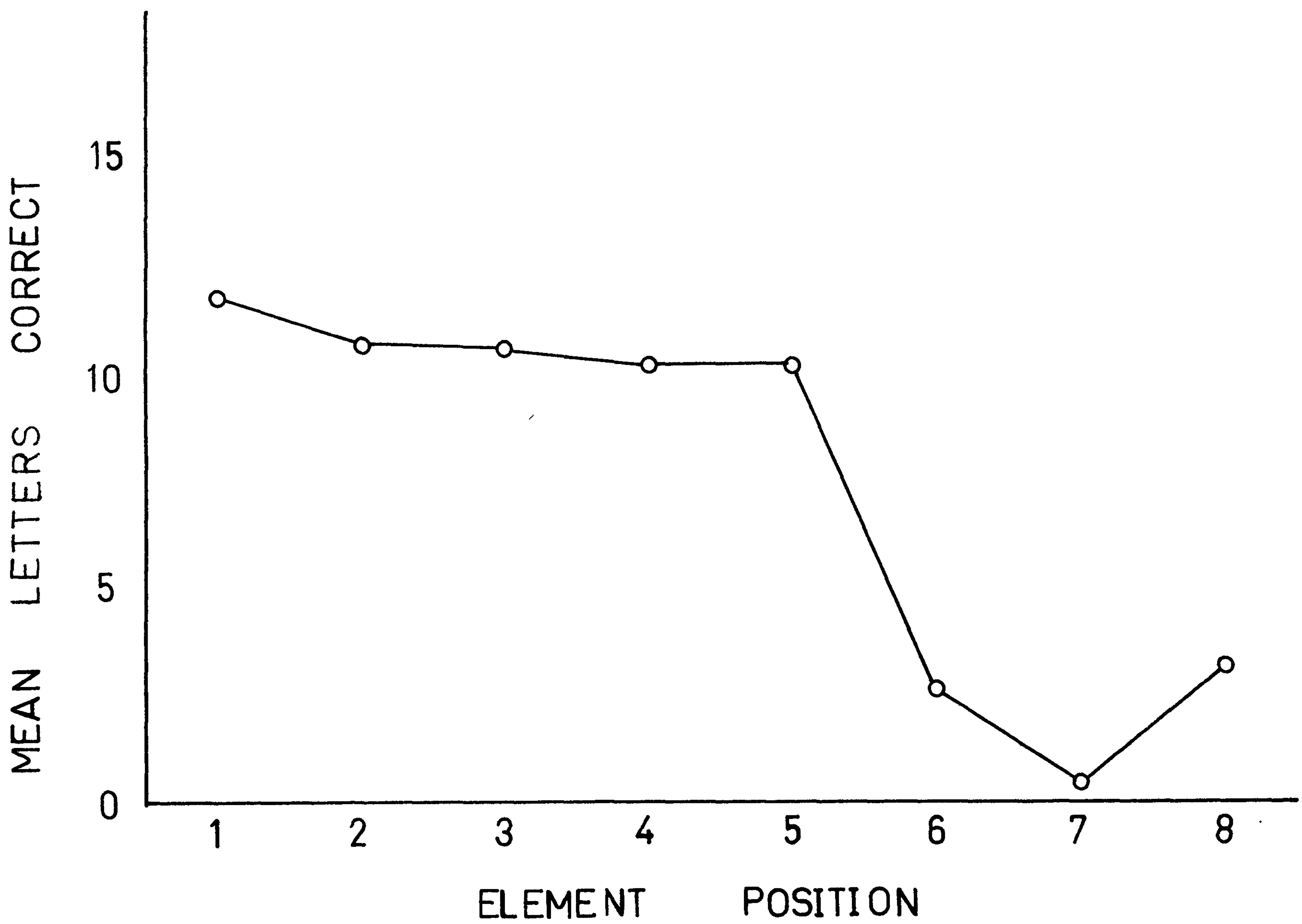

MEAN LETTERS CORRECT
0
5
10
15
1
2
3
4
5
6
7
8
ELEMENT POSITION

FIG. 11. Field position recognition curve for bilateral numbers based on group data.

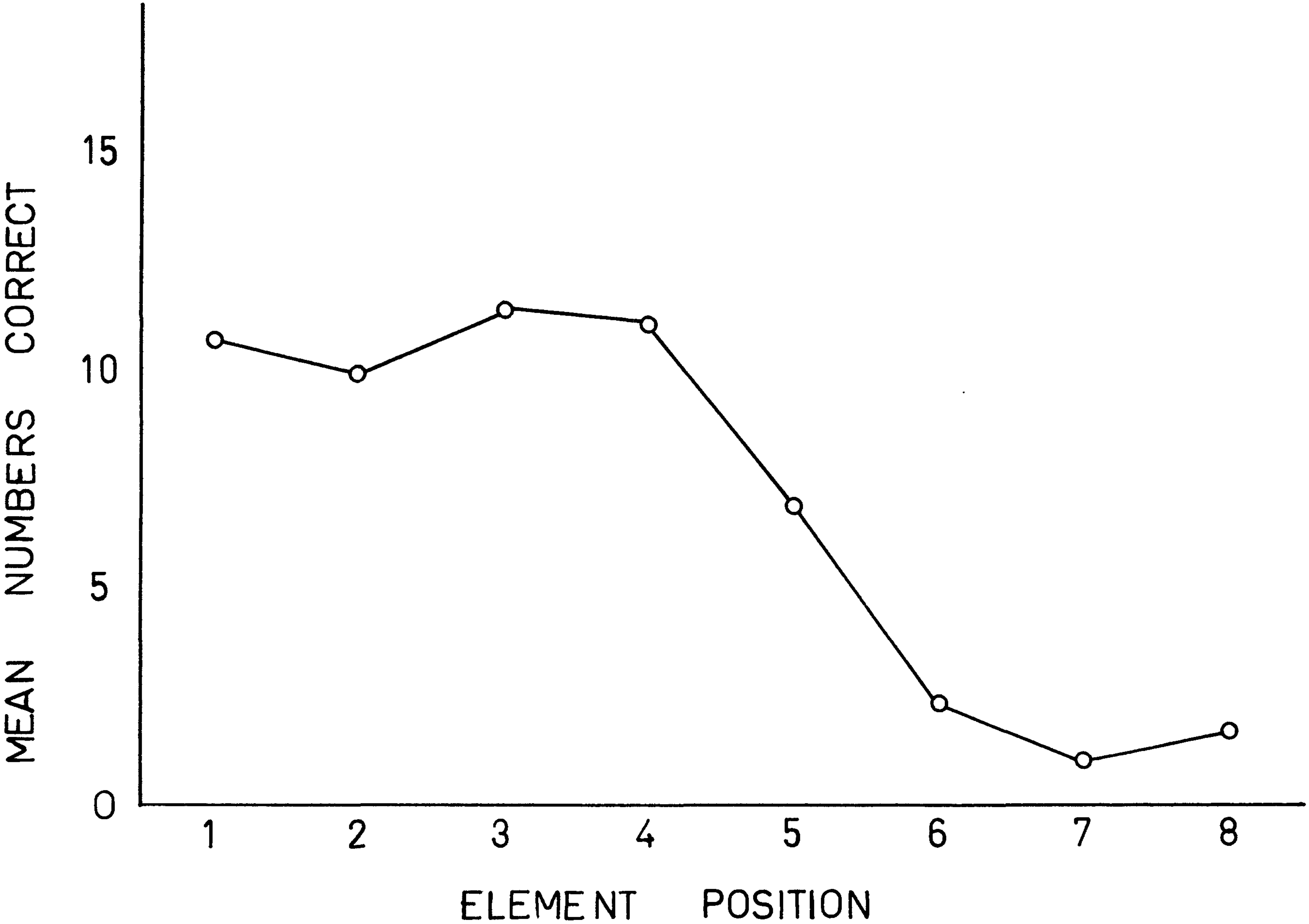

MEAN NUMBERS CORRECT
0
5
10
15
1
2
3
4
5
6
7
8
ELEMENT POSITION

FIG. 12. Field position recognition curve for bilateral symbols based on group data.

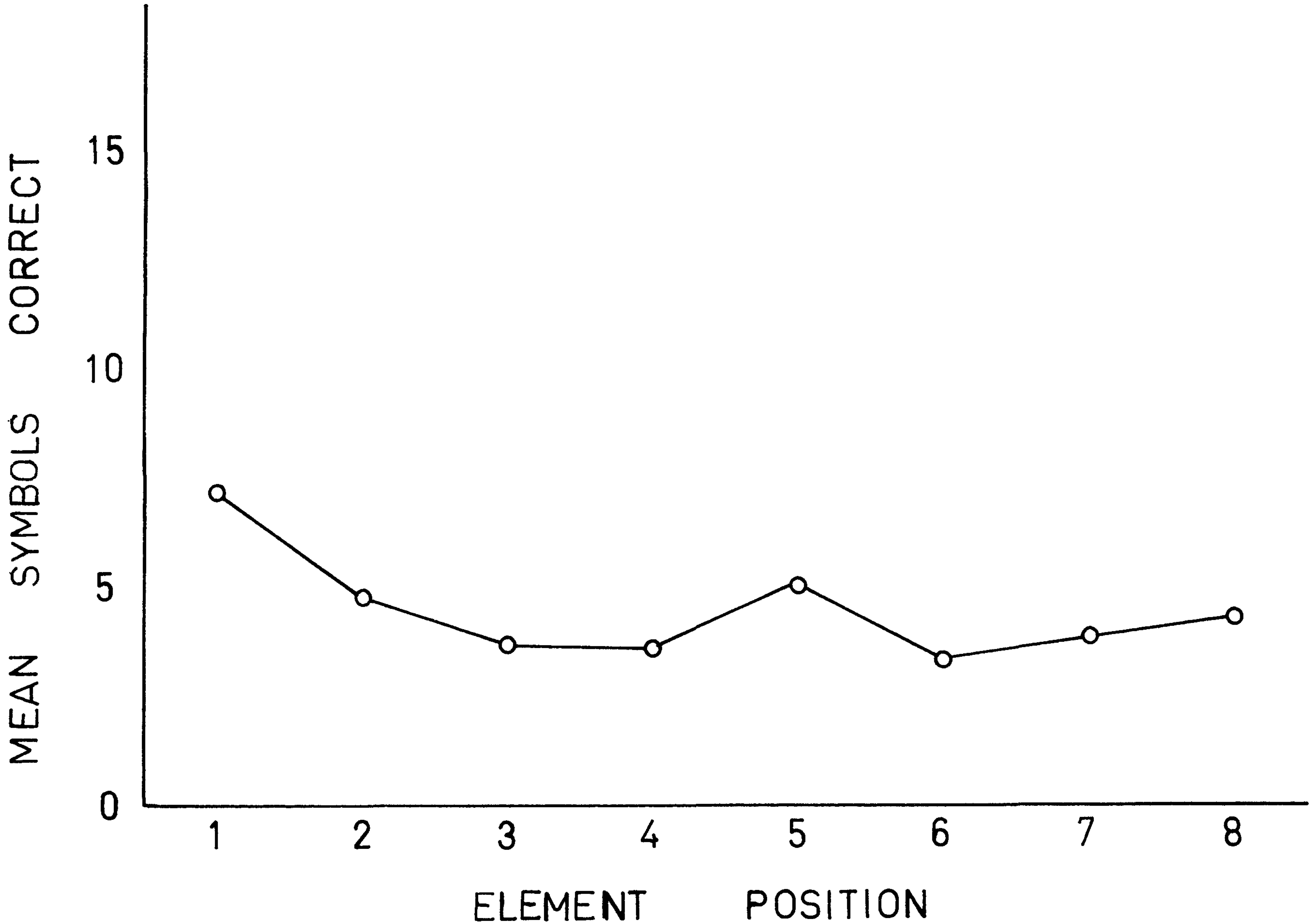

MEAN SYMBOLS CORRECT
0
5
10
15
1
2
3
4
5
6
7
8
ELEMENT POSITION

FIG. 13. Field position accuracy for bilateral letters: individual Ss.

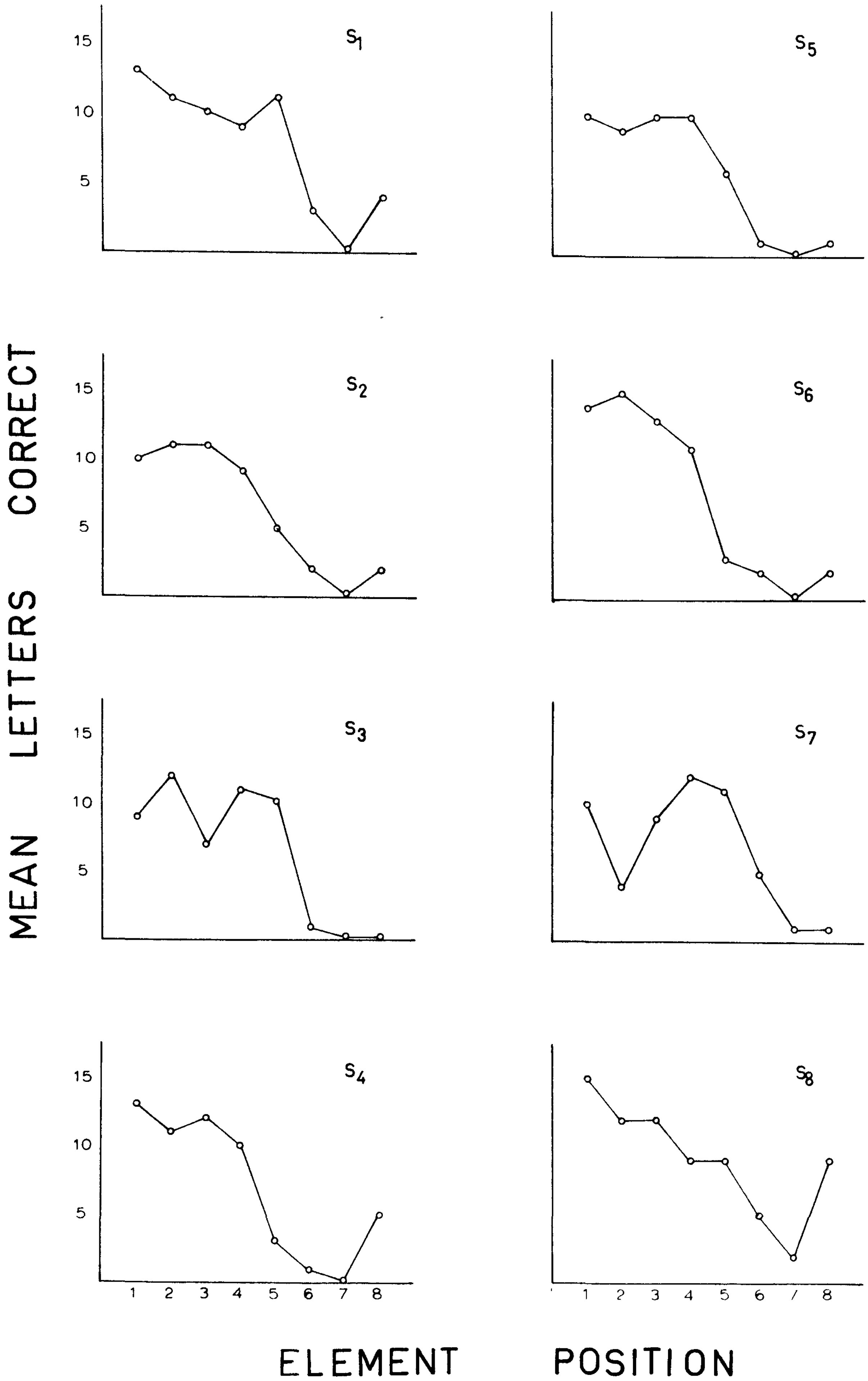

MEAN LETTERS CORRECT
ELEMENT POSITION
S_1
S_5
S_2
S_6
S_3
S_7
S_4
S_8
15
10
5
1 2 3 4 5 6 7 8

FIG. 14. Field position accuracy for bilateral numbers: individual *S*s.

