Background Information for Psychology 100 Lab Experiment on Lexical Decisions

Excerpts from pages 75-79 and 92 of Chapter 3 "Studying Asymmetries in The Normal Brain" of *Left Brain, Right Brain* (5th Edition) by Sally Springer and Georg Deutsch. New York: Freeman, 1998.

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VISUAL FIELD ASYMMETRIES

The investigation of visual asymmetries in normal subjects often resembles the testing situations used with split-brain patients. *Visual stimuli flashed briefly in the left visual field project first to the right hemisphere; stimuli flashed in the right visual field project initially to the left hemisphere*. In split-brain patients, this initial lateralization to one hemisphere or the other is maintained because the connections between the hemispheres have been cut. In a normal subject, however, the connections are intact and can transfer information presented to either hemisphere. Nevertheless, it was found that differences could be detected in a person's performance on certain tasks, depending on whether the task was presented to the right or the left visual field.

Visual-Field Differences: The Result of Reading Habits or a Sign of Hemispheric Asymmetry?

In the early 1950s, Mortimer Mishkin and Donald Forgays demonstrated that normal right-handed subjects were better at identifying English words briefly presented to the right of fixation than they were at identifying words flashed in the left visual field. However, when Yiddish words were presented in the same way to subjects who could read Yiddish, a slight advantage in favor of the left visual field was found. The authors concluded that experience with reading produces a "more effective neural organization [which] is developed in the corresponding cerebral hemispheres (left for English, right for Yiddish)." In other words, acquired directional reading habits result in better processing of written English in the right visual field, while Yiddish, a language that uses the Hebrew alphabet and reads from right to left, is processed more accurately in the left visual field!

This explanation enjoyed widespread acceptance for several years, although it did not address the question of why the advantage for the right visual field with English words was considerably greater than that for the left visual field with Yiddish words. A decade later, however, the publication of work with the California split-brain subjects suggested a reason for the lack of parallelism in the size of the visual-field differences. Split-brain subjects, as we have seen, showed dramatic differences in their ability to report printed English words in the left and the right visual fields. Those differences were interpreted as a reflection of the functional differences between the hemispheres for language. Perhaps, investigators began to think, the asymmetries found in the split-brain patients contribute to the visual-field differences found in normal subjects as well. Mishkin and Forgays' findings, then, may have been due to two factors operating simultaneously: *(1) the biases in favor of one visual field due to acquired reading habits in a particular language super-imposed on (2) an advantage for the right visual field resulting from differences between the left brain and the right brain.*

An important test of this two-factor interpretation came from later studies investigating visual-field asymmetries with English or Yiddish words presented vertically to minimize the possible role of directional scanning. With the effects of directional scanning reduced, the two-factor interpretation predicts that the functional differences between the hemispheres should produce a right-visual-field advantage for both Yiddish and English words. Precisely this result was found.

These findings, as well as a variety of other data that we will consider, lend support to the idea that visual-field differences in normal subjects reflect brain asymmetries in those subjects. This conclusion is an exciting one, for it suggests that differences between the left brain and the right brain found in clinical and split-brain subjects apply to the normal brain as well and that these differences can actually be studied in normal subjects.

Why Does Lateralized Presentation Result in Asymmetric Performance?

Before we turn to other evidence supporting the conclusion that visual-field differences reflect brain asymmetries in normal subjects, we should first address a fundamental issue. Even if there are functional differences between the hemispheres in normal subjects, why are they reflected in differences in performance for the two visual fields? Despite the initial lateralization or one-sided presentation, both hemispheres have access to all incoming information. Very brief presentations to one side of fixation [the point where the eyes are staring] ensure that a stimulus initially is projected directly to only one half of the brain, but the connections between the hemispheres can transmit information about the stimulus to the other side almost instantaneously. Why, then, do we find differences in performance between the visual fields?

Models of Hemispheric Specialization

There are two models of hemispheric asymmetry that are widely considered. The first, known as the **direct access model**, assumes that information will be processed by the hemisphere that first receives it, regardless of the differences in ability that may exist between the hemispheres. This is illustrated in Figure 3.1a. In other words, the first hemisphere to receive a task will be the one to handle it, although it may not be the one best equipped to do the job. *The direct access model, thus, predicts an advantage in performance for information that reaches the appropriately specialized hemisphere first, since processing by that hemisphere presumably would be better than processing by the other hemisphere.*

