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NOTE

CROSS FIELD AND WITHIN FIELD INTEGRATION OF VISUAL INFORMATION*

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Abstract—Subjects were tested for their ability to match words sequentially presented to the same visual field and to different visual fields. When the match was made between visual fields the error rate was significantly greater than when the match was made within fields. The combining of information from both visual fields requires its transmission across the corpus callosum, and the possibility that information is lost during this process is discussed.

INTRODUCTION

A VARIETY of recent studies have demonstrated that information presented to the right and left visual fields is often processed more accurately and efficiently in one field, with field superiority varying depending upon the type of task required, FILBEY and GAZZANIGA [1], KIMURA [2], MOSCOVITCH and CATLIN [3], WHITE [4]. Generally it is found that the left field excels in handling spatially related tasks while the right excels in verbally related tasks (GIBSON, FILBEY and GAZZANIGA [5], GEFFEN, BRADSHAW and WALLACE [6], KLATZKY and ATKINSON, 1970; RIZZOLATTI, UMILTA and BERLUCCHI [8], MCKEEVER and HULING [9]. The difference has been attributed to the particular properties of the cerebral hemispheres, each of which only receives direct visual input from the contralateral visual field. For a hemisphere to process information presented to the ipsilateral visual field there must be a transfer of information between hemispheres via the corpus callosum (GAZZANIGA [10]).

The present experiment attempted to investigate the transfer process itself by comparing the accuracy of word matches when the match was between words presented to opposite visual fields and when the words were presented entirely to one visual field.

Apparatus

Stimuli were projected upon a rear projection screen masked to provide a 5½ in. × 4 in. opening in one wall of a sound proof booth. The subjects viewed the screen from a distance of 24 in. and the screen was constantly illuminated from the rear with light projected through a Kodak #47 Wratten filter (440 nm) and a Bausch and Lomb linear polarizer HN-32, the light intensity being 0.52 ft-L. A Kodak Carousel projector was used to present the stimuli superimposed upon the background illumination, this projector had a #47 filter in front of it, and the intensity was varied with an iris diaphragm from about 0.2 ft-L to about 0.5 ft-L depending upon the subject. Interior lighting for the booth was provided by a 20 W incandescent bulb reflecting 0.4 ft-L from the front of the screen. The stimulus projector shutter was electronically actuated for a duration of 40 ms.

METHOD

Subjects

A total of 13 right handed graduate and undergraduate students from New York University were tested. The subjects had not been used in similar experiments and were not informed of any theoretical aspects related to the study.

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Stimuli

The stimuli were made up of 200 frequent four letter nouns. Combinations of a stimulus word were randomly chosen, and combinations that happened to have obvious associations were excluded. Words were never used more than once except in the case where a positive stimulus match was presented. Word length subtended a visual angle of 3.3 degrees, and letter height subtended a visual angle of 1 degree. The words were always presented so that the nearest letter was 1 degree to the left or to the right of the 0.2 degree fixation point.

Procedure

Subjects were instructed to sit in the sound proof booth with their foreheads against the rest and to keep their fixation upon the dark central fixation point at all times. One word was then flashed either to the left or right of fixation, and three seconds later two words were simultaneously flashed with one to the left and one to the right. One half second before each stimulus presentation a short warning beep was sounded in the subjects' earphones which normally presented white noise. The subjects' task was to say "yes" as soon as possible if the first word was repeated and "no" if it was not.

At the same time as the warning beep a motor was pulsed to give a slight spin to the polarizing filter in front of the projector providing background illumination. This produces an effect known as Haidinger's Brush, a small revolving shadow due to a polarization sensitive area at the center of the fovea.* Subjects were instructed to keep this brush spinning about the fixation point, and if it was not on the point it meant that they were looking in the wrong place and to correct their gaze.

Altogether, 80 trials were run in one session on each subject, and all subjects received the same fixed random order. The trials were broken down into 4 blocks of 20 each, and at the end of each block the subjects were told how many errors they had made and were given a short rest. One half of the trials contained repeated words and the first word presentation occurred equally often to the left and right of fixation.