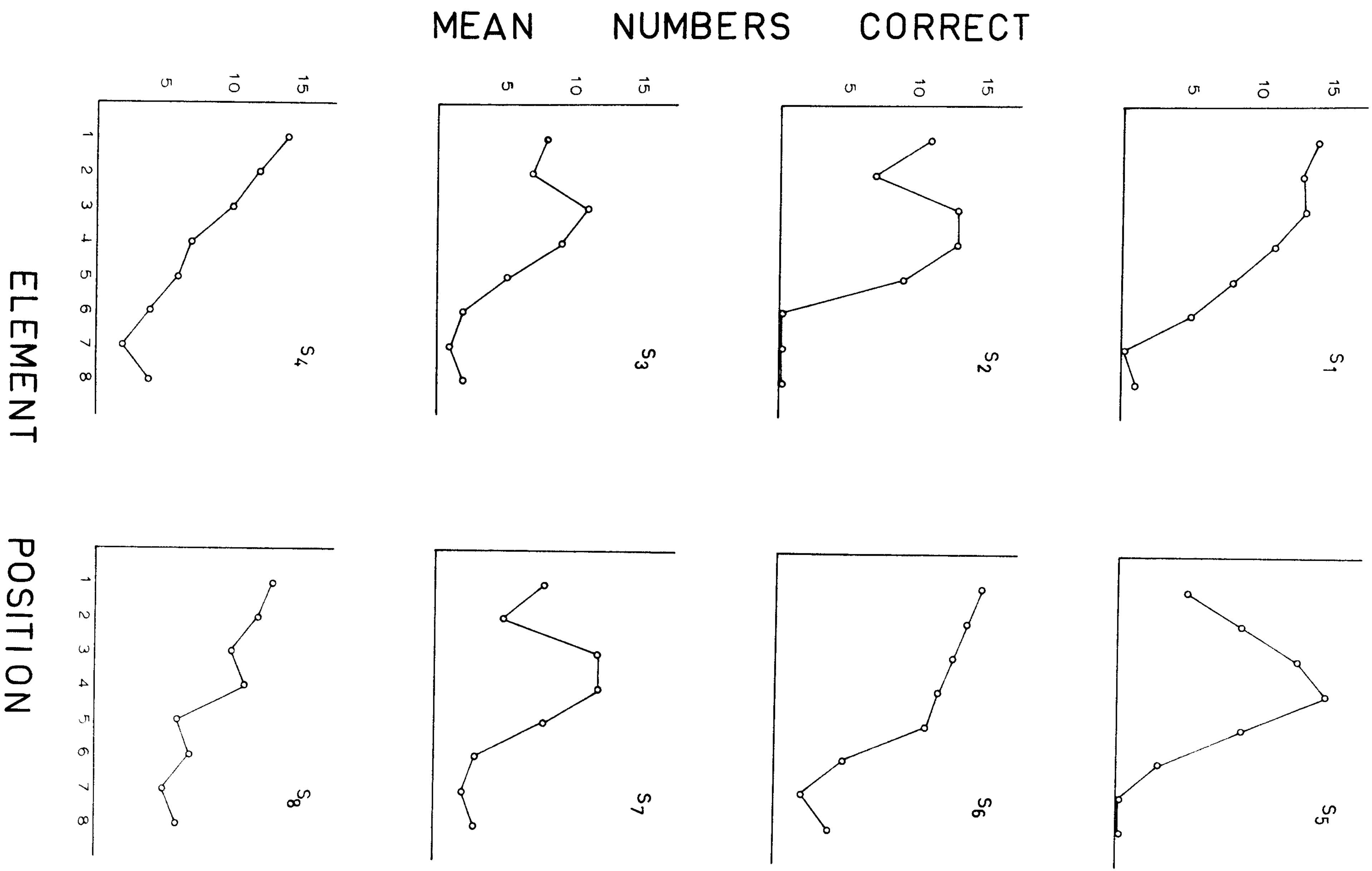
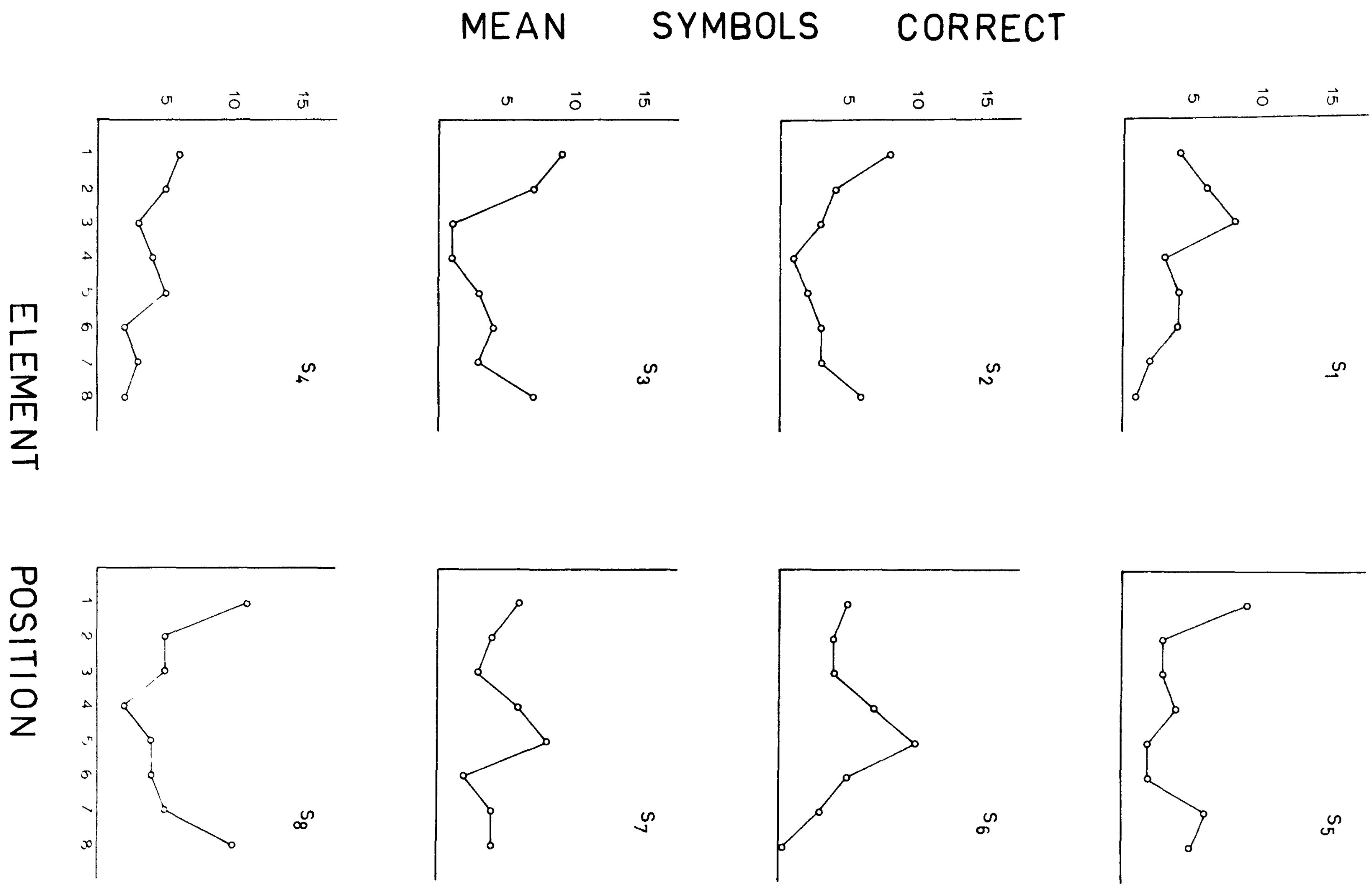

MEAN NUMBERS CORRECT
ELEMENT POSITION
S_1
S_2
S_3
S_4
S_5
S_6
S_7
S_8
5
10
15
1
2
3
4
5
6
7
8

FIG. 15. Field position accuracy for bilateral symbols: individual Ss.



MEAN SYMBOLS CORRECT
ELEMENT POSITION
S_1
S_2
S_3
S_4
S_5
S_6
S_7
S_8
5
10
15
1
2
3
4
5
6
7
8

(Figure 10) suggests uniformly high accuracy to position 5 and then a sharp decrement. Group accuracy for numbers (Figure 11), however, follows much the same pattern as the published curves, including a dip at position 2, recovery for positions 3 and 4 and then a decrement in the RVF.

The quite different function derived for symbols (Figure 12) indicates primacy for position 1 coupled with some sharpening at position 5.

For all three types of stimuli, the curves demonstrate a recency effect at position 8.

Inspection of the individual S's graphs engenders some doubt about the generality of the curves for group accuracy. With letter stimuli (Figure 13), Ss 4, 5 and 7 roughly approximate the published curves and S 1 bears some similarity to the group curve but the rest are divergent. Primacy for position 1 is not necessarily a rule (Ss 2, 3 and 6) nor is recency, being completely absent for Ss 3 and 7 and negligible for Ss 5 and 6.

Field position accuracy is equally variable for numbers (Figure 14). As with letters, an overall LVF superiority emerges but accuracy at the four LVF positions is highly variable both within and between Ss. Subject 5 presents a unique pattern of response accuracy.

Individual curves for symbols (Figure 15) generally reflect the shape of the mean curve, the tendency to increased accuracy at the ends of the array occurring in six of eight graphs.

A tendency to accuracy near fixation is evident for Ss 4, 5, 6 and 7 but this is offset by a depression in central accuracy in the remaining four records.

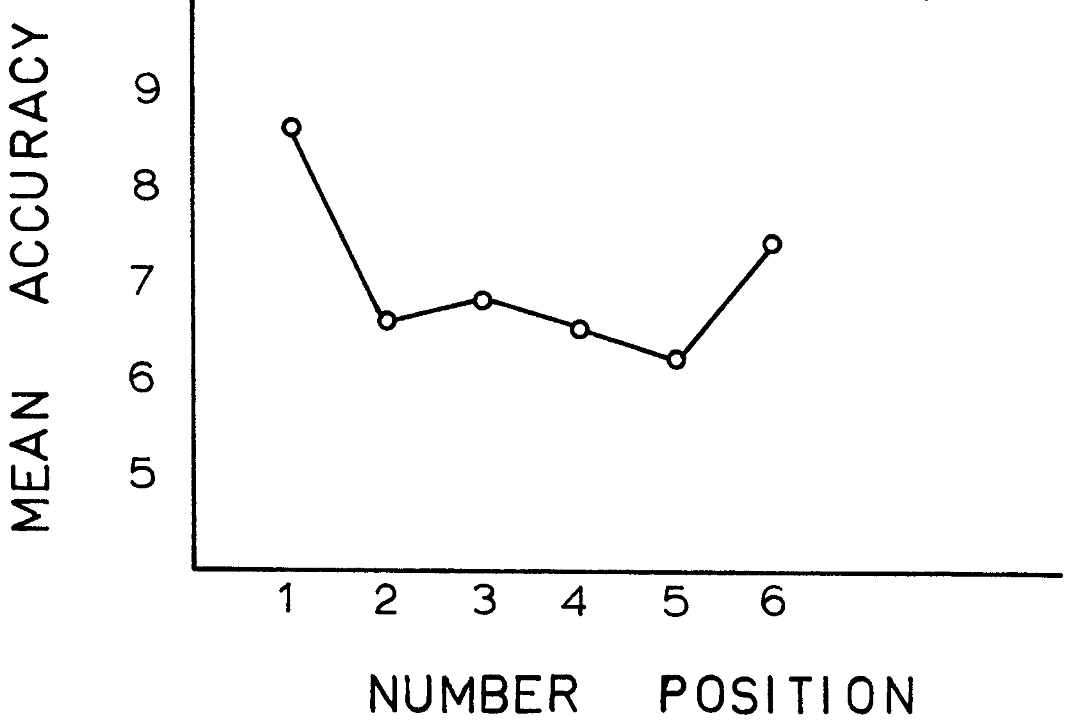
The only published curve that bears any direct resemblance to the curves for symbols denotes the effect of wide spacing between elements on accuracy (Figure 16; Bryden, 1966a). Although inverse, the error function derived by Harcum (Figure 16; Harcum, 1969) for his 28 element arrays indicates accuracy near fixation similar to Ss 6 and 7.

Subjects' performance with symbolic stimuli suggests that the recognition process is operating differently for this material. Not only are there no lateral differences, but EM latencies are longer (letters $\bar{x}$= 295.7, numbers $\bar{x}$= 291.8, symbols $\bar{x}$=397.0), there are more right moves, fewer left moves and more NM (Table 2). Although none of these results are statistically significant, in combination they cannot be ignored.

In contrast, the results for letters and numbers, albeit variable, do exhibit superiority for the LVF. Inspection of the individual curves suggests that some Ss maintain a high level of accuracy across the LVF and into the RVF. The sharp decrement in performance for the RVF does not occur until after position 5 (letters: Ss 1, 3, 7 and 8; numbers: Ss 2, 6 and 7). Further, the sequentially distributed drop-off in accuracy that was suggested as being prototypical for information loss due to the interaction

FIG. 16. Field position accuracy curves bearing some resemblance to the present results for bilateral symbols. Derived from Bryden _et al_., 1968; reproduced from Harcum, 1969.

Bryden et al, 1968



Harcum, 1969

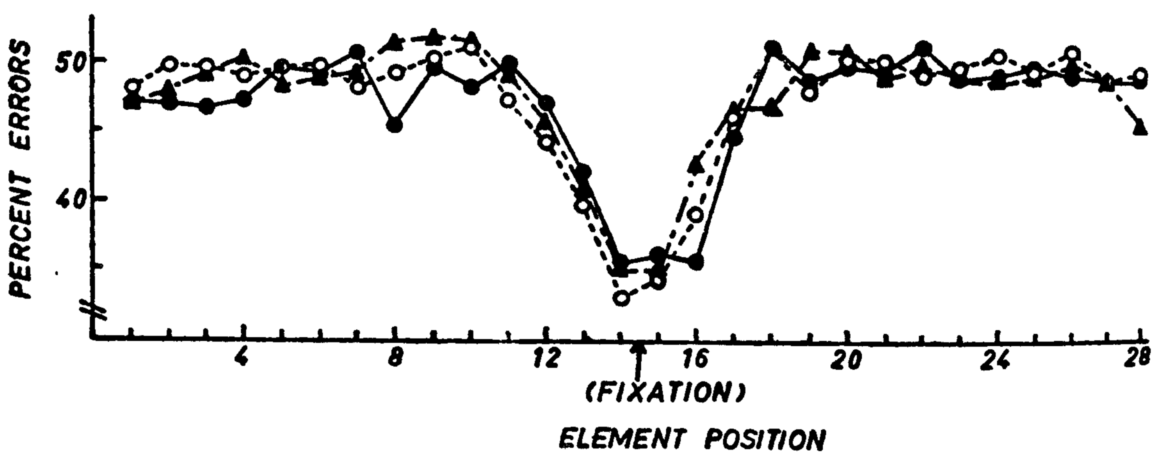
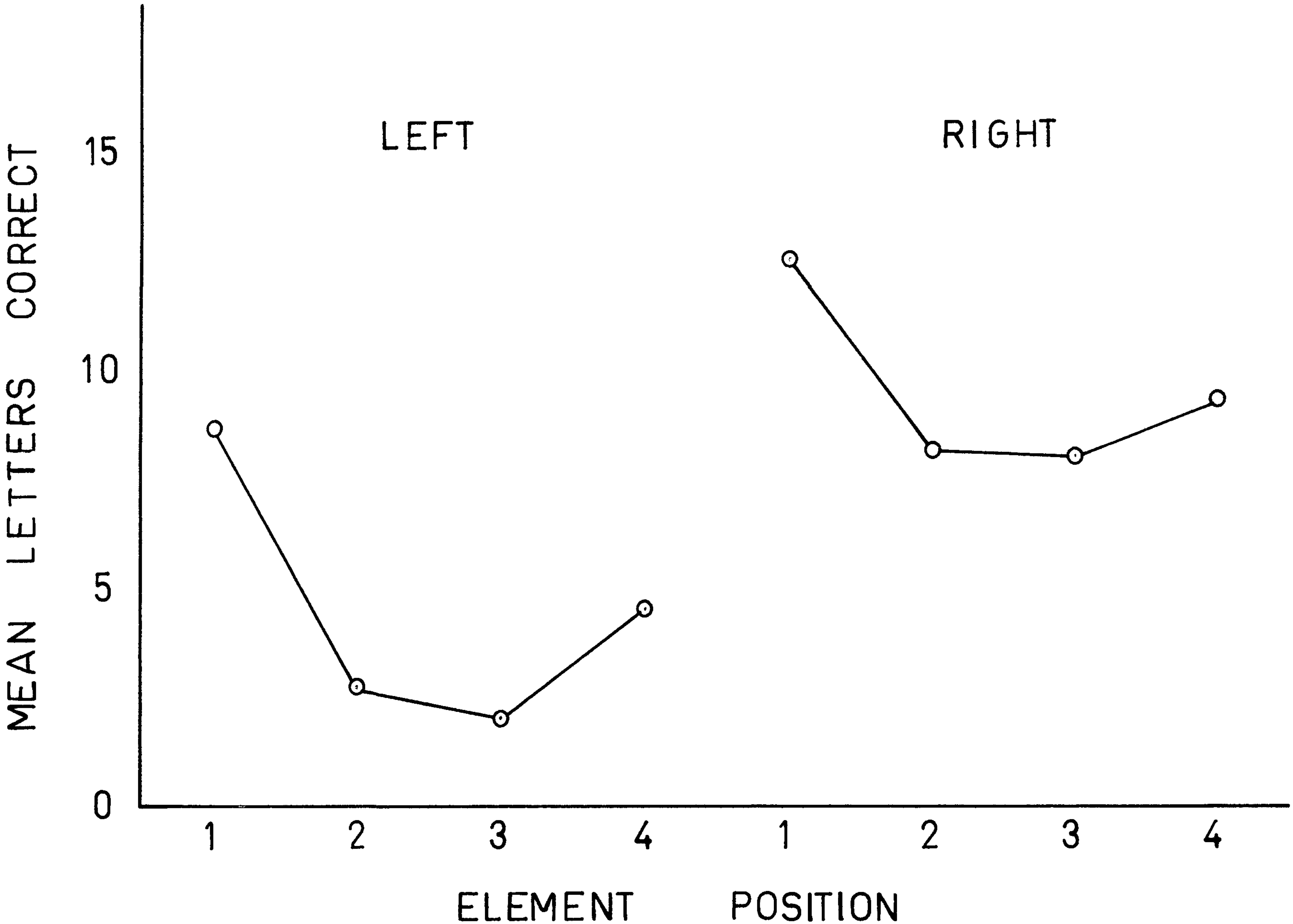


FIG. 17. Field position accuracy for unilateral presentation based on group data.