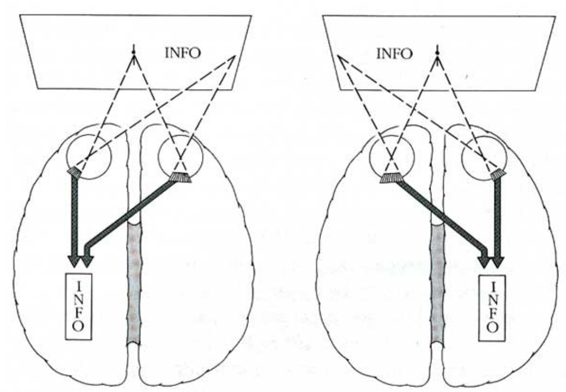

Figure 3.1a. In the direct access model, the hemisphere that receives the information first is the one that will process the material, regardless of its ability to do so.

The **relay model**, on the other hand, assumes that information is always processed by the hemisphere best equipped to deal with it. Material presented initially to the nonspecialized hemisphere, in this model, would have to reach the specialized hemisphere via the commissural fibers before processing could take place. *If this transfer results in some loss of clarity of information, as illustrated in Figure 3.1b, an advantage would be found for stimuli reaching the specialized hemisphere directly.*

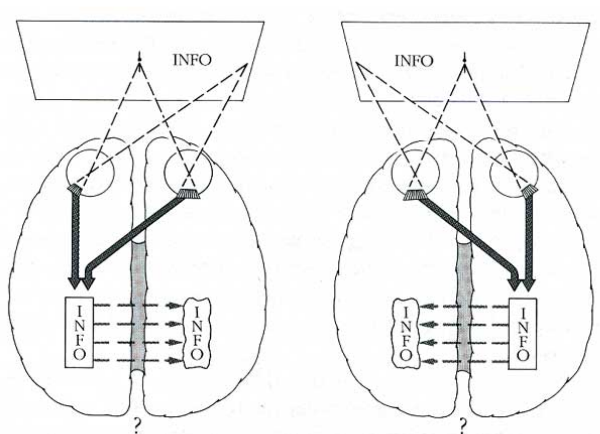

Figure 3.1b. In the relay model, information is processed by the hemisphere specialized to deal with it, regardless of the hemisphere that initially received the information.

In both models, asymmetries in performance between the visual fields emerge in tasks where the hemispheres do not have equal capacities to begin with. And in both, information presented directly 10 the hemisphere specialized for a specific function would be expected to produce better performance-that is, more accurate or faster responding-than one in which information goes first to the other half. They differ, however, in their view of the participation of the nonspecialized hemisphere, and in the role played by the cerebral commissures.

Perhaps the strongest evidence that visual-field asymmetries in normal subjects reflect underlying hemispheric differences is the similarity between these findings and what has been found in research with brain-damaged and split-brain patients. *Although a right-visual-field advantage is found with normal subjects in a variety of tasks using words and letters, subjects show a left-visual-field advantage for stimuli that are thought to be handled by the right hemisphere.*

For example, several studies have demonstrated that subjects recognize faces presented in the left visual field more quickly than those presented in the right visual field. Other work has shown that subjects more accurately remember the locations of dots presented on a card when the material is presented initially to the right hemisphere. *These findings provide strong support for the idea that visual-field differences reflect hemispheric differences: the right-visual-field advantage reflects left-hemisphere specialization for language functions, and the left-visual-field superiority results from right-hemisphere specialization for the processing of visuo-spatial stimuli.*

We should point out, though, that studies using nonverbal stimuli have not produced results as consistent as those found with words or letters. Some studies using nonsense forms and geometric shapes have shown no differences for the two visual fields; other studies have reported differences in performance. For the most part, however, the studies that do obtain differences between fields show the left visual field to be superior. The problem is that many studies that use stimuli believed by investigators to be processed by the right hemisphere do not find any differences between visual fields. This is reminiscent of the problems encountered when investigators started to look for evidence of special right-hemisphere functions in studies with brain-damaged patients. The functions of the right hemisphere proved to be much more elusive than those of the left.

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What Do the Tests Tell Us About the Nature of Asymmetries?

Yet another issue raised by dichotic and tachistoscopic studies is whether hemispheric differences are absolute or relative. Does a difference in performance between visual fields mean that only one hemisphere is capable of performing the task? Or does it simply reflect the fact that one hemisphere is better at the task than the other? The typical study with normal subjects does not allow us to tease apart these alternatives because performance in the "inferior" visual field may be the result of either less efficient processing by the nonspecialized hemisphere or processing by the specialized hemisphere after transfer of information across the commissures. In either case, we would expect the same results: a difference in performance between the two sides.