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Commentary: Overview of Language and Hemispheric Specialization

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The following section includes an excellent selection of papers dealing with event-related potentials (ERPs) and language. The tremendous progress that has been made in this area over the past few years is evident in both the sophistication and the diversity of the paradigms used in the execution of these experiments. In addition to the two experiments which take advantage of the wealth of ERP data on the 'oddball' task (Twist et al.; Harter), there are at least 8 other experimental designs employed. These include: (1) an extension of the oddball paradigm using mathematical equations (Herning); (2) simple phoneme discrimination (Mateer); (3) dichotic listening involving semantically related and unrelated words (Rothenberger et al.); (4) letter priming with vowels and consonants (Holcomb); (5) lexical decision wherein subjects decided whether a letter string constituted a legal English word or a non-word (Campbell et al.; Fischler et al.; Smith and Halgren); (6) object decision wherein subjects decided whether a drawing represented a real or a non-real object (Campbell et al.); (7) face recognition (Smith and Halgren); (8) reading sentences displayed via the rapid serial visual presentation (RSVP) (Kutas); and (9) visual categorization requiring same–different judgments between pairs of slides containing pictures of animals in various orientations (Shucard et al.). This final task is quite different from the others in that ERPs were recorded not only to the task relevant slides but also to task irrelevant auditory probes which occurred 2 sec following slide onset (for both slides of a pair). I believe that once the parameters of the probe technique have been worked out systematically, it will prove to be an important source of data on many questions both within and outside of language research.

These different paradigms were used to examine specific issues within cognition and cognitive neuroscience, such as the functional organization of the brain for a particular process as well as answer questions about cognitive ERPs. For example, both Campbell et al.'s and Fischler's designs were concerned with the commonality of conceptual representations. In specific, Campbell et al. addressed the question of whether words and pictures share a single, common representation or have dual representations. This is a very 'hot' topic within cognitive psychology these days. Campbell et al.'s approach

was to compare the ERPs in a word decision task (e.g., is the stimulus a word or nonword) to those in an object dicision task (e.g., is the stimulus an object or not). To the extent that the ERPs in the two conditions were similar, their mental representations would be considered equivalent. Using ERPs to compare the commonality of underlying processes is a good idea; however, Campbell et al. will face some difficult problems in interpretation due to the inequality of the physical characteristics of their word and picture stimuli. This situation can be remedied by comparing difference waves rather than the raw ERPs. In my opinion, this is most easily accomplished when each stimulus type has been subjected to one or more experimental manipulations. Then within-stimulus difference waves can be computed and compared across conditions. The answers resulting from such comparisons will be important for those interested in the similarities and differences in the processing and representations of words and pictures.

A very similar question is being addressed in a slightly different form by Fischler et al. Instead of looking at the mental representations of words and pictures, Fischler and colleagues are trying to determine whether bilinguals possess a single mental lexicon which includes the representations of words in both their languages or two distinct representations, one for each language. They examine this issue by comparing the ERPs within and between the languages during a repetition priming paradigm, that is, focusing on the ERP effects of repeating a word. Again, this is a very important question within cognitive psychology today and Fischler's experimental procedure is state-of-the-art. In this particular case, the results are difficult to interpret because no repetition priming effects were observed even within a language; however, the work is still in its preliminary phases and will no doubt prove to be very important.

The Kutas paper looked at the similarity of sentence processing at two different rates of presentation. In specific, I compared the ERPs elicited by the final words of congruous and incongruous sentences presented at rates of 1 word every 100 or 700 msec. The pattern of ERPs suggested that the processing of semantic anomalies was very similar at the two different rates, although the N400 was delayed by about 80 – 100 msec at the faster rate. These results enhanced the ecological validity of the ERP approach in the study of reading and the role of context on word recognition, as the faster rate was close to normal reading speeds.