LEFT
RIGHT
15
10
5
0
MEAN LETTERS CORRECT
1
2
3
4
1
2
3
4
ELEMENT POSITION

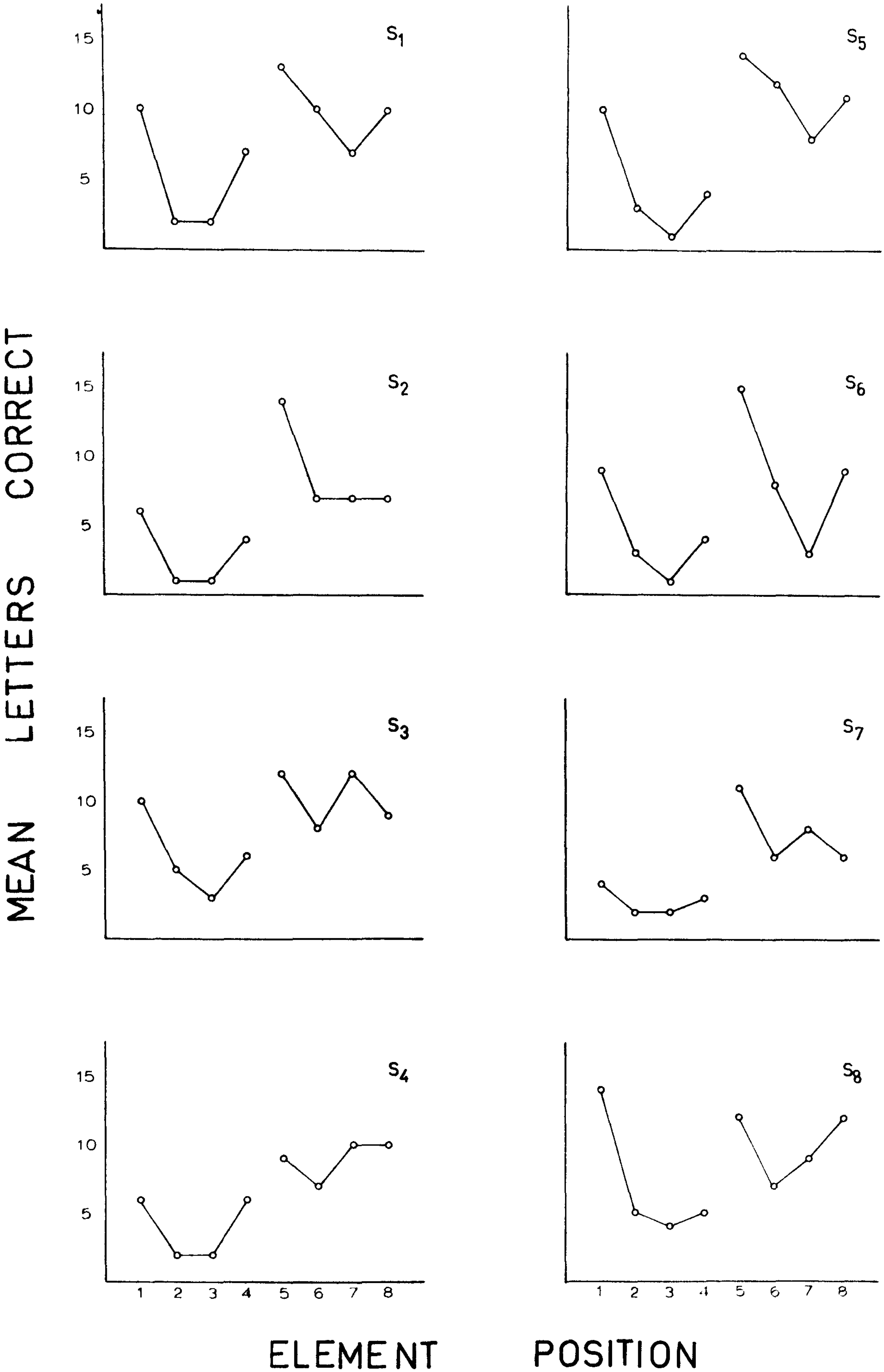
of scanning and trace decay is approximated in many of the graphs, particularly in Ss 1, 4, 6 and 8 for numbers and in Ss 2, 5, 6 and 8 for letters.

The most obvious feature of Ss' performance on symbols is the degree of accuracy at the ends of the array. From the curves it might be concluded that the Ss were simultaneously accurate at both ends. Inspection of the raw data (Appendix B), however, reveals that accuracy favored either one end or the other on any given trial. Occasionally, Ss did report only the first and last elements.

Turning to the graphs for unilateral presentation we find a reasonable degree of comparability. The group curves (Figure 17) and the published example (Figure 9; Bryden, 1966b) are very similar. Here, the primacy-recency effect is obtained with arrays of only three or four elements. Overall, the curves reflect the somewhat greater consistency obtained in scores for unilateral presentation. Subject variation (Figure 18) is less pronounced although this may be a function of the fewer degrees of freedom associated with the small arrays.

The variability described for bilateral stimuli suggested a further analysis of S performance based on ranked scores. If tachistoscopic recognition accuracy is related to post-exposural EM then some consistency might be expected in the rank ordering. For example, the most accurate S might also rank high in number of congruent EM and low in latency.

FIG. 18. Field position accuracy for unilateral presentation: individual _S_s.



MEAN LETTERS CORRECT
S1
S2
S3
S4
S5
S6
S7
S8
5
10
15
1 2 3 4 5 6 7 8
ELEMENT POSITION

However, comparison of the ranks (Spearman's *rho*, Wilcoxon's signed-ranks test; Siegel, 1956) did not reveal systematic relations.

Discussion

Simply stated, the purpose of the study was to provide demonstration and analysis of post exposural EM elicited by a procedure designed to detect lateral differences in visual field recognition. As such, the experiment was successful, although the results did not completely fulfil prediction.

With the exception of the results for symbols, the pattern and extent of lateral differences generally conform to those obtained by previous investigators. Thus, for letters and numbers, and for both modes of presentation, the accuracy-EM relation can be discussed with confidence. The unconventional results obtained with symbols are not considered a liability. On the contrary, these data serve as a fruitful source of new hypotheses.

The EM data provide ample evidence that a consistent EM behaviour is evoked by tachistoscopic exposures, but the implication of the results with regard to recognition accuracy requires clarification. In order to provide a reference for discussion of the EM, and because the recognition data encompass more than simple corroboration of previous investigations, these results will be discussed first. Discussion of data for the one second exposure will be reserved until last since the procedure conforms more closely to normal reading tasks and provides results that consolidate the impressions derived from tachistoscopic data.

A major anomaly in the recognition results was the similarity obtained between overall accuracy scores and hemifield differences for bilaterally presented letters and numbers. That the prediction of greater accuracy and more pronounced lateral disparity for letters was not confirmed, suggests that with the procedure used, processing of the two types of information was equally efficient. Two factors may possibly explain the result. The first, unfortunately, is based on a minor flaw in the procedure.

The letter stimuli were randomized from the full twenty-six character alphabet, resulting in a probability for guessing less than half of that associated with the ten digits. Some previous experiments have attempted to circumvent the problem by first selecting a group of letters and then sampling the arrays (e.g. Bryden, 1966b).

In addition to differences in guess probabilities, the Ss' use of a consistent set favouring letters was limited by the use of two modes of presentation and three types of stimuli. Previous discussion of differences in the processing of various stimuli have been based on separate trial series for each stimulus type. Within the present procedure no single set strategy would prove optimal and the differential effect favouring letter material was reduced. This, coupled with a probability of accurate guessing that favoured numbers may have resulted in the similar scores.

Inspection of the group curves for letters (Figure 10) and numbers (Figure 11), however, provides some indication that the scanning process remained more highly organized for letters. Subjects maintained high accuracy for letters to the fifth position in the array. Accuracy was more variable for numbers and decreased after position 4.

The results obtained with bilateral symbol arrays suggest that for this material both set and process were disorganized. From the raw data it appears that on any given trial, Ss processed the material right from fixation, left from fixation, or simply encoded those elements near fixation. On occasional trials the reports suggest that they scanned the length of the array but were only able to retrieve information from the ends, an extreme example of the primacy-recency phenomenon.

The primacy effect, evident in the results for all three stimulus types, has been described as an accuracy differential favouring the elements first processed. Recency is considered to favor those elements last processed before a response begins (Harcum, 1964).

Although these effects are probably operating for all stimulus conditions, the pronounced accuracy at the ends of the symbol arrays is more likely a result of the disorganized pattern of response accuracy suggested by the individual curves and evident in the raw data.

Bryden (Figure 16; Bryden, et al., 1968) and Harcum (Figure 16; Harcum, 1969) discuss their results as a breakdown in the scanning process. It seems reasonable that the present results obtained with symbols may be attributable to disorganized scanning.

What is not readily explained is the source of the disorganization. There is no obvious feature of the elements used that would predict the result. In any case, the symbols were demonstrably able to produce the lateral disparity effect in pilot investigation. A possible explanation is suggested by the discussion of set for letters and numbers.

Faced with the task of encoding both bilateral and unilateral stimuli and without a well organized discrimination for symbols, the Ss may have randomly shifted from one strategy to another. (For example, fixation, left to SP, encode right; fixation, right to SP, continue right encoding; inhibit scan, encode central elements, etc.) Further, confusion over the appropriate strategy may result in a time delay and concomitant loss of information before encoding begins.

Empirical tests of this explanation are readily conducted. In the present experiment the ratio of bilateral trials with alphanumeric stimuli to unilateral trials was

1:1. In other words, stimulation capable of eliciting either of the proposed stereotyped scanning processes occurred equally often. By varying the proportion of unilateral trials, a point should be reached at which the set produced for the "fixation, left to SP, encode right" sequence is in competition with the set required for right unilateral arrays. If the choice of process sequence for symbols is susceptible to disorganization by this competition the Ss' responses for symbols will deteriorate.

If successful, the results of such a study would appear to provide evidence against Fudin's (1969) conception of the SP. This is not completely the case, as the sweep to the SP, like all the mechanisms postulated by Heron (1957) and Fudin (1969), is proposed to operate primarily in response to linguistic stimuli. It is not surprising to find it disrupted with unfamiliar forms. An experiment including extended experience with the forms might reveal scores that gradually come to approximate those normally predicted for bilateral stimuli. Within the present study the limited number of trials did not produce a practice effect.

While the results for symbols provide evidence that processing of tachistoscopic information is not rigidly organized, description of the recognition results for letters and numbers also suggests that the mechanism involved in identifying these stimuli is not equally established for all *S*s. Although a common pattern does emerge, individual variation is pronounced.

In a science that was founded on the concept of individual differences, it is a common practice to report group data, discuss the means and ignore the individual. This is a valid procedure, of course, but one which masks those idiosyncratic behaviours that may provide the source of powerful explanation. Analysis and discussion of group data has been the rule in the lateral disparity literature, an unfortunate occurrence if the results of the present study are not artifactual.

The recognition process assumed to operate following tachistoscopic exposures is described in terms of oculomotor reading habits. The scan sequence is proposed to be highly overlearned in educated adults and highly organized and efficient as a result. Group data supports this postulation. Mean differences in hemifield accuracy and the field position graphs suggests a sequential left to right scan interacting with temporally fading afterstimulation.

The exceptions to the general pattern described in Results II cannot be discounted as spontaneous variation although this may be the case. Rather, they force us to question the assumed ubiquity of the scanning process.

A replication of the present study with particular attention to *S*s' patterns of response is necessary to determine the reliability of the phenomenon. Perhaps all that will be established is an overall lack of uniformity. On the other hand, a given pattern may prove highly reliable for an individual S. Further, various response patterns may prove characteristic for sub-groups of Ss. For example, is the total lack of primacy for numbers demonstrated by S 5 a characteristic mode of responding that can be found in other Ss? If so, then variations in tachistoscope performance may be related to performance on other tasks.

Reading skills are an obvious choice for investigation. Reading habits were used as a model for the proposed recognition process. It seems logical to assume that a S's pattern of recognition might yield predictions about his reading ability.

Again, only empirical investigation will decide if these suggestions have any merit. Given reliability and a lack of relationship with reading skills, other avenues remain, such as the study of personality variables.

The results for unilateral presentation are conspicuously more consistent. Data for unilateral letters corroborate those of previous investigations in terms of RVF superiority and the recognition curves obtained. The greater consistency may, as suggested in Results II, stem from the smaller range available for variation. More likely, is the possibility that the recognition process is necessarily more organized for arrays presented further into the periphery. In order to encode the material before it fades below threshold, a highly organized attentional process must be rapidly oriented to the field of presentation.

A unilateral analogue of Harcum's continuous array procedure could be used to test this hypothesis. Harcum (1964) extended his array size to seventeen elements and found a pronounced primacy for position 1. With twenty-eight elements (Harcum, 1969), Ss did not attempt to reach an SP and reported only those elements near fixation (Figure 14).

An experiment might be designed with unilateral arrays spaced at increasing intervals from fixation. If the attentional processes described by Fudin (1969) are operative, an angular displacement from fixation will be reached where only the first element in an LVF exposure can be retrieved and primacy for position 1 in the RVF is pronounced. At further distances into the periphery, scanning to the SP may break down and attention may shift to include only those elements nearest fixation.

Reversing the procedure and stepping the arrays closer to fixation, a point may be discovered where the response pattern becomes less organized and demonstrates variation similar to records for bilateral exposures. This result would imply that the attentional process becomes "lazy" for stimulation near the fovea and consequently more susceptible to either spontaneous variation or the effects of other factors as suggested above.

Part of Heron's (1957) investigation included unilateral presentation of four letters grouped in a square at five angular distances from fixation. At 1° 15' a small LVF superiority was obtained. The usual RVF superiority was significant at 2° 45' and 4° 15' (3° 30' for the present study), but became less marked at 5° 55' and 7° 7'. Although the use of square arrays limits comparability, and fined grained analysis of accuracy for individual elements is lacking (primacy was consistently obtained for the letter in the upper left of the square), these results certainly justify further research. Again, the importance of individual records should be emphasized.

Discussion of the recognition data reveals a complex behaviour, only partially explained. Unfortunately, the EM data do not further our knowledge of the recognition process. They do, however, reveal a reliable phenomenon interesting for its own sake.

A high proportion of initial EM were made to the LVF with bilateral stimuli, but for combined data the EM correlated only moderately ($\underline{r}$= + .49) with LVF recognition. The stronger relation obtained for letters, in contrast to the insignificant relations obtained for numbers and symbols, underscores the importance of letter material. However, the fact that proportions of left EM did not differ significantly among the stimulus types (Table 2, Figure 4) limits any implication of causality.

