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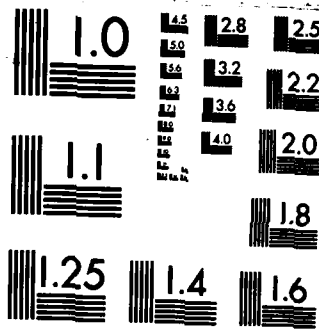
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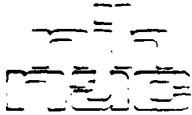
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April 9, 1985

AD-A155 092

Dr. Eugene E. Gloye
Department of the Navy
Office of Naval Research
Detachment Pasadena
1030 E. Green Street
Pasadena, CA. 91106

Dear Dr. Gloye:

This letter constitutes the Final Progress Report for ONR Contract Number N00014-83-C-0318 entitled "Resource Allocation in Cerebral Specialization of Function: Behavioral and Electrophysiological Studies," awarded from March 15, 1983 (not funded until August, 1983) to September 30, 1984.

Progress has been made in a number of areas at our site at National Jewish Hospital as well as in Dr. Polson's laboratory at the University of Colorado at Boulder.

Overview of the project

The purpose of this project was to study, using both cognitive and electrophysiological methods the relationship between resource allocation theory and functional cerebral lateralization. The behavioral studies would occur in Dr. Martha Polson's laboratory at the University of Colorado and the electrophysiological work was to be conducted in Dr. David Shucard's laboratory at National Jewish Hospital and Research Center in Denver.

Progress in the Behavioral Domain — Dr. Polson

A number of cognitive experiments have been completed during the period of this project. Two experiments were completed and analyzed that addressed the question of whether hemispheric differences in information processing may be characterized by differences in the way information is represented or the relative speed and accuracy with which the processes within a hemisphere can operate on a representational system. According to Anderson (1983) there are at least three types of representations of

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information which are qualitatively different: spatial images, temporal strings and abstract propositions. Theoretically, these representations differ in the way the information is encoded, the processes by which matches of incoming information are made against the current representation, and how new structures within a representational system are constructed.

Investigations in the field of cerebral specialization have speculated about the processing differences which characterize the two hemispheres. Dichotomies such as analytic versus holistic, verbal versus nonverbal, or serial versus parallel have been suggested as major processing differences between the hemispheres. It appears however, that none of these dichotomies adequately characterize the processing differences between the two hemispheres. The experiments conducted by Dr. Polson address the question of whether the three representational systems proposed by Anderson can be used as a basis for more precisely defining the mechanisms which underlie hemispheric differences in information processing. One advantage of this approach is that the types of encoding processes, match processes, and how new knowledge structures are synthesized are reasonably explicitly stated so that hypotheses can be more precisely explicated and tested than is possible with the dichotomous approach.

Without going into detail about the supporting studies in the literature, suffice it to say that evidence has been obtained showing that the match process for geometric figures and verbal material are different and that phonemic information is preserved when temporal order is being remembered but not when spatial arrangement is being remembered. These experiments were designed to study hemispheric differences in spatial image and temporal string representations and used response time as a dependent measure.

The experiments done to study this phenomenon in Dr. Polson's laboratory extended and modified the previously used procedures. The results at last, in part, replicated previous findings showing a relationship between stimulus type (figure or letter pair) and arrangement (triangle or row). The response times were larger for figures when they were in a row than when they were in the identical triangular arrangement as the study slide. The response times for the letter pairs were only slightly longer when arranged in a row than when in the identical triangular arrangement.

One interesting finding showed that when the trials were blocked by figures and words, there was an overall visual field by stimulus type interaction with responses to figures being faster in the left visual field and letters in the right visual field. In addition, the data also indicated that reaction time increased as a function of position of the letter pairs and visual field. That is, for letter pairs in the right visual field (RVF) there was a linear increase in reaction time as a function of position from left to right, top to bottom, while figures in the RVF always showed as V shaped function with response times to position labeled and in the display being fastest.

A second study was done which essentially confirmed the positional findings of the first. No significant sex differences were found in these studies, although sex differences and changes with practice were seen during the initial phases of these studies.

New stimuli were prepared to be used in a dual task experiment. The new stimuli make position in the "one different condition" equal in all conditions so that all positions are shown equally often. In this experiment error rate rather than response time has been used as the dependent measure for the load and lateralized task. Theoretically, if both figures and letters are being processed within the receiving hemisphere using their

own representational system and processes, there should be large decrements and performance trade-offs as RVF-LH trials regardless of stimulus types and small or no decrement on LVF-RH trials and no performance trade-offs. These data are currently being analyzed. In addition, data from a study begun earlier in the contract period in which letter pair and figure trials were randomly mixed together rather than blocked, as reported previously, are also being evaluated.