During the first block of trials intensity of the stimulus presentation was adjusted until the subject was making an appreciable number of errors.

RESULTS

The positive and negative response trials were analyzed in separate ANOVAS since the positive trials could be broken down along two variables, the field presentation of the first word and the field presentation of the matching word of the second pair, while the negative trials could only be broken down according to the field presentation of the first word.

Table 1. Data analysis for "yes" trials

1st stimulus	*L*		*R*	
2nd pair	*l*	*r*	*l*	*r*
% correct	67	52	53	75

F_{LR} = 2.22 df 1,12 $p>0.05$
F_{lr} = 0.99 df 1,12 $p>0.05$ 130 Trials/cell
$F_{LR\times lr}$ = 19.54 df 1,12 $p<0.05$

A Subjects × Field of first word × Field of matching word ANOVA was run on the positive trials, and Table 1 gives a summary of the results. The field of the first word presented is denoted by a large *L* or *R*, and the field of the matching word of the second pair is denoted by a lower case *l* or *r*. Neither the field of the first word nor the field of the second word had a significant effect upon the number of correct identifications ($p>0.05$). However, there was a significant interaction between the first field presentation and the field of the matching word ($p<0.05$). That is, the cross field combinations were significantly less accurate than the same field combinations. A separate analysis of variance between crossed and uncrossed presentations within first word left and first word right breakdowns revealed a significant difference in both cases ($F=7.73$, df 1, 12 $p<0.05$ and $F=12.1$, df 1, 12, $p<0.05$, respectively.

*We wish to thank Dr. Lloyd Kaufman for suggesting this method of correction for loss of fixation.

The negative response trials yielded a score of 86 per cent correct when the first word was presented to the left of fixaion and 85 per cent correct when the first word was presented to the right A subjects×. Field ANOVA of first word presentations showed no significant difference ($F=0.6$, df 1, 12. $p>0.05$).

DISCUSSION

The high error rate on cross field presentations supports the hypothesis that there is an information loss during transmission across the callosum and agrees with previous work with shapes (LORDAHL [11] and digits, DIMOND [12]. Equal hemisphere performance when the words are presented to the same visual fields indicates that there is no inherent advantage of one hemisphere over the other in this task and also suggests that the match may be performed on physical characteristics independent of the superior language handling ability of the left hemisphere. The fact that the subjects were unable to read the words presented at the same intensity that they could match further supports this notion.

Although the high error rate on crossed field presentations is consistent with the information loss hypothesis, it is also consistent with a hypothesis that the first word is preparing the hemisphere which receives it for the reception of the second word, thereby resulting in superior within field performance. Such an effect has been suggested in KINSBOURNE'S [13] work.

Further research with simultaneous stimulus presentations and different stimulus material should be able to distinguish between various hypothesis as to the cause of poorer cross field performance.

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Résumé—On a testé la capacité des sujets dans l'appariement de mots présentés en séquence au même champ visuel et aux champs visuels différents. Quand l'appariement a été fait entre les champ visuels, le taux d'erreurs était plus élevé de façon significative que lorsque l'appariement était fait dans les mêmes champs. La combinaison de l'information parvenant des deux champs visuels requiert sa transmission par le corps calleux et on discute la possibilité d'une perte de l'information durant ce processus.

Zusammenfassung—Versuchspersonen wurden gebeten, Wörter, die im linken Gesichtsfeld dargeboten wurden, mit vorausgegangenen Wörtern im gesamten Gesichtsfeld dargeboten, zu vergleichen. Dabei ergab sich eine größere Wortgenauigkeit für Expositionen im linken Gesichtsfeld. Dieses Ergebnis steht im Widerspruch zu der bisherigen Auffassung einer Dominanz des rechten Gesichtsfeldes für Worterkennen. Die linksseitige Feldüberlegenheit spricht dafür, daß das Erkennen von Wörtern auf einem vielfältig bestimmten Vorgang beruht und daß man nicht davon ausgehen darf, daß es sich bei der Leistungsstärke und Präzision der linken Hirnhälfte um eine invariable handelt.