Subjects, when confronted with bilateral stimuli, moved their eyes to the left regardless of the type of stimuli. Moreover, the overt processing of the information to be reported is not dependent on this movement. The analysis by ranks indicates that for a given S a high percentage of EM to the left is not associated with improved accuracy in the left field. Similarly, the number of right EM or NM do not contribute to lower accuracy in the LVF.

Unilateral presentation resulted in EM congruent with the field of presentation even more reliably than bilateral presentation. If the exposure occurred in the LVF, the eyes moved left; if in the RVF, the movement was to the right. The latencies were identical, but in the absence of a relation with accuracy, this result does not provide direct evidence that might resolve the differences between the postulations of Heron and Fudin. As a model for the covert process, however, the results parallel Fudin's conception.

The uniformity of EM response and the low latencies provide further indication that a more structured deployment of attention is necessary for the processing of material in the periphery. The results are not conclusive as we cannot deduce from the present data if the effect is simply the result of stimulation further into the periphery or if the characteristics of the stimuli are important. White, Eason and Bartlett (1961), and Bartz (1962) report increased latencies as the stimulus is moved away from fixation. The opposite result may be attributable to the recognition task or the stimuli or both. In the discussion of recognition, above, a study was proposed by analyze the effects of angular displacement from fixation on unilateral accuracy. Inclusion of symbols and the monitoring of EM in a similar design would allow investigation of the relative effects of stimuli and field position.

The present results for bilateral symbols are in sharp contrast to those for unilateral letters. Here, the inference of a differential effect of stimulus characteristics is most valid. As stated in Results II a general decrement in EM performance is associated with symbol exposures. The longer latencies, and more frequent NM and right moves cannot be discussed as evidence. However, the results do imply that the stereotyped EM is more reliably evoked following exposure of alphanumeric stimuli. That the disruption of EM was not statistically significant with symbols suggests that the habit is well established in the university students tested. A developmental study similar to that of Forgays (1952) or Hay and McRae (1969) with attention to EM might discover that the EM becomes more habitual as a function of grade level.

Neither Crovitz and Daves (1962) nor Bryden (1960) advanced strong conclusions concerning the involvement of post exposural EM in the recognition process. Bryden, for example, stated, ". . . the results of this experiment do not demonstrate a causal relation between eye movements and recognition. While there appears to be some justification for making this assumption, it is quite possible that eye movements are a result of recognition rather than serving to facilitate it" (Bryden, 1960, p. 224). It was hoped that the present study would demonstrate a causal relation and establish the post exposure EM as an indicator of the covert recognition process.

The lack of relation with hemifield accuracy does not require formulation of a new mechanism to account for the lateral disparity effect. Parsimony is least strained by the conception that both the EM and the attention process are simultaneous but unrelated results of reading experience. As such, both phenomena may be susceptible to modification by the same variables. The simple motor behaviour is less sensitive than the more complex, and therefore less stable, perceptuo-cognitive skill.

The results for the one second duration generally parallel the tachistoscopic data. Initial EM behaviour with the stimulus present is identical to that recorded after the 100 msec. exposures.

Second EM follows the pattern that would be predicted from the data of Carmichael and Dearborn (1947) and the postulates of Fudin (1969). For bilateral arrays the EM sequence follows a "fixation, left (presumably to an SP), then right" pattern. A similar sequence is evoked for LVF unilateral presentation.

The movements elicited with RVF unilateral provide unexpected support for the SP hypothesis. The proportion of second right moves suggests that the initial move was to the SP and the second was involved in encoding the array.

Recognition scores for bilateral arrays suggests the effects of the limited short term memory store (e.g., Brown, 1965; Miller, 1956; Sperling, 1967). Investigations of lateral disparity typically do not discuss the memory factor. The emphasis placed by Hebb (1949), Gibson (1950) and Lashley (cf. Beach et al., 1960) on the role of EM in establishing perceptual processes has generally overshadowed the contribution of memory.

For the present results, the high accuracy in the LVF coupled with the almost exclusive restriction of errors to the RVF suggests that scanning fulfils an input function. That is, even with the long exposure, encoding of the information is sequentially distributed from left to right. The encoded material is held in short term store until a response or output is required. The letters in the LVF, favoured by primacy, are less susceptible to loss during the period between input and output.

The very slight superiority demonstrated, for RVF unilateral scores is statistically insignificant. However, the discovery of any differential at a one second exposure is intriguing. The effects of scanning would be reduced by the long exposure and the limits of memory store are not stressed by only 4 elements. Cerebral dominance, normally masked by scanning (Bryden, 1966b) may have facilitated responses in the RVF. Although the effect is small and the hypothesis necessarily tenuous, experimental manipulations of *S* dominance would provide a straightforward test.

The results of the present study do not seriously reduce the effectiveness of post-exposural scanning based on reading EM as a model for the process involved. Hypotheses and models are tools to be used in the search for factual knowledge and the Heron-Fudin conception remains strongly descriptive. As a tentative explanation, it encompasses the majority of the data. That it does not apply in all cases reinforces an open perspective. The fault may lie in the model or, perhaps, in our application of it.

Indeed, Heron's (1957) original conception of activity in the EM centres providing facilitation to the fading after-stimulation may still be valid. The *S*s tested in the present study were sampled from a population characterized by a high level of reading experience and skill. Trace facilitation may not be necessary for these individuals. Whatever neural mechanism is required may be established and operating autonomously, without the involvement of the motor centres. If so, the overt EM is truly artifactual. Research with less educated adults and with children, however, may reveal a more important role for the EM.

Many suggestions for future research have been advanced throughout the body of the discussion. However, before further analytic research is conducted on lateral disparity or EM, two parametric studies should be completed and a necessary technique devised.

First, the study of Hebrew Ss is an important tool. Whether recognition patterns are reversed for these Ss under all conditions of stimulation is not known. No data is extant regarding post exposure EM. Although tentative hypotheses might be made, a study providing demonstration of the phenomena would provide a basis for more sophisticated predictions in an analytical design.

Second, the parametric information available regarding horizontal EM is inadequate. Early studies (e.g. Dodge and Cline, 1901; Diefendorf and Dodge, 1908) were concerned with simple EM, but while procedurally sound, were limited in extent. Recent studies in the reading literature (cf. reviews by Tinker, 1946, 1958) were concerned primarily with ad lib EM response to prose arrays. The few studies of simple EM in this literature (e.g. Tinker, 1947) were also limited in scope.

White Eason and Bartlett (1961) extracted their latency data from a study of other variables. Whether this is a factor in their results is not clear but there is the possibility of confounding, however slight. Further, their stimuli were placed at wide intervals from fixation (10°,

20°, 40°). Results of the present study indicate that variations in EM latency may be obtained well within 10° of visual angle.

Bartz (1962), a student of Bartlett's, reported data for stimuli 5° from fixation but analysis of response to stimuli spaced at smaller intervals has not been conducted. It would be a simple matter to design and conduct a fine grained parametric analysis of simple horizontal EM. For such a study the high resolution contact lens EM recording technique is the method of choice. The White, Eason and Bartlett and Bartz studies used electro-oculography.

Finally, a computer program should be devised that would allow trial by trial analysis. For example, the effects of set on response may vary on any given trial dependent on the previous trial or sequence of trials. Subtle effects of practice or fatigue might be detected. In any case, the trial by trial dynamics deserve particular attention.

In conclusion, the present study answers a number of questions concerning the tachistoscope task and the EM associated with it. As is often the case, however, many questions arise from the results and the basic problem, although clarified, remains essentially unsolved. Investigation of the phenomena associated with visual information processing continues to be an interesting and productive area of scientific endeavour. Continued research, as suggested above, should soon provide a succinct explanation of this important facet of human behaviour.

References

Anderson, I. & Crosland, H. R. A method of measuring the effect of primacy of report in the range of attention experiment. American Journal of Psychology, 1933, 45, 701-713.

Ayres, J. J. & Harcum, E. R. Directional response-bias in reproducing brief visual patterns. Perceptual and Motor Skills, 1962, 14, 155-165.

Bartz, A. E. Eye-movement latency, duration, and response time as a function of angular displacement. Journal of Experimental Psychology, 1962, 64, 318-324.

Barton, M. I., Goodglass, H., & Shai, A. Differential recognition of tachistoscopically presented English and Hebrew words in right and left visual fields. Perceptual and Motor Skills, 1965, 21, 431-437.

Beach, F. A., Hebb, D. O., Morgan, C. T. & Nissan, H. W. (eds.). The Neuropsychology of Lashley. New York: McGraw Hill, 1960.

Brown, J. Short-term memory. British Medical Bulletin, 1965, 20, 8-11.

Bryden, M. P. Tachistoscopic recognition of non-alphabetical material. Canadian Journal of Psychology, 1960, 14, 78-85.

Bryden, M. P. The role of post-exposural eye movements in tachistoscopic perception. Canadian Journal of Psychology, 1961, 15, 220-225.

Bryden, M. P. Tachistoscopic recognition and cerebral dominance. Perceptual and Motor Skills, 1964, 19, 686.

Bryden, M. P. Tachistoscopic recognition, handedness, and cerebral dominance. Neuropsychologia, 1965, 3, 1-8.

Bryden, M. P. Accuracy and order of report in tachistoscopic recognition. Canadian Journal of Psychology, 1966a, 20, 262-277.

Bryden, M. P. Left-right differences in tachistoscopic recognition: directional scanning or cerebral dominance? Perceptual and Motor Skills, 1966b, 23 1127-1134.

Bryden, M. P., Dick, A. O., & Mewhort, D. J. K. Tachistoscopic recognition of number sequences. Canadian Journal of Psychology, 1968, 22, 53-59.

Bryden, M. P. & Rainey, C. A. Left-right differences in tachistoscopic recognition. Journal of Experimental Psychology, 1963, 66, 568-571.

Carmichael, L. & Dearborn, W. F. Reading and Visual Fatigue. Boston: Houghton Mifflin, 1947.

Crosland, H. R. Letter position effects, in the range of attention experiment, as effected by the number of letters in each exposure. Journal of Experimental Psychology, 1931, 14, 477-507.

Crovitz, H. F. & Daves, W. Tendencies to eye movement and perceptual accuracy. Journal of Experimental Psychology, 1962, 63, 495-498.

Crovitz, H. F. & Zener, K. A group test for assessing hand- and eye-dominance. The American Journal of Psychology, 1962, 73, 271-276.

Dick, A. O. & Mewhort, D. J. K. Order of report and processing in tachistoscopic recognition. Perception and Psychophysics, 1967, 2, 573-576.

Diefendorf, A. R. & Dodge, R. An experimental study of the ocular reactions of the insane from photographic records. Brain, 1908, 31, 451-489.

Ditchburn, R. W. & Ginsborg, B. L. Involuntary eye movements during fixation. Journal of Physiology, 1953, 119, 1-17.

Dodge, R. & Cline, T. S. The angle velocity of eye movements. Psychological Review, 1901, 8, 145-157.

Dornbush, R. L. & Winnick, W. A. Right-left differences in tachistoscopic identification of paralogs as a function of order of approximation to English letter sequences. Perceptual and Motor Skills, 1965, 20, 1222-1224.

Ford, A. & Leonard, J. L. Techniques for recording surface biolectric direct currents. USN Electronics Laboratory Reports. No. 839, 1958.

Forgays, D. G. The development of a differential word recognition. Journal of Experimental Psychology, 1953, 45, 165-168.

Fudin.R.Critique of Heron's directional-reading conflict theory of scanning. Perceptual and Motor Skills. 1969, 29, 271-276.

Gaarder, K., Silverman, J., Pfefferbaum, D., Pfefferman, L., & King, C. Infra-red method for assessment of small and large eye movements in clinical experiments. Perceptual and Motor Skills, 1967, 25, 473-484.

Gibson, J. J. The Perception of the Visual World. Boston: Houghton Mifflin, 1950.

Glanville, A. D., & Dallenbach, K. M. The range of attention. The American Journal of Psychology, 1929, 41, 207-236.

Goodglass, H. & Barton, M. Handedness and the differential perception of verbal stimuli on left and right visual fields. Perceptual and Motor Skills, 1963, 17, 851-854.

Gould, J. D. & Schaffer, A. Appendix to "Eye-movement patterns in scanning." Perceptual and Motor Skills, 1965, 20, 534-535.

Guilford, J. P. Fundamental Statistics in Psychology and Education. New York: McGraw Hill, 1942.

Harcum, E. R. Interactive effects within visual patterns on the discriminability of individual elements. Journal of Experimental Psychology, 1964, 68, 351-356.

Harcum, E. R. Continuous tachistoscopic patterns reproduced without laterality effects. American Journal of Psychology, 1969, 82, 504-512.

Harcum, E. R. & Dyer, D. W. Monocular and binocular reproduction of binary stimuli appearing right and left of fixation. American Journal of Psychology, 1962, 75, 56-65.

Harcum, E. R. & Finkel, M. E. Explanation of Mishkin and Forgays' result as a directional-reading conflict. Canadian Journal of Psychology, 1963, 17, 224-234.

Harcum, E. R. & Jones, M. L. Letter recognition within words flashed left and right of fixation. Science, 1962, 138, 444-445.

Hay, J. M. & McRae, R. C. Development of left-right differences in the tachistoscopic recognition of letters. Unpublished manuscript. Department of Psychology, Waterloo Lutheran University, 1969.

Hebb, D. O. The Organization of Behaviour. New York: Wiley, 1949.

Heron, W. Perception as a function of retinal locus and attention. The American Journal of Psychology, 1957, 70, 38-48.

Holding, D. The amount seen in brief exposures. Quarterly Journal of Experimental Psychology, 1971, 23, 72-81.

Kimura, D. Cerebral dominance and the perception of verbal stimuli. Canadian Journal of Psychology, 1961, 15, 166-171.

Kimura, D. Dual functional asymmetry of the brain in visual perception. Neuropsychologia, 1966, 4, 275-285.

Miller, G. A. The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychological Review, 1956, 63, 81-97.

Mishkin, M. & Forgays, D. G. Word recognition as a function of retinal locus. Journal of Experimental Psychology, 1952, 43, 43-48.

Orbach, T. Retinal locus as a factor in recognition of visually perceived words. American Journal of Psychology, 1953, 65, 555-562.

Peters, R. J. The effects of training on recognition of tachistoscopically presented stimuli to the right or left of fixation. Unpublished B. A. thesis. Department of Psychology, Waterloo Lutheran University, 1970.

Runyon, R. P. & Haber, A. Fundamentals of Behavioral Statistics. Don Mills: Addison Wesley, 1967.

Shackel, B. Eye movement recording by electro-oculography. In P. H. Venables & I. Martin (eds.), A Manual of Psychophysiological Methods. Amsterdam: North Holland, 1967, 1967, pp. 299-334.

Siegel, S. Nonparametric Statistics for the Behavioral Sciences. New York: McGraw Hill, 1956.

Sperling, G. The information available in brief visual presentations. Psychological Monographs, 1960, 74, Whole No. 498.

Sperling, G. Successive approximations to a model for short term memory. Acta Psychologica, 1967, 27, 285-292.

Terrace, H. The effects of retinal locus and attention on the perception of words. Journal of Experimental Psychology, 1959, 58, 382-385.

Tinker, M. A. The study of eye movements in reading. Psychological Bulletin, 1946, 43, 93-120.

Tinker, M. A. Time relations for eye movement measures in reading. Journal of Educational Psychology, 1947, 38, 1-10

Tinker, M. A. Recent studies of eye movements in reading. Psychological Bulletin, 1958, 55, 215-223.

White, C. T., Eason, R. G. & Bartlett, N. R. Latency and duration of eye movements in the horizontal plane. Journal of the Optical Society of America, 1961, 52 210-213.

Winer, B. J. Statistical Principles in Experimental Design. New York: McGraw Hill, 1962.

