Splitting the normal brain with reaction time[1]

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Two simple choice-reaction-time experiments were performed using tachistoscopic flashes containing a dot to the right or left of fixation or a blank field as stimuli. One experiment required a verbal response and the other a manual response to the presence or absence of a dot. Median verbal reaction times to a right dot averaged 386 msec, while those to a left dot or to a blank field averaged 419 and 420 msec, respectively. Median manual reaction times to a blank field averaged 382 msec, while those to a right or to a left dot averaged 336 and 341 msec, respectively. The 30-40 msec differences are taken to be a reflection of callosal transmission time, that is, the delay required for the information received in one hemisphere to be acted upon by the other hemisphere.

The two cortical mantles of the human brain are normally richly interconnected across the midline by the corpus callosum. For years, it was supposed that this structure, the largest fiber system in the brain, served no important neurological or psychological function. During the last 2 decades, however, a variety of experimental studies on animals and also on man have delineated, with striking clarity, the role this interhemispheric commissure system plays in maintaining normal behavioral unity (Sperry, 1961, 1964; Gazzaniga, 1967, 1969). In brief, these "split-brain" studies have shown that the callosum is utterly responsible for such routine functions as relaying sensory and motor information present in the right hemisphere over to the left and vice versa. With it intact, one can verbally describe all visual events to the left or right of fixation, but with it sectioned, only those events falling into the right visual field, which projects directly to the left speech hemisphere, can be described. Events occurring to the left of fixation, thereby going to the right hemisphere, cannot be described–indeed, they go unnoticed by the left hemisphere in the split-brain human.

With the new knowledge of what is not possible when a specific neural communication channel is absent, an important task is to study the system intact, with the aim of coming to a closer understanding of the logic and nature of the information-transmission mechanism. The following experiments are an attempt to delineate some of the characteristics of this information system.

EXPERIMENT 1

The strategy used in this experiment is to capitalize on the fact that usually only the left hemisphere is responsible for speech. Information presented directly to the left hemisphere ought to be reported sooner than that presented to the right hemisphere. The difference in reaction time between the two modes of stimulus presentation should reflect the time needed to transmit the information across the callosum.

Method

Eight right-handed female coeds were instructed, following the onset of a warning buzzer, to fixate a specific point in the visual field. Following the flash containing the stimulus, they were instructed to make a verbal response indicating the presence or absence of a dot as quickly as possible and without making an error. In brief, a dot or a blank was presented tachistoscopically for 0.1 sec, being preceded 1.5 sec by a warning buzzer. The dot was presented either 1 deg to the right or left of fixation. Half of the Ss were instructed to be "dot detectors," verbally responding "yes" to the presence of a dot and "no" to a blank. The remaining Ss were instructed to be "blank detectors," responding "yes" to a blank and "no" to a dot presentation. In 5 days of testing, three banks of 20 trials plus 4 warm-up trials were run each day. Each bank of 20 trials was broken up into five blocks of four stimuli (blank, right dot, left dot, blank) that were block-randomized. Ss were given a 30-sec rest period between each bank of 20 trials. Each day of testing took about 20 min per S. The onset of the test flash started a millisecond timer that was stopped by a voice-operated relay, triggered by the S's spoken word into a nearby crystal microphone. The elapsed time for each correct response was recorded. Correct response times were also reported to the S to keep motivation at a high level during the task. Error trial times were not included in the data nor were the following four mock trial times, although these latter times were reported to the S as usual. These "mock" trials were inserted because it was found that, following an error, the S's next two or three reaction times were highly variable. Four mock trials were used to keep the stimuli counterbalanced.

Results

The results of the last 2 days of testing are tabulated in Table 1. Verbal responses to right dots were a little over 30 msec faster than those for either left dots or blank fields. Table 2 shows these results to be significant.

Discussion

The data show that when a callosal transmission is necessary for either making the discrimination (as in the case of a blank presentation) or responding appropriately (as in the case of a dot appearing to the left of fixation), reaction times are slower by about an average of 30 msec. It could be argued that this difference is due to more peripheral perceptual variables (or to the right cortex simply not being as fast at this kind of task) rather than to the brain mechanisms outlined above. To investigate this criticism, the following study was performed.

EXPERIMENT 2

Method

Eight right-handed female Ss were used to replicate the previous experiment. Instead of giving a verbal response, however, they were instructed to give a manual response. This consisted of moving a lever to the right or left, depending on the stimulus. A small displacement of the lever to either side stopped the millisecond timer. Again, half of the Ss were instructed to be "dot detectors," moving the lever to the right if they saw a dot in the field and to the left if the field was blank. The remaining Ss were instructed to be "blank detectors," moving the lever to the right

Table 1

Ss	Verbal Response to Dot	Right Dot: Mean of Medians	Right Dot: Mean SD	Right Dot: % Error*	Left Dot: Mean of Medians	Left Dot: Mean SD	Left Dot: % Error*	Blank: Mean of Medians	Blank: Mean SD	Blank: % Error*
MM	Yes	438	37.3	3.2	482	35.8	3.2	458	50.1	0.0
DG	Yes	342	51.8	0.0	388	64.3	0.0	419	64.1	0.0
NS	Yes	284	40.0	0.0	337	52.0	0.0	368	51.6	0.0
SC	Yes	565	76.3	0.0	569	62.7	3.2	592	74.6	1.6
VS	No	359	38.8	0.0	368	31.5	3.2	344	58.8	1.6
CL	No	374	73.7	0.0	422	82.9	6.5	402	49.6	1.6
CF	No	330	58.4	3.2	397	76.7	3.2	364	80.3	0.0
TL	No	388	41.7	0.0	390	55.8	0.0	412	57.0	1.6
Average Over Ss		386	52.2	0.8	419	57.7	2.4	420	60.8	0.8

* *Percentage computation does not include mock trials.*