# Left is Not Necessarily Right

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Past investigations in pattern recognition have been used by some researchers as a reference point for studying cerebral asymmetry in terms of an analytic versus holistic processing model (Bagnara, Boles, Simion and Umilta, 1982; Taylor, 1976; Patterson and Bradshaw, 1975; Hock, 1973; Nickerson, 1971; and Bomber, 1969). In these investigations, an experimental paradigm requiring subjects to make same-different judgments was utilized to address the analytic versus holistic dichotomy. According to Bagnara et al. 1982), the theory of a two-process system of comparisons maintains that an analytic process is responsible for (slower) "different" judgments whereas a holistic process accounts for (faster) "same" judgments. The analytic process, associated with left brain function, is described as the encoding and decoding of a stimulus based on the individual features which comprise a stimulus. The analytic approach to decision making requires a feature-by-feature comparison resulting in longer reaction times for "different" judgments. In contrast, a holistic process, associated with right brain function, occurs by way of template matching and the interrelationships among the elements of the stimuli, resulting in the processing of information as a whole rather than by the processing of a stimulus feature by feature. This dual system of processing maintains that faster "same" responses are dictated by a holistic method whereas slower "different" judgments are the responsibility of an analytic process.

Taylor (1976) studied the reaction times of subjects making same-different judgments to successively presented letter pairs. He found that subjects' "different" reaction time judgments decreased with increases in the degree of difference between the two letters. More important to this discussion, Taylor found that "same" responses were significantly faster than "different" responses. Taylor concluded that "same" responses were governed by a faster holistic process since these judgments were unaffected by the degree of difference and number of segments to be analyzed. Bagnara et al. (1982) studied the analytic versus holistic hypothesis by looking at visual field superiority for same-different responses in eight male subjects. The subjects in this investigation were required to respond by pressing keys to visual stimuli. All visual stimuli followed a 500-msec warning signal period. Reaction times were analyzed for both left and right visual fields. The results of this experiment support previous investigations indicating faster reaction times for "same" responses than for "different" responses. Reaction times were shown to decrease with increases in the degree of differences for "different" judgments. The authors hypothesized that the results of this experiment suggest analytic processing for "different" responses and holistic processing for "same" responses. The authors' conclusion supported Taylor's hypothesis of a dual processing system of comparison.

Patterson and Bradshaw (1973) also addressed the analytic-holistic dichotomy. Like the previous investigations cited, these authors theorized that "same" responses were always faster than "different" responses. They concluded that "same" responses resulted from a nonfeature process and are associated with right hemisphere function. "Different" responses on the other hand, were associated with left hemisphere specialization. These are two basic methodological approaches of experimentation in this area. Some studies use tachistoscopic presentations to each visual field while others measure only reaction time of same-different judgments.

Even though an extensive data base exists for analytic versus holistic processing of visual stimuli, and left versus right brain preference, comparatively little is known with regard to the brain-injured population. Levy and Sperry (1968) and Sperry (1973), studying commissurotomized patients, suggested that the left hemisphere is indeed more specialized for analytic processing than the right. In addition, these authors described the specific holistic processing attributes of right brain function. These investigations begin to approach the effects of brain function on the analytic versus holistic model but data regarding visual processing for aphasic adults to date is limited.

The study of brain-damaged subjects' reaction time as an outcome variable is not new. Goldstein (1939) addressed decreased receptivity and increased reaction time for patients with central nervous system impairments. Blackburn and Benton (1955) studied thirty patients with cerebral disease and thirty patients with no history of cerebral impairment on choice and simple reaction time tasks. Blackburn and Benton's results indicated that the brain injured subjects had significantly slower reaction times than the control group did. Benton, Sutton, Kennedy and Brokaw (1962) demonstrated similar effects for a brain damaged group in an experiment involving reaction time to light stimuli preceded by a second stimulus. These results have been corroborated by Bruhn and Parsons (1971), Costa (1962), Kriendler and Fradis (1968) and DeRenzi and Faglioni (1965). Loverso and Prescott (1981) demonstrated longer reaction times and proportionately more errors in a complex decision-making task for fifteen aphasic subjects compared to a non-brain-damaged group. While these authors found longer reaction times and more errors for the brain damaged group, no analysis of speed and accuracy by decision type was offered. Since the dual system of processing (holistic/analytic) has been theorized to be associated with right or left brain functioning, it appears reasonable to assume that a left brain lesion might give the right brain (or holistic processor) an advantage.

It was the purpose of this investigation to measure and study reaction time and response accuracy of fifteen left-brain-damaged adults and fifteen non-brain-damaged adults on a visual same-different comparison task. Specifically, the following questions were asked: (1) Are there statistical differnces between normal and aphasic adults' reaction times and the accuracy of their performance on a same-different comparison task? (2) Do the results support or refute the theoretical dichotomy of analytic versus holistic processing?