APPENDIX A

SUMMARIES OF THE ANALYSES OF VARIANCE

TABLE 1

ANALYSIS OF VARIANCE

Recognition Scores for Bilateral Presentation

SOURCE	SS	df	MS	F
Stimuli (A)	1,202.54	2	601.27	45.48**
Visual Field (B)	4,720.33	1	4,720.33	123.44**
A X B	1,829.54	2	914.77	6.29*
Subjects	520.00	7	74.29	
A X Subject	185.12	14	13.22	
B X Subject	267.67	7	38.24	
A X B X Subject	2,037.00	14	145.50	

*$p < .05$
**$p < .01$

TABLE 2

ANALYSIS OF VARIANCE

Recognition Scores for Unilateral Presentation

SOURCE	SS	df	MS	F
Visual Field	1,580.06	1	1,580.06	159.28*
Residual	69.44	7	9.92	
Between	284.44	7		
Within	1,649.50	8		

*$p < .01$

TABLE 3

ANALYSIS OF VARIANCE

EM Direction for Bilateral Stimuli

SOURCE	SS	df	MS	F
Stimuli (A)	3.17	2	1.58	<1
Visual Field (B)	972.00	1	972.00	43.99*
A X B	49.50	2	24.75	11.06*
Subjects	93.67	7	13.38	
A X Subject	94.83	14	6.77	
B X Subject	154.66	7	22.09	
A X B X Subject	31.34	14	2.24	

*$p < .01$

TABLE 4

ANALYSIS OF VARIANCE

EM Direction for Unilateral Presentation

SOURCE	SS	df	MS	F
Visual Field (A)	.28	1	.28	< 1
Eye Movement (B)	22.78	1	22.78	3.39
A X B	1,116.28	1	1,116.28	8.08*
Subjects	3.97	7	.57	
A X Subject	2.47	7	.35	
B X Subject	46.97	7	6.71	
A X B X Subject	966.69	7	138.10	

*$p < .05$

TABLE 5

ANALYSIS OF VARIANCE

EM Latencies for Bilateral Stimuli

SOURCE	SS	df	MS	F
Stimuli	56,852.60	2	28,426.30	1.508 N.S.
Residual	263,894.29	14	18,849.59	
Between	80,276.95	7		
Within	320,746.88	16		

TABLE 6

ANALYSIS OF VARIANCE

EM Latencies for Unilateral Presentation

SOURCE	SS	df	MS	F
Visual Field	14.78	1	14.78	< 1
Residual	2,860.90	7	408.70	
Between	44,555.74	8		
Within	2,875.68	7		

APPENDIX B

RAW DATA

SUBJECT I

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
1	K U Z V	A Y I P	K U Z V	A T	4	1	L	160	
2		U C A L		K A L		2	R	190	
3	V D U P		V D C D		2		L	110	
4	O R Z S		K H Z T		1		L	115	
5	1 6 7 8	4 3 5 2	1 6 7 8		4	0	L	150	
6	J U T D	C E F Q	J U T G	I	3	0	EB	---	
7	P X B L	Z Q G A	P D X L	Z I	2	1	L	140	
8	R T G N	M Q D F	R T T		2	0	R	140	
9	6 9 0 8	1 2 4 7	6 0 0 8	1 2 5	3	2	L	170	
10	L M T J	Q A Y E	L A T Z	I I K E	3	1	L	200	
11	H W X D	O E K B	H Z Q D	O U P	2	1	L	180	
12		E G K U		E G E U		3	R	150	
13	1 2 9 0	6 7 8 4	1 2 6 0	4 9 2	3	0	L	200	
14	3 7 1 9	2 0 4 6	3 7 1 9	2 0 5 4	4	2	L	185	
15	3 1 4 6	5 7 0 8	3 1 4 5	6 4 7 0	3	0	L	195	

SUBJECT I

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
16	T C D O	W K L A	T C D O	W H̸ L̸	4	1	L	200	
17	◒ ● ◐ θ	◒ ◐ O θ	Ø O O O	Ø Ø O	3	1	L	190	
18		R W V J		R W V L̸		3	R	135	
19	D B H J		D N̸ I̸ J		2		L	130	
20	M Q D R	A O V C	N̸ Q D R	A O K̸ C	3	3	L	205	
21	◐ ⦶ O θ	◐ ⊕ ⊕ ●	Ø O Ø O	Ø Ø O	2	1	L		510
22	● ⦶ θ ◐	O ◐ ● ◐	O O O Ø	Ø Ø	3	0	L	235	
23	A F N O		A V̸ T̸ O		2		L	120	
24	B L A N K						R	275	
25		L J I U		L J D̸ Ø		2	R	175	
26		O E G M		C̸ E Ø M		2	R	140	
27	O ◐ ● ◒	θ ⊕ ⊕ O	O O Ø O	Ø O O	3	2	R	240	
28	B L A N K						NM	---	
29	T R X C		T V̸ D̸ V̸		1		L	140	
30	I E M C	Z O U N	T̸ E M K̸	Z O	2	2	L	235	
31	9 2 5 6	1 4 8 7	Ø 2 5 6	1 9̸ 4̸	3	1	L	190	

SUBJECT I

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
32		Z Q S E		Z Q S E		4	R	130	
33		T B S A		T R̸ B̸ M̸		1	R	130	
34	I Q O L		L̸ Ø V̸ A̸		0		L	110	
35	3 7 0 2	5 4 8 6	3 7 0 2	4̸ 5̸ 1̸ 9̸	4	0	R	190	
36		C U A L		C U A L		4	R	145	
37	B L A N K						EB	---	
38	A H N O	I L D K	A .P̸ Ø Z̸	I M̸ L̸	1	1	L	190	
39	O ◐ ◑ θ	◐ ◑ O ◓	O Ø O Ø	Ø O	2	1	L	165	
40	U J C G		U J C L̸		3		L	125	
41	F R C S		V̸ C̸ L̸ S		1		L	110	
42	B L A N K						NM	---	
43	H Q M K		H Ø Ø K		2		L	120	
44	A U X Z		A Z̸ M̸ K̸		1		L	140	
45	◒ ◐ ● O	◒ ◐ ◓ ◑	Ø Ø Ø		0	0	L	170	
46	K V L T	J P̸ C D	K V L t	J Ø	4	1	L	205	

SUBJECT I

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
47	U O P R		U D̸ L̸ T̸		0		L	135	
48		L T C G		L C̸ T̸ G		2	R	130	
49	V M Y D		K̸ V̸ D̸		0		R	140	
50	Z O L U		Z C̸ L̸ U		2		L	120	
51	◒ Φ ◐ O	● ◐ θ ◒	Ø O Ø Ø	O O	1	2	L	215	
52	J I X Z	A C R T	J I X Z̸	A N̸ C̸ T	3	2	L	180	
53	F Q J K		K̸ L̸ N̸ D̸		0		L	115	
54	B L A N K						EB	---	
55		P K T J		K̸ P̸ T J		2	R	140	
56	H C R N	A P X K	N̸ C R A̸	J̸ P	2	1	L	185	
57	◐ ◒ ◐ O	θ ● θ ◐	Ø Ø Ø O	O O	1	2	L	200	
58		C [illegible] [illegible] I		C N B̸ I		3	EB	---	
59	◐ O θ ◐	◒ ◒ ◒ Φ	Ø Ø O Ø	Ø	1	0	L	185	
60	θ θ ◐ ◐	◐ [illegible] ● ●	O O O Ø		3	0	L	175	
61		E R [illegible] I		E A̸ F̸ I		2	R	195	

SUBJECT I

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
62	5 9 1 2	6 4 8 3	5 9 1 2	3̸	4	0	L	215	
63	θ ◐ ⊕ O	⦶ ● ◐ θ	ø ø ø ø	ø	0	0	R	170	
64	B L A N K						EB	---	
65	4 6 1 7	2 0 3 9	4 6 1 7	ø 3̸ 4̸	4	0	L	105	
66	◒ ◐ θ ◐	O ⊕ θ ●	ø ø ø ø	0	0	1	R	145	
67	B L A N K						L		280
68		N D C E		N D E̸ ¢		2	R	130	
69	O ◐ ◐ ◒	⦶ θ θ ●	ø ø ø 0		1	0	R	145	
70	7 5 8 1	9 4 0 6	7 8̸ 9̸ 1	ø 4 3̸	2	1	L	170	
71	0 9 6 1	3 5 4 2	9̸ 6̸ 1̸ 4̸	3 5 1̸	0	2	L	170	
72	1 9 6 0	2 7 8 3	1 9 6 0	2 3̸ 4̸ 1̸	4	1	L	250	
73	A T X R	W V L C	A T X̸ R	I̸ X̸ T̸ C	3	1	L	205	
74	B L A N K						L	230	
75	S H U I		Z̸ U̸ C̸ I		1		L	160	
76	A J Q B	R Y C P	A J B̸ ¢	R Y̸ Q̸ K̸	2	1	L	175	

SUBJECT I

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
77	9 7 1 0	6 4 2 3	9 7 1 0	4̸ 2̸ 3̸	4	0	L	185	
78	● ◑ ⊕ ◑	⊖ ◐ ◑ ◐	0 Ø 0 Ø	Ø Ø	2	0	L	155	
79	⊖ ◑ ⊕ ◑	⊖ ◑ ◐ 0	Ø Ø 0 Ø	0 0	1	2	L	185	
80	A S Z H		A H̸ C̸ A̸		1		L	175	
81	7 0 1 6	4 5 8 2	7 0 1 4̸	2̸	3	0	L	200	
82	0 ◑ ● ◐	◑ 0 ◑ ◑			0	0	L	190	
83	8 2 0 3	5 7 6 1	8 2 0 5̸	1̸ 2̸ 9̸	3	0	NM	---	
84	B M O E	T U D I	B M̸ O E	T N̸ U̸ I	3	2	L	100	
85	0 2 1 3	9 6 7 5	0 2 1 9̸	3̸ 4̸ 7̸ 5	3	1	L	185	
86		J A X L		J A X L		4	R	160	
87		T L D N		T N̸ A̸		1	R	155	
88		Q L B M		Q L B A̸		3	R	180	

SUBJECT 1

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	Second
1	R O U L	G S V H	R O U L	G S I N	4	2	200L	670R
2		V T W Q		V T W Q		4	160R	EB
3		Z V U K		Z V U K		4	140R	460R
4		B S X C		B S X C		4	160R	630R
5	G E N K	L Z Q V	G E N K	L Ø ¢ V	4	2	195L	530R
6		C D G J		C D G J		4	190R	EB
7	E S H M			E S H M		4	140L	760R
8	E U N M	X V L K	E U N M	X V T H	4	1	200L	850R
9	J M W G		J M W G		4		135L	610R
10	N K F Q	C D S A	N K F Q	Ø D S N	4	2	225L	860L
11	D E T R		D E T R		4		145L	650L
12	N G X K		N G X K		4		160L	820R
13		R I X K		R I X K		4	150R	570R
14	S N T V		S N T V		4		130L	740R
15		D I T H		D I T H		4	155R	420R

SUBJECT 1

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	EM Latency and Direction Second
16	R O K H	M V F S	R O K H	Ø ~~M~~ ~~A~~ S	4	1	180L	490R
17	W A D K		W A D K		4		120L	850R
18	K N O W	B X M H	K N O W	B ~~I~~ M ~~T~~	4	2	210L	520R

SUBJECT 2

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
1	K U Z V	A Y I P	K		1	0	L	195	
2		U C A L		U C		2	L	180	
3	V D U P		S̸ C̸ U N̸		1		L	140	
4	O R Z S		O N̸		1		L	235	
5	1 6 7 8	4 3 5 2	- 7 6̸ 8		1	0	L	210	
6	J U T D	C E F Q	J U T Ø		3	0	L	200	
7	P X B L	Z Q G A	K̸ X K̸ T̸	Z Ø	1	1	L		710
8	R T G N	M Q D F	R T G N		4	0	L		770
9	6 9 0 8	1 2 4 7	6 Ø 9̸ 8	7	2	1	L	205	
10	L M T J	Q A Y E	- M J̸ T̸	Ø A - E	1	2	NM	---	
11	H W X D	O E K B	H W X Ø	Ø	3	0	L		630
12		E G K U		E G F̸ N̸		2	R	125	
13	1 2 9 0	6 7 8 4	1 2 Ø 4̸	6 3̸	2	1	L	210	
14	3 7 1 9	2 0 4 6	1 9	2 Ø	2	1	NM	---	
15	3 1 4 6	5 7 0 8	- 1 4 6	5	3	1	NM	---	

SUBJECT 2

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
16	T C D O	W K L A	T C D O	M̸ K	4	1	NM	---	
17	◒ ● ◐ θ	◒ ◐ O θ	Ø Ø		0	0	NM	---	
18		R W V J		R I̸ J̸ M̸		1	R	155	
19	D B H J		J		1		L	250	
20	M Q D R	A O V C		R A Ø	0	2	NM	---	
21	◐ ◑ O θ	◐ θ θ ●	Ø Ø		0	0	L		890
22	● ◑ θ ◑	O ◑ ● ◐	Ø Ø Ø		0	0	NM	---	
23	A F N O		O		1	0	R	220	
24	B L A N K						NM	---	
25		L J I U		L J I		3	R	160	
26		O E G M		Ø E M̸ M		2	R	200	
27	O ◑ ● ◒	θ θ θ O	O O Ø Ø		2	0	L		890
28	B L A N K						NM	---	
29	T R X C		K̸		0		R	120	
30	I E M C	Z O U [illegible]	M C	Z	2	1	NM	---	
31	9 2 5 6	1 4 8 7	9 5 6	1	3	1	L		670

SUBJECT 2

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
32		Z Q S E		Z Ø S E		3	R	125	
33		T B S A		T K̸ S E̸		2	R	150	
34	I Q O L		I Q Ø		2	0	L	145	
35	3 7 0 2	5 4 8 6	9̸ 2	5 9̸	1	1	NM	---	
36		C U A L		C ¢ A̸ L		2	R	150	
37	B L A N K						NM	---	
38	A H N O	I L D K	A H N ¢	L̸	3	0	NM	---	
39	O ◐ ◐ θ	◐ ⦶ O ◒		O O O Ø	0	3	NM	---	
40	U J C G		U ¢ C ¢		2		L	155	
41	F R C S		F - ¢ 5̸		1	0	L	105	
42	B L A N K						NM	---	
43	H Q M K		¢ K		1	0	NM	---	
44	A U X Z		K̸ X̸		0	0	L	190	
45	◒ ◐ ● O	◒ ◐ ◒ ◐	O Ø O Ø		2	0	NM	---	
46	K V L T	J P̸ C D	K V L T		4	0	L		540

SUBJECT 2

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
47	U O P R				0	0	L	170	
48		L T C G		L Ɨ C ₵		2	L	175	
49	V M Y D		V Ƶ Ɏ D		2		L	195	
50	Z O L U		L Ⱥ		1		L	160	
51	◒ θ ◐ O	● ◐ θ ◒	Ø Ø Ø Ø	Ø Ø O O	0	2	NM	---	
52	J I X Z	A C R T	J - X Z	A - Ŧ -	3	1	NM	---	
53	F Q J K		J Ӿ		1		L	170	
54	B L A N K						NM	---	
55		P K T J		P Ɏ T		2	R	195	
56	H C R N	A P X K	Ꝁ C Ⱥ N	Ŧ	2	1	NM	---	
57	◐ ◒ ◐ O	θ ● θ ◐	Ø Ø Ø Ø		0	0	NM	---	
58		C N X I		C Ꞥ Ɇ Ƒ		1	R	125	
59	◐ O θ ◐	◒ ◒ ◓ θ	O O Ø	O	2	1	NM	---	
60	◌ ◍ O ◐	◌ ◌ ● ●	Ø Ø Ø Ø		0	0	L		600
61		E R X I		E Ꞥ Ƒ I		2	L	155	

SUBJECT 2

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
47	U O P R				0	0	L	170	
48		L T C G		L I̸ C ¢		2	L	175	
49	V M Y D		V Z̸ Y̸ D		2		L	195	
50	Z O L U		L A̸		1		L	160	
51	◒ ⦶ ◐ O	● ◐ θ ◒	Ø Ø Ø Ø	Ø Ø O O	0	2	NM	---	
52	J I X Z	A C R T	J - X Z	A - T̸ -	3	1	NM	---	
53	F Q J K		J X̸		1		L	170	
54	B L A N K						NM	---	
55		P K T J		P Y̸ T		2	R	195	
56	H C R N	A P X K	K̸ C A̸ N	T̸	2	1	NM	---	
57	◐ ◓ ◐ O	θ ● θ ◐	Ø Ø Ø Ø		0	0	NM	---	
58		C N X I		C N̸ E̸ F̸		1	R	125	
59	◐ O θ ◐	◒ ◒ ◓ ⦶	O O Ø	O	2	1	NM	---	
60	O ⦶ ⦶ ◐	[illegible] [illegible] ● ●	Ø Ø Ø Ø		0	0	L		600
61		E R X I		E N̸ F̸ I		2	L	155	