Progress in Electrophysiological Domain — Dr Shucard

Cont'd → The unity of the concept of cerebral specialization with the allocation of resources model has proven useful in accounting for otherwise disparate research findings involving perception, cognition, and motor performance. Moreover, this approach suggests explanations for patterns of task interference that are not readily interpretable within the information processing framework. It should be emphasized, however, that the link between cerebral specialization and allocation of resources suggested by Friedman and Polson is primarily an hypothetical link between the "conceptual" brain of the cognitive psychologist and "physical" brain of the neuroscientist. In order to strengthen this connection, measurable aspects of brain activity must be shown to covary in accordance with the predictions of allocation of resources theory.

Behaviorally, the allocation of resources is typically inferred from altered performance accompanying changes in difficulty in a single task situation or from performance trade-offs between tasks in a dual task situation. When tasks are selected for these behavioral studies, assumptions are made about the resources used to process the information involved with these tasks. Behavioral responses on task experiments are used to confirm or disconfirm these assumptions or hypotheses. It is therefore of critical importance to provide more direct measurement of the resources allocated for different tasks. Studies combining both behavioral and electrophysiological approaches may accomplish this goal.

The purpose of the studies conducted in the electrophysiological domain was to further elucidate the possible connection between electrophysiological measures and the multiple resources approach to cerebral specialization of function proposed by Friedman and Polson.

Progress toward this goal has been made in a number of areas: The intricate software for data collection and analysis has been developed and simplified so that cortical evoked activity can be obtained from up to 8 channels, single trials can be sorted and evoked potential (EP) peaks can be identified. In addition, power spectral and moments analysis of the electroencephalogram can be done on selected epochs during various stages of the experiment. Finally, the creation of the experimental paradigms has been greatly simplified so that it is now possible to have a researcher rather than an electrical engineer/software expert create the experimental paradigms to be run in the laboratory. All of our software is menu driven.

Two studies have been completed and the data scored, analyzed and summarized with a manuscript currently in preparation for the first.

In study one, we examined the sensitivity of our EP technique to information processing under two levels of load. This study has been described in a previous quarterly report. In summary, the findings showed significant electrophysiological effects as a function of load level. In addition, sex effects were also present with males producing much greater lateralized responding.

The second study examined the ongoing electroencephalogram (EEG) rather than EPs only. In this study the EEG data were obtained both prior to load stimulus presentation and while the load was being held in short term memory store during two load conditions. This experiment required the development of computer software which allowed us to collect and store sufficient EEG data so that reliable power spectral analysis (PSA) could be performed on the data. In addition the PSA software was developed along with an analysis program that provides a summary of the PSA function. These data have been scored and are now in the process of being summarized and should provide an important link not only between cognitive and electrophysiological measures but also between measures of evoked activity and ongoing EEG activity. Such comparisons will allow us to determine which of these two electrophysiological measures are most sensitive to the differences in cognitive load.

Next, the paradigm was created and pilot data collected on a three load experiment (2, 3 and 4 CVCVCs). Because we wished to determine the effects of set, in this study, in contrast to the previous two each load level was presented in blocks rather than in a randomized order. From these pilot studies significant questions arose about the value on the 4 load condition for studying load level effects, since most subjects were unable to effectively store, even for a short time period, 4 CVCVCs. Based on these results, we have decided to examine the effect of blocking the 2 and 3 load stimuli and compare the effects of the blocking procedure with results obtained in the randomized paradigms described above.

Finally, we have evaluated Dr. Harold Gordon's (University of Pittsburgh) behavioral test battery which has been used to assess relative degrees of cerebral specialization across individuals. Our goal was to combine these behavioral techniques with our electrophysiological methods with the hope that the measures obtained could provide a more powerful evaluation of individual differences in the functional organization of the brain and ability to process higher cognitive information. Our evaluation of the potential of this method indicated that it is feasible to combine the two techniques. This approach should be followed up in the near future.

Sincerely,



David Wm. Shucard, Ph.D.
 Director, Brain Sciences Laboratories
 Department of Pediatrics
 National Jewish Hospital and Research Center
 Professor, Department of Psychiatry
 University of Colorado School of Medicine

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