INTRODUCTION

The collection of event-related potentials (ERPs) is a noninvasive method of investigating "online" brain activity. Physiologically, they represent post-synaptic activity of neuron populations arranged in parallel orientation that are synchronously active (Coles & Rugg, 1995). Later occurring components, such as the N400, have been found to be sensitive to experimental psychological variable such as the semantic processing of a stimulus (Bentin, 1989). Individual ERP components can be identified by their particular waveform morphologies: peak latency, peak amplitude, and scalp distributional patterns.

The N400 ERP component was first described by Kutas and Hillyard (1980) during a lexical (semantic) congruity-incongruity task. The N400 waveform is a negative deflecting waveform that typically begins it negative deflection around 250 milliseconds (ms) post-stimulus onset and peaks around 400 ms. When elicited from the presentation of lexical stimuli, it is most typically observed around the centro-parietal areas of the scalp, and larger amplitudes are associated with greater semantic incongruity. The N400 component has also been observed during the semantic processing of pictorial stimuli as well (Barrett & Rugg, 1990), and differences in scalp distributional patterns have been reported (Holcomb & McPherson, 1994; Pratarelli, 1994).

Only a handful of studies have been conducted using ERPs to examine online language (semantic and syntactic) processing deficits in people with aphasia (Hagoort, Brwon & Swaab, 1996; Revonsuo & Laine, 1996; Swaab, Brown & Hagoort, 1997; Frederici, Hahne, & Yves von Cramon, 1998; Frederici, Yves von Cramon & Kotz, 1999). However, none of these studies have investigated if there are any differences between the lexical and nonlexical semantic processing abilities in people with aphasia. Thus, the purpose of this study was to investigate how the form

of information (lexical or nonlexical) affects semantic processing abilities in people with aphasia.

METHODS

Eight participants, all native English speakers and right handed or premorbidly right handed, were divided into three groups: a 3 participant low comprehension aphasia group (LC), a 2 participant high comprehension aphasia group (HC), and a 3 participant normally-aging adult control group (NAE). All people with aphasia were administered the Western Aphasia Battery (Kertesz, 1982) and the Short Form of the Token Test (SFTT) (DeRenzi & Faglioni, 1978). Scores from the SFTT were utilized to assign the people with aphasia to either the LC or HC groups. The NAE participants were screened using the Mini-Mental State Questionnaire (Folstien, Folstein & McHugh, 1975) and the Miami Veteran's Administration Medical Center Communication Screening-Revised (Bollinger, 1988) to rule out the presence of language and cognitive-linguistic deficits. The members of the aphasic groups were matched to the members of the aphasia groups by age (+/- 3 yrs) and level of education (i.e., completion of high school, bachelors degree, and graduate degree).

ERPs were collected using a 21 electrode ECI Electro-cap following the International 10/20 electrode placement system (Jasper, 1958). Additionally, a lateral ocular electrode was used to monitor for eye movement artifacts. Data was collected along 3 midline scalp sites (i.e., Fz, Cz, Pz) and 4 lateral sites (F3, F4, P3, P4). Electroencephalographic (EEG) data was collected, and analyzed offline to develop ERP waveforms, using a NeuroScan Quicktrace 8 channel amplifier and the NeuroScan version 4.0 software package (NeruoScan Inc., 1996). All

digitized stimuli were presented on a 17 inch monitor in a time-locked manner controlled by the E-prime version 1.0 software (Schneider, Eschman, & Zuccolotto, 2002) .

All participants were seated in a comfortable chair inside an audiological testing booth and passively viewed two counterbalanced blocks of 96 pairs of prime-target stimuli. Each block consisted of 46 related and 46 unrelated prime-target pairs. The related pairs were chosen from three literature sources (Battig & Montague, 1969; Nelson, McEvoy, & Schreiber, 1998; Postman & Keppel, 1970). The stimuli in the lexical pairs block were presented as black letters on a white background in a bolded, size 48 Courrier font, while the picture stimuli consisted of black and white line drawings taken from the Snodgrass and Vanderwart (1980) study digitized to 300 dots per-square-inch resolution at a 100% scale. Visual angles subtended for both blocks were not statistically different (pictures = 2.4 degrees; words = 2.3 degrees). Each participant was informed that they would complete a stimulus-pair recognition task following each block to help focus their attention during the presentation of each stimulus block.

Individual participant N400 difference waveforms were developed from the data for both the lexical and nonlexical conditions, and group grand average waveforms for both conditions were compiled. The data (N400 onset latencies, N400 peak latencies, and N400 peak amplitudes) from the group grand average waveforms was utilized for statistical comparison.

RESULTS

Due to the limited number of participants in this study, no statistically significant differences were noted between groups for the measures of N400 onset latency, N400 peak latency in either the lexical or nonlexical conditions. However, some interesting trends were noted.

For the lexical condition, there were noticeable differences between groups. For the measure of peak latency, the NAE group had the shortest onset latencies (M=336.5ms), followed by the LC group (M=513.7ms) and the HC group (601.9ms). Along the midline sites, the NAE and LC groups showed slightly faster parietal-to-frontal patterns of activation where as the HC group demonstrated an opposite frontal-to-parietal direction of activation along the midline sites For the measure of peak latencies, the NAE group had the shortest peak latency (M=409.5ms), followed by the LC group (M=551.9ms) and the HC group (M=646.6). Topographical distribution along the midline sites for this measure revealed that the NAE group showed a parieto-frontal faster than central pattern of activation. However, the LC group showed a clear parietal-to-frontal pattern of activation, while the HC group showed a similar timeline of activation at all midline sites (i.e., Fz, Cz, and Pz = 661 ms). Peak amplitudes were similar across all groups (NAE group M=-5.91mV; LC group M=-5.46mV; HC group M = -5.96mV). The NAE group showed a clear centro-parietal activation, while the HC group showed a frontal greater than centro-parietal pattern of activation. Finally, the LC group showed a fronto-central greater than parietal pattern of activation.

In the nonlexical condition, all three groups had similar onset latencies (i.e., NAE M=337.7 ms; HC M=352.9 ms; LC M=393.6ms). The NAE and HC groups showed similar fronto-parietal activational patterns, while the LC group had a dissimilar pattern (i.e., parietal faster than frontal, frontal faster than central). All three groups also had similar peak latencies (i.e., NAE M=401.3ms; HC M=392.0ms; LC M=432.9ms). Both the NAE and HC group had a fronto-central to posterior pattern of activation along the midline sites while the LC group showed a parietal-frontal-central pattern of activation along the midline sites. Peak amplitudes differed among the three groups (i.e., NAE M= -4.60mV; HC M=-5.73mV; LC M=-4.92mV).

Along the midline sites, the NAE group had a fronto-central greater than parietal pattern of activation, while the HC group showed a parietal greater than frontal-central pattern of activation. The LC group had a central greater than fronto-parietal pattern of activation.

DISCUSSION

Based on the small number of study participants, only limited inferences can be made. However, results from this study support the notion that people with aphasia have impaired lexical semantic processing abilities. Findings from this study hint that those people with aphasia who have moderate to severe auditory comprehension abilities may also have impairments in their abilities to process nonlexical semantic information, provided they are not using a covert lexical naming compensatory strategy during information processing. However, further investigation in this area is needed. Also, this study presents a limited view of the localization of processing for both lexical and nonlexical semantic information in people with aphasia.

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