## METHOD

Subjects. The subjects for this investigation were fifteen left-brain-damaged (aphasic) and fifteen normal adults. All subjects in the left-brain-damaged group met the following selection criteria. Each subject was at or above the 50th percentile on the Porch Index of Communicative Ability (Porch, 1967). Each subject had left brain damage, confirmed by three of the following four procedures; abnormal angiogram, abnormal motor signs, abnormal CT scan, or abnormal brain scan. Any subject who exhibited right hemisphere brain damage was excluded from the study. In addition, each left-brain damaged subject showed no more than a 30 dB HL hearing level, had sufficient visual acuity and understood the concept of "same" or "different" as measured by stimulus comparison pretrials.

All subjects who were included in the normal group were at or above the 92nd percentile on the Porch Index of Communicative Ability, showed no more than a 30 dB HL hearing level, had adequate visual acuity, understood the concept of same or different as measured by stimulus comparison pretrials, and had no history of neurologic impairment. In addition, all subjects in the normal group made no errors on the left-right discrimination test.

Stimuli. The stimuli for this investigation were 300 picture pairs which were paired by similarity in size, shape, and coloring. There were 150 picture pairs requiring a "same" judgment and 150 pairs requiring a "different" judgment. All pairs were randomly presented to all subjects studied.

Apparatus and Experimental Procedure. All procedures were carried out in a sound-treated room. Within the sound room was a 6' by 2.5' by 2.5' compartment with the interior painted black, except for a 6" x 6" viewing screen for viewing picture stimuli. These stimuli were projected at a ten degree angle, five feet from the subject in a sitting position. Each subject responded "same" or "different" by touching either a red or green switch mounted directly in front of the subject, 4.5" apart.

## RESULTS AND CONCLUSIONS

Results. To establish whether or not any reaction time differences existed between "same" or "different" responses, correct or incorrect responses, the existence of any group differences, and the existence of any interaction effects, all test results were subjected to an analysis of variance and covariance procedure with repeated measures. Table 1 summarizes these results for reaction time.

Table 1. Summary of analysis of variance and covariance for reaction time in both groups.

| VARIABLE | PROBABILITY |
|---|---|
| Group | .003* |
| Correct/Incorrect | .028* |
| Same/Different | .321 |
| Correct/Incorrect x Group | .772 |
| Same/Different x Group | .949 |
| Correct/Incorrect x Same/Different | .425 |
| Correct/Incorrect x Same/Different x Group | .329 |

* $(p < .05)$

Statistically significant ($p < .05$) differences were found for correct versus incorrect responses and for the two groups. The normal group's overall mean reaction time to the task was 1.26 seconds while the pathologic group's mean reaction time was 1.68 seconds--an advantage of .42 seconds for the normal group. Figure 1 shows the reaction time means of both groups for correct versus incorrect decisions. The normal group had a reaction time mean of 1.19 seconds for correct responses and 1.32 seconds for the incorrect responses. The aphasic group's mean reaction time was 1.63 seconds for correct responses and 1.73 seconds for incorrect responses.

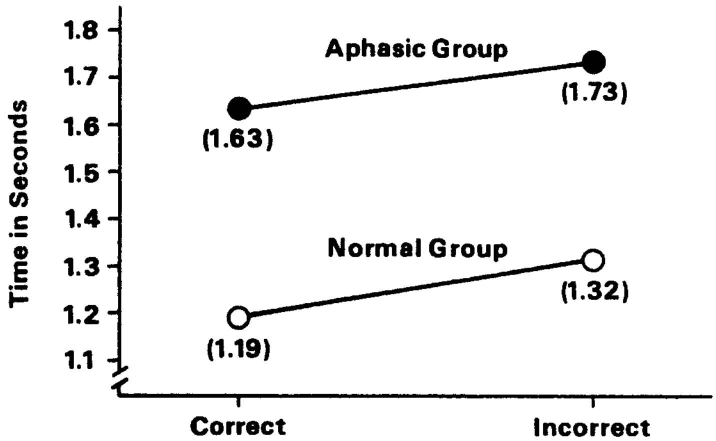


Figure 1. Reaction time of each group for "Correct" versus "Incorrect" responses.

Figure 2 shows reaction time means for both groups for same-different judgments. While not statistically significant, it is a finding of note. The normal group responded with a mean of 1.24 seconds for "same" and 1.27 seconds for "different" decisions. The aphasic group had a mean of 1.67 seconds for "same" and 1.69 seconds for "different" responses.

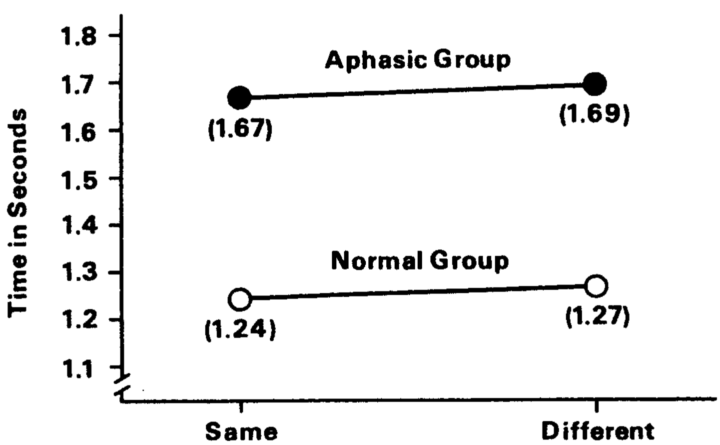


Figure 2. Reaction time of each group for "Same"-"Different" judgments.