SUBJECT 2

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
62	5 9 1 2	6 4 8 3	5 1 2	4̸ 6̸	3	0	NM	---	
63	θ ◑ ⊕ 0	⦶ ◓ ◐ θ	0 Ø Ø		1	0	NM	---	
64	B L A N K						NM	---	
65	4 6 1 7	2 0 3 9	1 7	2 6̸ Ø	2	1	NM	---	
66	◒ ◐ θ ◑	0 ⊕ θ ●	Ø 0 0	0	2	1	R	245	
67	B L A N K						L		670
68		N D C E		N̸ D C E		3	R	195	
69	0 ◑ ◐ ◒	⦶ θ θ ◓	0 Ø Ø		1	0	NM	---	
70	7 5 8 1	9 4 0 6	7 - 8 1	9	3	1	NM	---	
71	0 9 6 1	3 5 4 2	0 - 6 1	9̸ 3̸	3	0	L		330
72	1 9 6 0	2 7 8 3	1 9 6 2̸		3	0	NM	---	
73	A T X R	W V L C	A T X R	W	4	0	NM	---	
74	B L A N K						NM	---	
75	S H U I		I		1		NM	---	
76	A J Q B	R V C P	A - Q B		3	0	NM	---	

SUBJECT 2

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
77	9 7 1 0	6 4 2 3	9 7 1 0	6	4	1	NM	---	
78	● 0 θ 0	◒ ◓ 0 ◓	0 Ø	0	1	1	NM	---	
79	◒ 0 θ 0	θ ◐ ◐ 0	0 Ø Ø 0	0	2	1	NM	---	
80	A S Z H		A		1		L	180	
81	7 0 1 6	4 5 8 2	7 0 1 5		3	0	NM	---	
82	0 ◐ ● ◓	◐ 0 0 ◐	0 0 0 Ø	Ø 0 0 0	3	3	NM	---	
83	8 2 0 3	5 7 6 1	- 2 0 3	5	3	1	NM	---	
84	B M O E	T U D I	Ø M O E		3	0	NM	---	
85	0 2 1 3	9 6 7 5	0 2 1 3		4	0	NM	---	
86		J A X L		J A X L		4	R	160	
87		T L D N	T L Ø N			3	R	155	
88		Q L B M		Q L K M		2	L	125	

SUBJECT 2

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	EM Latency and Direction Second
1	R O U L	G S V H	R O U L	G	4	1	270L	NM
2		V T W Q		V T W Q	0	4	175R	850R
3		Z V U K		Z V U K	0	4	170R	850R
4		B S X C		B S X C	0	4	155R	640R
5	G E N K	L Z Q V	G E N K	L	4	1	270L	670R
6		C D G J		C D G J	0	4	150R	1010R
7	E S H M		E S H M		4	0	145L	640L
8	E U N M	X V L K	E V N M	X V L X	3	3	270L	620R
9	J M W G		J M W G		4	0	145L	640L
10	N K F Q	C D S A	N K F Q		4	0	230L	630R
11	D E T R		D E T R		4	0	220L	820R
12	N G X K		N G X K		4	0	230L	600R
13		R I X K		R I X K	0	4	175R	750R
14	S N T V		S N T K		3	0	230L	650L
15		D I T H		D I T H	0	4	145R	620R

SUBJECT 2

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	EM Latency and Direction Second
16	R O K H	M V F S	R O K H		4	0	255L	740R
17	W A D K		W A D K		4	0	160L	780R
18	K N O W	B X M H	K N O W	B	4	1	450L	740R

SUBJECT 3

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
1	K U Z V	A Y I P	Z̸		0	0	L		400
2		U C A L		U		1	L	180	
3	V D U P		V		1		L	125	
4	O R Z S				0	0	L	130	
5	1 6 7 8	4 3 5 2	1 6 7 8	4	4	1	L	190	
6	J U T D	C E F Q	J U T D	C	4	1	L	185	
7	P X B L	Z Q G A	K̸ X B L	Z Ø	3	1	L	115	
8	R T G N	M Q D F	R T Ø N	M Ø	3	1	L	145	
9	6 9 0 8	1 2 4 7	0 8	1 2	2	2	L		280
10	L M T J	Q A Y E	L M T J	A̸ Ø	4	0	L		330
11	H W X D	O E K B	M̸ W K̸ D	O	2	1	L	205	
12		E G K U		E G X̸ U		3	R	135	
13	1 2 9 0	6 7 8 4	- 2 9 0	6	3	1	L	230	
'	3 7 1 9	2 0 4 6	3 7	4 6	2	2	L	200	
15	3 1 4 6	5 7 0 8	3 1 4		3	0	L	170	

SUBJECT 3

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
16	T C D O	W K L A	T C D --	W	3	1	L	150	
17	◒ ● ◐ θ	◒ ◐ O θ	O O	O O	2	2	L	145	
18		R W V J		R Ø V Ø		2	R	135	
19	D B H J		3 8		0		L	130	
20	M Q D R	A O V C	Ø Ø D R	A	2	1	L	230	
21	◐ ◐ O θ	◐ ⊕ ⊕ ●	Ø O Ø Ø		1	0	L	190	
22	● ◐ θ ◐	O ◐ ● ◐	O Ø Ø Ø	O	1	1	L	165	
23	A F N O		A F N		3		L	105	
24	B L A N K						L		305
25		L J I U		L J I		3	R	155	
26		O E G M		Ø E G M		3	R	160	
27	O ◐ ● ◐	θ ⊕ ⊕ O	O O		2	0	L	190	
28	B L A N K						NM	---	
29	T R X C		T		1		NM	---	
30	I E M C	Z O U N	I E Ø C		3	0	L	215	
31	9 2 5 6	1 4 8 7	5 6	7	2	1	L	205	

SUBJECT 3

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
32		Z Q S E		Z Ø S E		3	R	150	
33		T B S A		T R̸ S A		3	R	145	
34	I Q O L		I Q O L		4		L	125	
35	3 7 0 2	5 4 8 6	3 7 0 2		4	0	L	165	
36		C U A L		C - A L		3	R	105	
37	B L A N K						NM	---	
38	A H N O	I L D K	M̸ H N O	I L	3	2	NM	---	
39	O ◐ ◑ θ	◐ ◎ O ◒	0 0 Ø Ø	0	2	1	L	140	
40	U J C G		U J		2		L	150	
41	F R C S		F S		2		L	130	
42	B L A N K						NM	---	
43	H Q M K		K		1		L	130	
44	A U X Z		A X̸ Y̸ Z		2		R	115	
45	◒ ◐ ● O	◒ ◐ ◒ ◐	0 Ø Ø Ø	Ø Ø Ø 0	1	1	L	210	
46	K V L T	J P C D	K Y̸ L P̸	J	2	1	L	220	

SUBJECT 3

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
47	U O P R		R		1		L	145	
48		L T C G		L T C G		4	R	150	
49	V M Y D		V M̸ Y̸ P̸		1		L	110	
50	Z O L U		Z U		2		L	135	
51	◒ ◐ ◐ O	● ◐ θ ◒	Ø Ø Ø O		1	0	R	185	
52	J I X Z	A C R T	J Z	¢	2	0	L	175	
53	F Q J K		F Q J K		4	0	L	135	
54	B L A N K						NM	---	
55		P K T J		P̸ K T J		3	R	145	
56	H C R N	A P X K	C K̸ N	A	2	1	L	225	
57	◐ ◒ ◐ O	θ ● θ ◐		O O O O	0	4	NM	---	
58		C N X I		C N X		3	R	155	
59	◐ O θ ◐	◒ ◒ ◔ ◐	Ø O Ø Ø	Ø O	1	1	R	185	
60	○ ◔ ○ ◐	◔ ◔ ● ●		O O O Ø	0	3	L	215	
61		E R Y I		E N̸ X T̸		2	R	155	

SUBJECT 3

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
62	5 9 1 2	6 4 8 3	5 9 1 6̸		3	0	L	200	
63	θ ◐ ⊕ 0	◐ ● ◐ θ	0 0̸		1	0	NM	---	
64	B L A N K						NM	---	
65	4 6 1 7	2 0 3 9	4 7 1 -	3̸	2	0	R	215	
·66	● ◐ θ ◐	0 ⊕ θ ●	0		1	0	R	220	
67	B L A N K						L		460
68		N D C E		E		1	R	160	
69	0 ◐ ◐ ●	◐ θ θ ●		0 0	0	2	R	180	
70	7 5 8 1	9 4 0 6	7 - 8 1	9 6̸	3	1	L	195	
71	0 9 6 1	3 5 4 2	4̸ 1	5̸ 2̸	1	0	R	175	
72	1 9 6 0	2 7 8 3	1 6̸	7̸	1	0	L	225	
73	A T X R	W V L C	A T N̸ W̸		2	0	L		290
74	B L A N K						NM	---	
75	S H L I		5̸ H		1		R	130	
76	A J Q B	R V C P	A J B̸ K̸		2	0	L	170	

SUBJECT 3

T	Left	Right	L	R	Score		FM	Latency 250	250+
						P			
77	9 7 1 0	6 4 2 3	7 7 1 Ø		2	0	L	190	
78	● θ θ θ	◐ ◐ θ ◐	0 Ø 0 Ø	Ø Ø 0 Ø	2	1	L	190	
79	◐ θ θ θ	θ ◐ ◐ 0	0 Ø	0	1	1	L	230	
80	A S Z H		Ø 4		0		R	155	
81	7 0 1 6	4 5 8 2	7 4 1 6		3	0	L	185	
82	0 ◐ ● ◐	◐ 0 θ ◐	0 0	0 Ø 0	2	2	R	190	
83	8 2 0 3	5 7 6 1	- 2 1 3	5	2	1	R	120	
84	B M O E	T U D I	- M Ø E	T	2	1	NM	---	
85	0 2 1 3	9 6 7 5	1 3	9 6	2	2	R	220	
86		J A X L		J A X		3	R	135	
87		T L D N		D N		2	R	155	
88		Q L B M		Q L B M		4	R	145	

SUBJECT 3

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	Second
1	R O U L	G S V H	R O U L		4	0	160L	NM
2		V T W Q		V T W Q		4	150R	820R
3		Z V U K		Z V U K		4	160R	NM
4		B S X C		B S X C		4	120R	500R
5	G E N K	L Z Q V	G E N K	L Z Q V	4	4	240L	520R
6		C D G J		C D G J		4	150R	450R
7	E S H M		E S H M		4		125L	630R
8	E U N M	X V L K	E U N M	X V	4	2	175L	600R
9	J M W G		J ~~M~~ ~~W~~ G		2		120L	1220R
10	N K F Q	C D S A	N K F Q	C D S	4	3	145L	790R
11	D E T R		D E T R		4		170L	530R
12	N G X K		N G ~~K~~ ~~X~~		2		130L	NM
13		R I X K		R I X K		4	120L	230R
14	S N T V		S N T ~~V~~		3		115L	230R
15		D I T H		D I T H		4	135R	570R

SUBJECT 3

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	EM Latency and Direction Second
16	R O K H	M V F S	R O K H	M V	4	2	125L	660R
17	W A D K		W A D K		4		175L	600R
18	K N O W	B X M H	K Ø W̸ N̸	B X M H	1	4	EB	

SUBJECT 4

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
1	K U Z V	A Y I P	I̸ P̸ A̸ V	V̸ K̸	1	0	L	160	
2		U C A L		L̸ C A K̸		2	R	130	
3	V D U P		T̸ V̸ P̸		0		L	130	
4	O R Z S		T̸ V̸ Z S		2		L	120	
5	1 6 7 8	4 3 5 2	1 6 7	2	3	1	L	180	
6	J U T D	C E F Q	J U T D	E̸ Q	4	1	L	170	
7	P X B L	Z Q G A	P X B L		4	0	L	140	
8	R T G N	M Q D F	K̸ T G N	M̸ D̸ Ø F	3	1	L	195	
9	6 9 0 8	1 2 4 7	6 9 0 1̸	8̸	3	0	L	145	
10	L M T J	Q A Y E	L M T J		4	0	L	120	
11	H W X D	O E K B	- M̸ X D	O E	2	2	L	150	
12		E G K U		E G Q̸ S̸		2	R	115	
13	1 2 9 0	6 7 8 4	1 2 Ø Ø̸	7̸ 8̸	2	0	EB	---	
14	3 7 1 9	2 0 4 6	3 7 1 Ø	9̸ 2̸ 4	3	1	L	135	
15	3 1 4 6	5 7 0 8	3 1 6̸ 4̸	5 7 0	2	3	EB	---	

SUBJECT 4

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
16	T C D O	W K L A	T C D O	I̸ W̸	4	0	L	150	
17	◒ ● ◐ θ	◒ ◐ O θ	Ø Ø		0	0	L	170	
18		R W V J		P̸ W V J		3	R	100	
19	D B H J		H J		2		L	130	
20	M Q D R	A O V C	M D̸ J̸ P̸	V̸ I̸	1	0	L	155	
21	◐ ◐ O θ	◐ ⊕ ⊕ ●	O Ø Ø Ø		1	0	L	175	
22	● ◐ θ ◐	O ◐ ● ◐	O O Ø Ø	O	2	1	L	155	
23	A F N O		A E̸ I̸ O		2		L	100	
24	B L A N K						R		590
25		L J I U		L I̸ I D̸		2	R	130	
26		O E G M		O E G M		4	L	205	
27	O ◐ ● ◐	θ θ ⊕ O	O	O O O Ø	1	3	NM	---	
28	B L A N K						NM	---	
29	T R X C		T X̸ K̸		1		L	130	
30	I E M C	[illegible] C U Y	I E		2	0	L	240	
31	9 2 5 [illegible]	[illegible] 4 8 7	5 6	1 4	2	2	L	180	

SUBJECT 4

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
32		Z Q S E		M̸ Q S E		3	R	130	
33		T B S A		- B S A		3	R	155	
34	I Q O L		L̸ Q Ø		1		L	160	
35	3 7 0 2	5 4 8 6	3		1	0	L	180	
36		C U A L				0	R	115	
37	BLANK						L		370
38	A H N O	I L D K	A M̸ N O	I K	3	2	L		670
39	O ◐ ◑ ◓	◐ ◑ O ◒		0 0 0 Ø	0	3	L		440
40	U J C G		E̸ G		1		L	130	
41	F R C S		F R̸ S̸		1		L	185	
42	BLANK						NM	---	
43	H Q M K		E̸ H̸ K̸ J̸		0		L	150	
44	A U X Z		A V̸ E̸ Z		2		L	130	
45	◒ ◐ ● O	◒ ◑ ◒ ◑	Ø Ø Ø O		1	0	L		420
46	K V L T	J P C D	K V L T	P̸ J̸ Ø	4	0	NM	---	

SUBJECT 4

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
47	U O P R		U̸ O		1		L	130	
48		L T C G		L T̸ C		2	R	115	
49	V M Y D		V T̸ P̸		1		L	130	
50	Z O L U		Z P̸ L X̸		1		L	120	
51	◒ θ ◐ O	● ◐ θ ◒	Ø O Ø Ø	Ø	1	0	L		550
52	J I X Z	A C R T	J I X	T	3	1	L	220	
53	F Q J K		F C̸ K̸		1		L	195	
54	B L A N K						NM	---	
55		P K T J		P Ø T J̸		2	R	110	
56	H C R N	A P X K	H C̸ N̸ P̸	Ø	1	0	L	230	
57	◐ ◒ ◐ O	θ ● θ ◐	Ø O Ø Ø		1	0	L		430
58		C N A I		C N N̸ I		3	R	120	
59	◐ O θ ◐	◒ ◒ θ θ	Ø Ø Ø O	O	1	1	L	200	
60	◒ ◒ θ ◐	◒ ◒ ● ◒	Ø O O O	Ø	3	0	L	230	
61		E R Y I		C̸ A̸ X I		2	R	110	

SUBJECT 4

T	Left	Right	L				R				Score L	Score R	EM	Latency 250	Latency 250+
62	5 9 1 2	6 4 8 3	5	9	1	2	4̸				4	0	L	160	
63	θ ◐ ⊕ O	⦶ ◓ ◐ θ	Ø	0	0	Ø	Ø			0	2	1	L		420
64	B L A N K												NM	---	
65	4 6 1 7	2 0 3 9	4	6	1	7	Ø	3̸			4	0	L	195	
66	◒ ◐ θ ◑	O ⊕ θ ●	0	Ø	Ø	Ø			0	0	1	2	L		460
67	B L A N K												NM	---	
68		N D C E					A̸	B̸	C	E		2	R	120	
69	O ◑ ◐ ◒	⦶ θ θ ◓									0	0	R	220	
70	7 5 8 1	9 4 0 6	7	5	8	1	9	4			4	2	L	240	
71	0 9 6 1	3 5 4 2	0	6̸	1̸	5̸	3̸	2̸			1	0	L	160	
72	1 9 6 0	2 7 8 3	1	9	6	0	7			3	4	1	L		560
73	A T X R	W V L C	A	T	X	-	W			C	3	2	NM	---	
74	B L A N K												NM	---	
75	S H U I		A̸	X̸	W̸	I					1		L	110	
76	A J Q D	R V C P	A	J	Q	P̸					3	0	NM	---	