Other experiments were designed to assess changes in the functional organization of the brain with experience. For example, Meuter and Donald examined the processing of congruous and incongruous sentences in monolinguals and bilinguals in both their languages. Their report in this volume concerns the similarities and differences between bilinguals who learned English as a first language and French as a second language or vice versa. The pattern of results is complicated and awaits more subjects who are equated for age of language acquisition, language proficiency, fluency, etc. From conversations with the authors at the meeting, I learned that they have been pursuing this line of research and finding some tantalizing differences between bilinguals and monolinguals. On the one hand, both monolinguals and bilinguals seem to process semantic anomalies similarly by responding with a negativity peaking around 400 msec. On the other hand, however, the lateral distribution of this negativity seems to vary as a func-

tion of the number of languages a person knows. Monolinguals show the typical right hemisphere N400; in contrast, bilinguals are characterized by an N400 largest over the left hemisphere.

Harter, likewise, investigated the functional organization of the brain by comparing the ERPs of normal children with those of children with reading disabilities (RD) with and without attentional deficit disorder (ADD). This is an excellent design, in that it includes two groups of RD children with and without ADD, several experimental conditions, multiple recording sites and several measurements. Harter concludes that the differences in the RD and ADD ERP effects indicate that the two disorders involve different deficits in the brain. This interpretation follows from the data. However, Harter also makes several more specific statements that I feel are over-interpretations. For example, he found that the amplitude and variability of the P240 was reduced in children with RD compared to normal readers and that this reduction was specific to the left-central site. Harter interpreted this as reflecting a general neural processing deficit in the left-central cortical area of RD children. As many of the tutorials pointed out, this sort of anatomically specific interpretation should be made with caution.

Twist et al. examined the lateral organization of the brain for receptive language processes. This study is an excellent combination of materials, patient groups, and disciplines. They modified the oddball task so as to take advantage of the known language deficits of left-hemisphere patients (e.g., semantic discrimination) and impairments in prosody of the right-hemisphere patients. In addition, they verified their subjects' lesions via CT scans and their behavioral deficits with a battery of neuropsychological tests. The results provide little new information about the patients, but they do converge with what is known; that is, the left-hemisphere patients having more difficulty with the semantic than prosodic discriminations and vice versa for the right-hemisphere patients. This differential pattern of deficits was evident in the reduced amplitude and prolonged latencies of the associated P3s. The study does, however, tell us something about the limits of the P3. The 'oddball' P3 does not seem to reflect the nature of the eliciting stimulus in its lateral distribution.

Mateer's report also examines the anatomical organization of the cerebral hemispheres for language by providing a record of the ERPs from the surface of the left- and right-lateral and mesial temporal cortices via subdural, surgically implanted strip electrodes. Her results show a greater tendency for EPs elicited by simple phonemes to be seen in the left- than right-hemisphere records and a fairly focal representation within the left hemisphere. Except for the fact that these subjects were epileptic, this is an excellent preparation. These patients provide a rare opportunity for asking some very sophisticated questions about brain organization. Mateer's report is a good beginning which could have been more easily evaluated if the figures included calibration and time markings.

The studies by Smith and Halgren represent lines of research which they are performing in both normal and patient populations with scalp and depth recordings. They chose to use tasks common in experimental psychology such as the lexical decision task and to vary parameters known to influence reaction times in order to examine the effect of these same variables on the associated ERP waveforms. Such work is important, for

it is the only way that we can track the associations and dissociations between the effects of frequency, concreteness, pronouncability on reaction time and ERP measures.

It is clear from these reports that we are developing a large data base on the relation between various behavioral and ERP measures within the language domain. Much of our knowledge is based on findings with college undergraduates on the processing of isolated pictures or visually presented words. We know significantly less about similar processes in the auditory modality, in brain-damaged adults, and in children, normal or disabled. We know almost nothing about the electrophysiology of sentence, text, and grammatical processing. However, since many of these reports are but one in a systematic, theory-based series being conducted by the investigators interested in language processing, we can expect that our current knowledge will continue to be validated as well as supplemented by new findings in yet unexplored areas.

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