Table 2 illustrates group differences for correct versus incorrect responses and same-different judgments. For the normal group, mean reaction times for correct "same" responses was 1.13 seconds and 1.26 seconds for correct "different" responses. The aphasic group had a 1.62 second mea reaction time for correct "same" responses and 1.65 seconds for correc "different" responses. A 1.35 second mean reaction time for incorrect "same and 1.30 second mean reaction time for incorrect "different" responses wa seen for the normal group. The aphasic group had a 1.71 second mean reactio time for incorrect "same" and a 1.75 second mean reaction time for incorrec "different" responses.

Table 2. Reaction times for same-different (correct) and same-differen (incorrect) for both groups.

| RESPONSE | NORMAL GROUP | APHASIC GROUP |
|---|---|---|
| Same/Correct | 1.13 | 1.62 |
| Different/Correct | 1.26 | 1.65 |
| Same/Incorrect | 1.35 | 1.71 |
| Different/Incorrect | 1.30 | 1.75 |

Individual analysis of each subject's reaction time performance is generally similar to the data presented in the tables and figures for both groups. Of the 30 subjects studied, individual analysis of their reaction time performances reveals little or no difference for same-different judgments with change in reaction time performance for correct versus incorrect responses. Analysis of variance indicated differences between groups for accuracy. The normal group had a mean accuracy of 240 items while the brain-damaged group had a mean of 220 items correct.

Conclusions. The aphasic group was slower and less accurate for both "same" and "different" comparisons than the normal group. Correct responses were faster than incorrect responses for both groups. The pathologic group performed much like the normal group except with respect to the level of performance. Based on the results of previous research regarding analytic versus holistic processing and left versus right brain preference for same and different comparisons, it might be expected that the normal group would have responded much faster to "same" comparisons. If this process model for left versus right brain preference was specific to this type of task, it might be expected that the pathologic group would show significant reaction time increases for the left side preference, or judgments which required an analytic-different response. This was not the case. Neither group showed a reaction time advantage for either type of response. The results of this study do not support the analytic-holistic dichotomy. It appears that using this dichotomy to observe hemispheric specialization is premature and not specific to tasks such as this.

Fairweather et al. 1982) provides classes of experimental conditions affecting the degree and nature of observed laterality effects. These are task material, nature of the task, and subject status. Task requirements and individual differences in the ability for holistic and analytic processing have been shown by other researchers (Bouma and Ippel, 1983) to be key factors in the ways the left and right hemispheres are involved in the processing of visual stimuli. The results of the present study are unable to support a separate system of comparison for same and different responses. There is more evidence to support parallel processing by left and right hemispheres.

The dichotomy of "same" versus "different" is not sufficient for indicating hemispheric specialization in terms of an analytic or holistic processing. Depending on task requirements and individual preferences for method of processing, either brain might function holistically or analytically. It appears that an all-or-none conclusion regarding cerebral functioning is not supported by the present investigation.

There are several applications of these findings to clinical settings. First, severity may be an important issue. One may have expected a right hemisphere bias in the patient group due to left hemisphere damage. Since our subjects' scores were in the mild to moderately impaired ranges on the PICA, it is possible that they used the damaged left hemisphere as a non-brain-damaged subject would. Selinger (1982), for example, found that on an auditory event-related-potential task, right hemispheric involvement in language increased with severity of aphasia. Therefore, "different" or analytic process type tasks could both be designed for patients falling in the milder ranges while "same" or holistic judgment tasks may need to be designed for the more severe patients. Similar studies might well raise the same issues with a more severely impaired population.

Second, since this study appears to support the idea that the left hemisphere can make both kinds of judgments, we should be careful to design our tasks and stimuli in such a way that the left hemisphere's natural abilities are activated and further developed. Exclusive use of feature-by-feature analytic language tasks may hinder rather than benefit recovery.

Third, we must analyze, task by task, the means of processing required to complete our programs. For example, by asking patients to describe everything they see in a picture, we might be requiring analytic ("different") functioning to the exclusion of same ("holistic"). Evaluation of our tasks in this way may help us to balance our programs for our patients and in turn this may increase recovery of function.

Fourth, inclusion of more direct physiological measures of laterality (e.g. tachistoscope and event-related-potentials) into our aphasia batteries may not only provide a data base about hemispheric superiority in aphasic subjects but would provide information for planning treatment appropriately for the individual patient.

Finally, based on findings such as these, there appears to be a need to better define our independent variables and necessity for replication studies of cerebral laterality in aphasia. If this can be accomplished, our understanding and our treatment of aphasic adults will improve.

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