SUBJECT 4

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
77	9 7 1 0	6 4 2 3	9 7 1 0	6 3̸	4	1	L	195	
78	● ⦶ ⊕ ⦶	◒ ◓ ⦶ ◒	0 Ø 0 Ø		2	0	L		340
79	◒ ⦶ ⊕ ⦶	θ ◐ ◑ 0	Ø Ø Ø Ø	0	0	1	L		450
80	A S Z H				0		R	110	
81	7 0 1 6	4 5 8 2	7 0 1 5̸	4 6̸ 3̸	3	1	L	230	
82	0 ◐ ● ◓	◐ 0 ⦶ ◐	0 Ø Ø Ø		1	0	L		440
83	8 2 0 3	5 7 6 1		5 2̸ Ø 1	0	2	L	165	
84	B M O E	T U D I	B M O T̸	M̸ I	3	1	NM	---	
85	0 2 1 3	9 6 7 5	0 2 1 3	5̸ 9̸ 7 5	4	2	NM	---	
86		J A X L		J K̸ A̸ L		2	R	155	
87		T L D N		T I̸ Ø N		2	R	140	
88		Q L B M		Q I̸ B M		3	R	125	

SUBJECT 4

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	Second
1	R O U L	G S V H	R O U L	G ~~M~~ ~~S~~	4	1	140L	860R
2		V T W Q		V T W Q		4	105R	NM
3		Z V U K		Z V U K		4	110R	NM
4		B S X C		B S ~~K~~ C		3	125R	1560R
5	G E N K	L Z Q V	G E N -	L Z O	3	3	250L	1060R
6		C D G J		C D G ~~Z~~		3	110R	1000R
7	E S H M		E S H M		4		120L	740R
8	E U N M	X V L K	E U N M	X K	4	2	230L	1270R
9	J M W G		J M W G		4		110L	840R
10	N K F Q	C D S A	~~W~~ K F Q	C D S ~~T~~	3	3	185L	860R
11	D E T R		D E T R		4		90L	730R
12	N G X K		N G X K		4		110L	1210R
13		R I X K		R I X K		4	90R	NM
14	S N T V		S N T V		4		110L	640R
15		D I T H		D I T H		4	105R	500R

SUBJECT 4

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	Second
16	R O K H	M V F S	R O K H	M S	4	2	220L	650R
17	W A D K		W A D K		4		140L	630R
18	K N O W	B X M H	~~K~~ ~~W~~ O W	B ~~N~~ ~~Q~~	2	1	230L	660R

SUBJECT 5

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
1	K U Z V	A Y I P	K U		2	0	EB	---	
2		U C A L		A L		2	R	170	
3	V D U P		V		1		L	120	
4	O R Z S		O		1		L	155	
5	1 6 7 8	4 3 5 2	1 6 8̸ 7̸	4 5̸	2	1	NM	---	
6	J U T D	C E F Q	J U T C̸	D̸	3	0	L	235	
7	P X B L	Z Q G A	P L	Z	2	1	L	185	
8	R T G N	M Q D F	G N	M	2	1	EB	---	
9	6 9 0 8	1 2 4 7	8	1	1	1	L	175	
10	L M T J	Q A Y E	L M T J		4	0	NM	---	
11	H W X D	O E K B	M̸ W X Ø		2	0	NM	---	
12		E G K U		E G H̸ U		3	R	210	
13	1 2 9 0	6 7 8 4	1 - 9 0	6	3	1	EB	---	
14	3 7 1 9	2 0 4 6	- 7 1 9		3	0	NM	---	
15	3 1 4 6	5 7 0 8	- 1 4 6		3	0	L	200	

SUBJECT 5

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
16	T C D O	W K L A	T C D O	W	4	1	NM	---	
17	⊖ ● ◐ θ	⊖ ◐ O θ	O Ø		1	0	L	195	
18		R W V J		R W M̸ J		3	R	155	
19	D B H J				0		R	175	
20	M Q D R	A O V C	M̸ Q Ø R		2	0	NM	---	
21	◐ ◐ O θ	◐ ⊕ ⊕ ●	Ø Ø Ø O	O	1	1	NM	---	
22	● ◐ θ ◐	O ◐ ● ◐	O Ø Ø Ø		1	0	L		730
23	A F N O		A		1		L	210	
24	B L A N K						R	170	
25		L J I U		L M̸ I̸ J		2	R		870
26		O E G M		O E G M		4	R	175	
27	O ◐ ● ◐	θ ⊕ ⊕ O	O O	- O O Ø	2	2	NM	---	
28	B L A N K						NM	---	
29	T R X C		T M̸		1		L	205	
30	I E M C	Z O U N	- E M C	Z	3	1	NM	---	
31	9 2 5 6	1 4 8 7	- 2 5 6	- 8̸	3	0	NM	---	

SUBJECT 5

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
32		Z Q S E		Z Q		2	R	175	
33		T B S A		T B S A		4	R	155	
34	I Q O L		I		1		EB	---	
35	3 7 0 2	5 4 8 6	3 7 0 2		4	0	NM	---	
36		C U A L		C U A L		4	R		610
37	B L A N K						NM	---	
38	A H N O	I L D K	A H N O	I L	4	2	L	145	
39	O ◐ ◐ θ	◐ ◐ O ◒	O O	O	2	1	NM	---	
40	U J C G		U		1		NM	---	
41	F R C S		F S		1		L	210	
42	B L A N K						NM	---	
43	H Q M K		K		1		L	190	
44	A U X Z		A U		2		L	220	
45	◒ ◐ ● O	◒ ◐ ◒ ◐	O	O O	1	2	NM	---	
46	K V L T	J P C D	K - L T	D	3	1	L		480

SUBJECT 5

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
47	U O P R		U O R̸ P		2		L		270
48		L T C G		L T C		3	R	190	
49	V M Y D		V		1		EB	---	
50	Z O L U		Z O L ₵		3		L	135	
51	◒ Ø ◐ O	● ◐ θ ◒	Ø Ø O O		2	0	NM	---	
52	J I X Z	A C R T	J X̸		1	0	L		540
53	F Q J K		F̸		0		L	240	
54	B L A N K						NM	---	
55		P K T J		P K T J		4	R	155	
56	H C R N	A P X K	N̸ ₵	K̸	0	0	NM	---	
57	◐ ◒ ◐ O	θ ● θ ◐	O O	O O	2	2	NM	---	
58		C N X I		C N X I̸		3	R	150	
59	◐ O θ ◐	◒ ◒ θ Ø	O		1	0	L		660
60	θ θ Ø ◐	◐ O ● ●	O O	O O	2	2	NM	---	
61		E R X I		E R		2	R		950

SUBJECT 5

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
62	5 9 1 2	6 4 8 3	4 9 1 2		3	0	L		630
63	θ ◐ ⊕ O	⦶ ◓ ◐ θ	Ø Ø 0		1	0	NM	---	
64	B L A N K						NM	---	
65	4 6 1 7	2 0 3 9	1 7	2 0	2	2	L		540
66	◒ ◐ θ ◐	O ⊕ θ ●		0 0 0 0	0	4	L		680
67	B L A N K						EB	---	
68		N D C E		N̸ C̸ D̸ E		1	R	215	
69	O ◐ ◐ ◒	⦶ θ θ ◓	Ø Ø Ø 0	0	1	1	L		410
70	7 5 8 1	9 4 0 6	- 5 8 1	9	2	2	L		680
71	0 9 6 1	3 5 4 2	- 9 - 1	3 5	2	2	L		550
72	1 9 6 0	2 7 8 3	1 9 6 0	5̸	4	0	L		760
73	A T X R	W V L C	A T X		3	0	L	200	
74	B L A N K						NM	---	
75	S H U I				0		R		920
76	A J Q B	R V C P	A - Q B		3	0	NM	---	

SUBJECT 5

T	Left	Right		L	R	Score L	Score R	EM	Latency 250	Latency 250+
77	9 7 1 0	6 4 2 3		1 0	6	2	1	EB	---	
78	● ◐ ⊕ ◐	◒ ◓ ◐ ◒		∅ ∅	∅ 0 0 ∅	0	2	NM	---	
79	◒ ◐ ⊕ ◐	⊖ ◐ ◐ 0	0			1	0	L		560
80	A S Z H					0		L		560
81	7 0 1 6	4 5 8 2		1 5̸	4	1	1	NM	---	
82	0 ◐ ● ◓	◐ 0 ◐ ◐	0			1	0	NM	---	
83	8 2 0 3	5 7 6 1		3	6̸ 7	1	1	L		490
84	B M O E	T U D I		E	T	1	1	NM	---	
85	0 2 1 3	9 6 7 5		1 3	9	2	1	L		410
86		J A X L			J A		2	R	150	
87		T L D N			T L D N		4	R		690
88		Q L B M			Q M		2	NM	---	

SUBJECT 5

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	Second
1	R O U L	G S V H	R O U L	G	4	1	185L	500R
2		V T W Q		V T W Q		4	170R	NM
3		Z V U K		Z V U K		4	150R	870R
4		B S X C		B S X C		4	130R	720R
5	G E N K	L Z Q V	G E N K	L Z	4	2	145L	630R
6		C D G J		C D G J		3	135R	530R
7	E S H M		E S H M		3		195L	NM
8	E U N M	X V L K	E U N M	X V L	4	3	215L	520R
9	J M W G		J M W		3		140L	800R
10	N K F Q	C D S A	N K F Q	C	4	1	200L	670R
11	D E T R		D E T T		4		250L	850R
12	N G X K		N G X K		4		155L	820R
13		R I X K		R I X K		4	145R	700R
14	S N T V		S N T V		4		140L	760R
15		D I T H		D I T H		4	160R	650L

SUBJECT 5

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	EM Latency and Direction Second
16	R O K H	M V F S	R O K H	M V F	4	3	185L	830R
17	W A D K		W A D K		4		130L	NM
18	K N O W	B X M H	J N O W	B	4	1	170L	650R

SUBJECT 6

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
1	K U Z V	A Y I P	K U Z		3	0	L	140	
2		U C A L		U		1	R	210	
3	V D U P				0		R	235	
4	O R Z S				0	R	250		
5	1 6 7 8	4 3 5 2	1 Ø 7 8	~~3~~ ~~4~~ 5	3	1	L	200	
6	J U T D	C E F Q	J U T D	C Q	4	2	L	210	
7	P X B L	Z Q G A	P X B L	A	4	1	L	170	
8	R T G N	M Q D F	R T G		3	0	L		410
9	6 9 0 8	1 2 4 7	6 9 0 8	1	4	1	L	180	
10	L M T J	Q A Y E	L M ~~K~~		2	0	L	190	
11	H W X D	O E K B	H - X D		3	0	L		970
12		E G K U		E G		2	R	155	
13	1 2 9 0	6 7 8 4	1 2 9 0	6 7 ~~4~~	4	2	NM	---	
14	3 7 1 9	2 0 4 6	3 7 1 9	Ø ~~2~~ ~~6~~	4	0	L		470
15	3 1 4 6	5 7 0 8	3 1 4 6	~~8~~ 7	4	1	L	195	

SUBJECT 6

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
16	T C D O	W K L A	T C D O	~~L~~ ~~W~~	4	0	L	240	
17	◒ ● ◐ θ	◒ ◐ O θ	O O O		3	0	NM	---	
18		R W V J		R W ~~J~~		2	R	210	
19	D B H J		D		1		L	130	
20	M Q D R	A O V C	~~M~~ Q - R		2	0	L		550
21	◐ ◐ O θ	◐ ⊕ ⊕ ●	Q	O	1	1	NM	---	
22	● ◐ θ ◐	O ◐ ● ◐		O O O	0	3	R		420
23	A F N O		A F		2		L	150	
24	B L A N K						L		970
25		L J I U		L		1	R	170	
26		O E G M		O ~~H~~ ~~C~~ M		2	R	205	
27	O ◐ ● ◒	θ ⊕ ⊕ O	O	O	1	1	L	235	
28	B L A N K						NM	---	
29	T R X C		T C		2		L	190	
30	I E M C	Z O U N	~~T~~ E M C	Z O	3	2	L		500
31	9 2 5 6	1 4 8 7	9 2 5 6	1	4	1	EB	---	

SUBJECT 6

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
32		Z Q S E		Z Q - E		3	R	220	
33		T B S A		T A		2	R	145	
34	I Q O L		L̸ D̸ Q̸ L		1		L	155	
35	3 7 0 2	5 4 8 6	3 7 0 2	Ø 5 8 6	4	3	L		430
36		C U A L		C N̸ - L		2	L	200	
37	B L A N K						NM	---	
38	A H N O	I L D K	A H N O	I L - K̸	4	2	L		510
39	O ◐ ◑ θ	◐ ◑ O ◒	Ø	Ø	0	0	NM	---	
40	U J C G		F̸		0		L	240	
41	F R C S		F		1		L		370
42	B L A N K						R		000
43	H Q M K		A̸ Q M		2		L	190	
44	A U X Z		A Z		2		L	215	
45	◒ ◐ ● O	◒ ◐ ◒ ◑	O	O O O Ø	1	3	NM	---	
46	K V L T	J P C D	K V L T	¢	4	0	L		670

SUBJECT 6

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
47	U O P R				0		L	140	
48		L T C G		L T C G		4	R	190	
49	V M Y D		V M		2		L	210	
50	Z O L U		Z Ø - W̸		1		L	230	
51	◒ ◑ ◐ O	● ◐ θ ◒	O O O		3	0	L		450
52	J I X Z	A C R T	J I X Z		4	0	L		580
53	F Q J K		F Ø M̸		1		L	165	
54	B L A N K						NM	---	
55		P K T J		P T̸		2	R	205	
56	H C R N	A P X K	H C P̸ N̸	K̸	2	0	L		470
57	◐ ◓ ◐ O	θ ● θ ◐	O O	Ø Ø	2	0	L		660
58		C N X I		C I		2	R	160	
59	◐ O θ ◐	◒ ◒ ◓ ◑		O O O Ø	0	3	NM	---	
60	θ ◓ ◑ ◐	G C ● ●	O O O Ø	Ø Ø	3	0	L		480
61		E R X I		E R - T̸		2	R	175	

SUBJECT 6

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
62	5 9 1 2	6 4 8 3	5 9 1 2	6 4	4	2	L		400
63	θ ◐ ⊕ 0	◍ ◓ ◐ θ	0 - 0 0	0	3	1	NM	---	
64	B L A N K						R		990
65	4 6 1 7	2 0 3 9	4 6 1 7	2 3̸ 9̸ 0̸	4	1	L		390
66	◒ ◐ θ ◑	0 ⊕ θ ●	0 0̸ 0̸ 0̸	0̸ 0̸ 0̸	1	1	NM	---	
67	B L A N K						NM	---	
68		N D C E		- D C E		3	R	180	
69	0 ◐ ◐ ◒	◍ θ θ ◓	0	0 0̸ 0̸ 0̸	1	1	L		610
70	7 5 8 1	9 4 0 6	7 5 8 1	9 6̸ 4̸ 6	4	2	L	230	
71	0 9 6 1	3 5 4 2	9̸ 6̸ 1̸ 5̸	8̸ 2	0	1	L		440
72	1 9 6 0	2 7 8 3	1 9 0̸ 6̸	2 7 3̸	2	2	EB	---	
73	A T X R	W V L C	A T X R	V̸	4	0	L	135	
74	B L A N K						NM	---	
75	S H U I		S M̸ T̸ I		2		L	150	
76	A J Q B	R V C P	A J Q B	P̸	4	0	L		390

SUBJECT 6

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
77	9 7 1 0	6 4 2 3	9 7 1 Ø	Ø 3	3	1	L	240	
78	● 0 θ 0	● ● 0 ●		0 0 0 Ø	0	3	NM	---	
79	● 0 θ 0	θ ● ● 0	0	0 0 Ø Ø	1	2	NM	---	
80	A S Z H				0		R	175	
81	7 0 1 6	4 5 8 2	7 0 1 6	4 2	4	1	R		890
82	0 ● ● ●	● 0 0 ●	0 0	0	2	1	L		590
83	8 2 0 3	5 7 6 1	8 2 3 Ø	5 8 - 1	2	1	L	155	
84	B M O E	T U D I	B M O T		3	0	L		380
85	0 2 1 3	9 6 7 5	0 2 1 3	9 7	4	1	L	220	
86		J A X L		J A X L		4	R	155	
87		T L D N		T Ø		1	R	195	
88		Q L B M		Q M		2	R	215	

SUBJECT 6

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	Second
1	R O U L	G S V H	R O U L	¢ Ⱥ $ Ƶ	4	0	470L	1290R
2		V T W Q		V T W Q		4	190R	580R
3		Z V U K		Z V U K		4	150R	1030R
4		B S X C		B S X C		4	165R	490R
5	G E N K	L Z Q V	G E N K	L Z Ø V	4	3	235L	550R
6		C D G J		C D G J		4	185L	670R
7	E S H M		E S H M		4		155L	810R
8	E U N M	X V L K		X - L K		3	240L	660R
9	J M W G		J M W G			4	120L	780R
10	N K F Q	C D S A	N K F Q	A	4	1	210L	630R
11	D E T R		D E T R		4		310R	610R
12	N G X K		N G X K		4		135R	540R
13		R I X K		R I X K		4	180R	540R
14	S N T V		S N T V		4		155L	560R
15		D I T H		D I T H		4	135R	550L

SUBJECT 6

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction: Initial	EM Latency and Direction: Second
16	R O K H	M V F S	R O K H	M ~~A~~ F S	4	3	235L	600R
17	W A D K		W A D K		4		205L	NM
18	K N O W	B X M H	K N O W	B X ~~X~~ ~~Z~~	4	1	185L	550R

SUBJECT 7

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
1	K U Z V	A Y I P	K		1	0	L	220	
2		U C A L		I 4		0	R	170	
3	V D U P		D P		1		R	230	
4	O R Z S		Q E		0		R	130	
5	1 6 7 8	4 3 5 2	1 6	2	2	1	L	210	
6	J U T D	C E F Q	J D	C E F	2	3	L	130	
7	P X B L	Z Q G A	L	Z	1	1	NM	---	
8	R T G N	M Q D F	R G	N	2	1	L	185	
9	6 9 0 8	1 2 4 7	6 7 0 9		2	0	L	215	
10	L M T J	Q A Y E	J	Q	1	1	NM	---	
11	H W X D	O E K B	H M X D	O E	3	2	NM	---	
12		E G K U		E G K U		4	R	150	
13	1 2 9 0	6 7 8 4	0	6 7	1	2	NM	---	
14	3 7 1 9	2 0 4 6	1 9		2	0	L	160	
15	3 1 4 6	5 7 0 8	- 1 4 6		3	0	L	155	

SUBJECT 7

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
16	T C D O	W K L A	T C D		3	0	NM	---	
17	θ ● θ θ	θ θ O θ	Ø		0	0	R		970
18		R W V J				0	R	185	
19	D B H J		Ø B H		2		L	220	
20	M Q D R	A O V C	M Q D R	T	3	1	L	185	
21	θ θ O θ	θ θ θ ●	O	O O O	1	3	R	160	
22	● θ θ θ	O θ ● θ	O O O Ø	O Ø	3	1	L		370
23	A F N O		A		1		R	170	
24	B L A N K						NM	---	
25		L J I U		M L I U		2	R	140	
26		O E G M		O E G M		4	R	155	
27	O θ ● θ	θ θ θ O		O O O	0	3	R		255
28	B L A N K						NM	---	
29	T R X C				0		R	160	
30	I L M C	7 O U N	M	C Z	1	2	R	185	
31	9 2 5 3	1 4 8 7	- 2 5 6	1	3	1	L	140	

SUBJECT 7

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
32		Z Q S E		Z		1	R	145	
33		T B S A		T		1	R	175	
34	I Q O L		¢		0		R	170	
35	3 7 0 2	5 4 8 6	3 7 - 2		3	0	NM	---	
36		C U A L	C Ƶ A			2	R	135	
37	B L A N K						L	230	
38	A H N O	I L D K	A N̸ Ø R̸		1	0	L	250	
39	O ◐ ◑ ⊖	◐ ◑ O ◒	O O O		3	0	L	155	
40	U J C G		C G		2		L	195	
41	F R C S		A̸ S		1		L	190	
42	B L A N K						NM	---	
43	H Q M K				0		R	150	
44	A U X Z		A H̸		1		L	155	
45	◒ ◐ ● O	◒ ◐ ◒ ◑	O	O	1	1	NM	---	
46	K V L T	J P C D	K - L T	J P	3	2	L	210	

SUBJECT 7

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
47	U O P R		N̸		0		R	130	
48		L T C G		L T C		3	R	180	
49	V M Y D		T̸ M		1		L	210	
50	Z O L U		Z		1		L	150	
51	◒ Φ ◐ O	● ◑ θ ◒	Ø Ø		0	0	NM	---	
52	J I X Z	A C R T	X Z	A	2	1	NM	---	
53	F Q J K		N̸		0		L	250	
54	B L A N K						NM	---	
55		P K T J		A̸ F̸ T J		2	R	165	
56	H C R N	A P X K	- C R	K	2	1	R		520
57	◐ ◓ ◐ O	θ ● θ ◑	Ø 0 Ø	0	1	1	NM	---	
58		C N X I		C N - I		3	R	150	
59	◐ O θ ◑	◒ ◒ ◓ Φ	0 0	0 0	2	2	L		260
60	◒ ◑ Φ ◐	◑ ◔ ● ●	Ø 0	0 0	1	2	NM	---	
61		E R X I		E		1	R	135	

SUBJECT 7

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
62	5 9 1 2	6 4 8 3		4 8 3	0	3	NM	---	
63	θ ◑ ⊕ O	⦶ ◓ ◐ θ	0	0	1	1	R		850
64	B L A N K						NM	---	
65	4 6 1 7	2 0 3 9	1 7	2 0	2	2	NM	---	
66	◒ ◐ θ ◑	O ⊕ θ ●		0 0	0	2	NM	---	
67	B L A N K						NM	---	
68		N D C E		N E		2	R	180	
69	O ◑ ◐ ◒	⦶ θ θ ◓	0	0	1	1	NM	---	
70	7 5 8 1	9 4 0 6	8 1	9	2	1	L	200	
71	0 9 6 1	3 5 4 2	6 1	3 5 4 2	2	4	NM	---	
72	1 9 6 0	2 7 8 3	1 - 6 0	2	3	1	L	230	
73	A T X R	W V L C	A - X R	W	3	1	L	200	
74	B L A N K						NM	---	
75	S H U I				0		R	230	
76	A J Q B	R V C P	A - Q B		3	0	L	220	

SUBJECT 7

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
77	9 7 1 0	6 4 2 3	1 0	6	2	1	NM	---	
78	● 0 0 0	0 0 0 0	0 0	0	2	1	NM	---	
79	0 0 0 0	0 0 0 0	0	0	1	1	NM	---	
80	A S Z H		A		1		L	185	
81	7 0 1 6	4 5 8 2	7 - 1 6	4	3	1	NM	---	
82	0 0 ● 0	0 0 0 0	0		1	0	NM	---	
83	8 2 0 3	5 7 6 1	8 3 0 2	7	1	0	NM	---	
84	B M O E	T U D I	B M O E	T U	4	2	L	215	
85	0 2 1 3	9 6 7 5	0 2 1		3	0	L		390
86		J A X L		J A X		3	R	210	
87		T L D N		T L D		3	R	175	
88		Q L B M				0	L	130	

SUBJECT 7

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	Second
1	R O U L	G S V H	R O U L	G S	4	2	760L	NM
2		V T W Q		V T W Q		4	210R	NM
3		Z V U K		Z V U K		4	155R	NM
4		B S X C		B S X C		4	235R	800R
5	G E N K	L Z Q V	G E N ~~K~~	~~L~~ ~~S~~ ~~Q~~ ~~V~~	3	0	130R	NM
6		C D G J		C D G J		4	EB	
7	E S H M		E S H M		4		200L	410L
8	E U N M	X V L K	E U N M	X V L	4	3	150L	970R
9	J M W G		J M W G		4		180L	880L
10	N K F Q	C D S A	N K F Q	C D	4	2	160L	NM
11	D E T R		D E T R		4		150L	NM
12	N G X K		N G X ~~L~~		3		185L	NM
13		R I X K		R I X K		4	160R	NM
14	S N T V		S N T V		4		165L	760L
15		D I T H		D I T H		4	125R	NM

SUBJECT 7

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	EM Latency and Direction Second
16	R O K H	M V F S	R O K H	M V F S	4	4	190L	610R
17	W A D K		W A D K		4		155R	810R
18	K N O W	B X M H	K N O W	B X M	4	3	185L	1220L

SUBJECT 8

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
1	K U Z V	A Y I P	K A̸ V̸	P	1	1	EB	---	
2		U C A L		U C A L		4	R	215	
3	V D U P		V D A̸ P		3		L	140	
4	O R Z S		O K̸ A̸ K		1		L	180	
5	1 6 7 8	4 3 5 2	1 4̸	8̸ 5̸	1	0	EB	---	
6	J U T D	C E F Q	J U C̸ T̸	Q	2	1	L	170	
7	P X B L	Z Q G A	P V̸ B L	Z U̸ - A	3	2	EB	---	
8	R T G N	M Q D F	R T G N	V̸ Ø - F	4	1	L	170	
9	6 9 0 8	1 2 4 7	9̸ 8̸ 7̸ 8		1	0	EB	---	
10	L M T J	Q A Y E	L M S M̸	Q̸ E	3	1	EB	---	
11	H W X D	O E K B	H N̸ X D	O K̸	3	0	L	145	
12		E G K U		E N̸ D̸ K̸		1	R	210	
13	1 2 9 0	6 7 8 4	1 - 9 0	6 7 8	3	3	L	170	
14	3 7 1 9	2 0 4 6	3 7 1 9	- 0 7 6	4	2	L		460
15	3 1 4 6	5 7 0 8	1̸ 1 4 6	7̸ 8̸ 6̸	3	0	L	190	

SUBJECT 8

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
16	T C D O	W K L A	T C D I	O W - A	4	3	L		260
17	◒ ● ◐ θ	◒ ◐ O θ	O O Ø		2	0	L		410
18		R W V J		K̸ M̸ V J		2	R	135	
19	D B H J		D B		2		L	155	
20	M Q D R	A O V C	M Q̸ R̸ Ø	A O	1	2	L	200	
21	◐ ◑ O θ	◐ ⊕ ⊕ ●	O O	O	2	1	NM	---	
22	● ◑ θ ◐	O ◐ ● ◐		O O O	0	3	NM	---	
23	A F N O		A N̸ F̸ O		2		L		430
24	B L A N K						L		370
25		L J I U		L J I U		4	R	135	
26		O E G M		O E - M		3	NM	---	
27	O ◐ ● ◒	θ ⊕ ⊕ O	O	O O O	1	3	R	205	
28	B L A N K						NM	---	
29	T R X C		T C̸		1		L	200	
30	I E M C	Z O U N	I E M		3	0	L		440
31	9 2 5 6	1 4 8 7	6	1 4	1	2	L	170	

SUBJECT 8

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
32		Z Q S E		Z Q ~~K~~ ~~L~~		2	R		490
33		T B S A		T ~~Z~~ S A		3	R	155	
34	I Q O L		~~T~~ Ø O L		2		L	155	
35	3 7 0 2	5 4 S 6	3 7 0 2	5 4 8	4	3	L		600
36		C U A L		C ~~K~~ A L		3	R	210	
37	B L A N K						NM	---	
38	A H N O	I L D K	A H N O	I - ~~J~~ K	4	2	L		530
39	O ◐ ◑ θ	◐ θ O ◒	O Ø O Ø	Ø	2	0	L		610
40	U J C G		U ~~Z~~ C ~~K~~		2		L	200	
41	F R C S		F ~~K~~		1		L	150	
42	B L A N K						NM	---	
43	H Q M K		H M Q		3		L	210	
44	A U X Z		A		1		L	135	
45	◒ ◐ ● O	◒ ◐ ◓ ◑		O O Ø Ø	0	2	L		490
46	K V L T	J P C D	K V L T	J P C D	4	4	L		420

SUBJECT 8

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
47	U O P R		L O K		1		L		430
48		L T C G		L T ¢ G		3	R	210	
49	V M Y D		V M Y D		4		L	230	
50	Z O L U		Z		1		L	190	
51	◒ ⦶ ◐ O	● ◑ θ ◒	O		1	0	L		410
52	J I X Z	A C R T	J I X Z	A	4	1	L		390
53	F Q J K		F K		2		L	200	
54	B L A N K						NM	---	
55		P K T J		P K T J		4	R	205	
56	H C R N	A P X K	H C R		3	0	NM	---	
57	◐ ◓ ◐ O	θ ● θ ◐			0	0	NM	---	
58		C N X I		C X		2	R	210	
59	◑ ○ θ ◑	◒ ◒ θ ⦶	Ø O O	O	2	1	NM	---	
60	○ ⊕ ⦶ ◐	◑ ○ ● ●	O O O	O O	3	2	L		390
61		E R X I		E M Ƶ I		2	R	215	

SUBJECT 8

T	Left	Right	L				R				Score L	Score R	EM	Latency 250	Latency 250+
62	5 9 1 2	6 4 8 3	5	6	1	2				3	4	1	L		410
63	θ ◑ ⊕ 0	⊕ ◒ ◐ θ	0	0					0	0	2	2	L		440
64	B L A N K												L		470
65	4 6 1 7	2 0 3 9	4	6	1	7	2	0			4	2	L		910
66	◒ ◐ θ ◑	0 ⊕ θ ●			0	0	0	0	-	0	2	3	L		480
67	B L A N K												NM	---	
68		N D C E					K̸	Ø	E̸	L̸		0	R	200	
69	0 ◑ ◐ ◒	⊕ θ θ ◒	0							0	1	1	EB	---	
70	7 5 8 1	9 4 0 6	7	5	8	1				6	4	1	NM	---	
71	0 9 6 1	3 5 4 2	0	9	6					8̸	3	0	L	250	
72	1 9 6 0	2 7 8 3	1	9	Ø	Ø̸	7̸	2̸	8	3	2	2	L		410
73	A T X R	W V L C	A	T	X	R	W	V	L̸	C	4	3	L		350
74	B L A N K												NM	---	
75	S H U I		S	U̸	V̸	M̸					1		NM	---	
76	A J Q B	R V C P	A	J	B̸	C̸				P	2	1	L		380

SUBJECT 8

T	Left	Right	L	R	Score L	Score R	EM	Latency 250	Latency 250+
77	9 7 1 0	6 4 2 3	9 7 1 0	6 4 2	4	3	L	250	
78	● ⦶ ⊕ ⦶	◒ ◓ ⦶ ◒	0	0 0	1	2	NM	---	
79	◒ ⦶ ⊕ ⦶	⊖ ◐ ◑ 0	0 - 0 0	0 0	3	2	L	245	
80	A S Z H		A Z̸ N̸ K̸		1		L	210	
81	7 0 1 6	4 5 8 2	7 0 1 6	2̸ 4̸ 8 2	4	2	NM	---	
82	0 ◐ ● ◓	◐ 0 ⦶ ◑	0	0	1	1	NM	---	
83	8 2 0 3	5 7 6 1	8 2 3̸ Ø	5 7	2	2	L	205	
84	B M O E	T U D I	K̸ N̸ O E	T U D	2	3	L		350
85	0 2 1 3	9 6 7 5	0 2		2	0	EB	---	
86		J A X L		L		1	NM	---	
87		T L D N		T L D N		4	R	190	
88		Q L B M		Z̸ Ø B M		2	R	175	

SUBJECT 8

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	Second
1	R O U L	G S V H	R O U L	G V M̸	4	2	220L	670L
2		V T W Q		V T W Q		4	190R	470L
3		Z V U K		Z V		2	165R	NM
4		B S X C		B S X C		4	185R	700L
5	G E N K	L Z Q V	G E N K	L Ø	4	1	230L	750R
6		C D G J		C D G J		4	155R	590L
7	E S H M		E S H N̸		3		195L	EB
8	E U N M	X V L K	- U N M	X V L	3	3	235L	770R
9	J M W G		J W̸ M̸ G		2		175L	970R
10	N K F Q	C D S A	N K F Q	S A	4	2	225L	830L
11	D E T R		D E T R		4		135L	850L
12	N G X K		N G X K		4		175L	940R
13		R I X K		R I X K		4	150R	NM
14	S N T V		S N T V		4		200L	500L
15		D I T H		D I T H		4	135R	690R

SUBJECT 8

T	Left	Right	L	R	Score L	Score R	EM Latency and Direction Initial	EM Latency and Direction Second
16	R O K H	M V F S	R O H M	- V K S	3	2	235L	750R
17	W A D K		W A D K		4		135L	EB
18	K N O W	B X M H	K N O W	B X M H	4	4	170L	930R