

Osterhout (1994) explains that one strategy for ERP studies is to use a known ERP component to study cognitive processing, even if the cognitive process underlying the ERP response is unknown. Two well-known ERP wave-forms are the N400 and the P600 which are thought to reflect the integration of semantic meaning and syntactic structure, respectively. Patel, Gibson, Ratner, Besson, and Holcomb (1998) investigated the positive-going waveform, the P600. It has been elicited by words that are difficult to integrate into an existing syntactic frame. Some claim that it reflects reanalysis of structural relations by the human syntactic parser. Patel et al. (1998) hypothesized that the P600 is not unique to linguistic processing but rather reflects more general cognitive operations in processing structural relations in rule-governed sequences. They conducted the following experiment to examine the cognitive processes underlying the P600.

In their study, they compared the ERP response for aurally presented syntactically anomalous sentences to musically incongruent phrases. For the linguistic stimuli, three types of sentences were presented: normal, garden-path sentences with reduced relative clauses, or ungrammatical. These subjects appear particularly poor at processing garden-path sentences as they only determined 61% of these grammatically correct sentences as acceptable. There were also three types of musical phrases: in-key, out-of-key but nearby on the circle of fifths, or out-of-key distant on the circle of fifths. Their primary dependent variable was the latency, polarity, and scalp distribution of the P600. If the P600 was elicited for both musical and linguistic stimuli, this would indicate that it is not unique to linguistic processing.

In the music conditions, Patel et al. found what was termed an RATN or a right antero-temporal N350 wave. A similar wave-form was not found in the linguistic conditions. The RATN was compared to the LAN that has been found in other ERP studies of syntactic anomalies in sentence processing. The LAN is thought to originate from Broca's area in the left hemisphere. Therefore, the RATN and LAN are similar since they are both positive waveforms appearing at approximately the same time; however, the neuronal sources of these two waveforms appear to originate in opposite hemispheres. Previous work has not consistently found the LAN in ERP studies of

syntactic anomalies, and Patel et al. also do not report a LAN in their study. A well-articulated hypothesis of what these early negative wave-forms represent is lacking in the literature. In conclusion, although the presence of RATN in musical stimuli and absence of it in linguistic stimuli may indicate that these tasks require different cognitive mechanisms, the authors are focused on only the P600.

Patel et al. identified the presence of a P600 in both the music and language tasks. In both tasks, the amplitude of the P600 wave increased as the stimulus items increased in incongruity. Critically, they found that the P600 in the language and music tasks is not statistically distinguishable in latency range, amplitude, or scalp distribution. Despite differences in the temporal presentation of the music and linguistic items, both of these tasks elicited a very similar P600. Given these results, they concluded that the driving force behind the P600 is unlikely to be language-specific. The P600 is proposed to reflect more general processes of knowledge-based structural integration required in detecting syntactic anomalies and musical phrase anomalies. Evaluating the structural fit between a target and the context may ultimately be what the P600 represents.

Their hypothesis makes several predictions that are easily testable. First of all, it predicts that other tasks that involve knowledge-based structural integration will elicit the P600. That is, other tasks involving the evaluation of a target with a previously established content or knowledge-base will show a P600. One area in which individuals have a knowledge-base is mathematics. My hypothesis is that if subjects calculate an established mathematical pattern and then encounter a calculation incongruent with the pattern, they will also elicit the same P600 response found in syntactic and musical phrase anomalies.

In order to test this hypothesis, the following experiment is proposed. Subjects will be presented with a string of numbers that increase incrementally by a particular pattern under three conditions. The first condition will be a normal, congruous pattern. For example, if a specific trial presented numbers that increased by “3”, the string will appear as follows: 0, 3, 6, 9, 12, 15, 18, etc. The second condition will be the “easy” incongruous math pattern in which one of the numbers from the first condition is off by plus or minus 1. Thus, the example above will appear as follows with the incongruent number underlined: 0, 3, 6, 10, 12, etc. The third condition will be the “hard” incongruous math

pattern in which the increment of increase is no longer constant but “n+1”. An example trial is as follows with the incongruent number underlined: 0, 1, 3, 6, 10, 15, 22, 29). This task is hypothesized to elicit a P600 with greater amplitude in the “hard” condition than the “easy” condition. Finding a P600 on the task proposed would lend further evidence to the proposal that the P600 is not language-specific.

A second prediction based on Patel et al. (1998) is that patients that suffer from domain-specific knowledge deficits may not elicit a normal P600 because their knowledge in a particular domain has been disrupted or because additional general cognitive mechanisms of integrating structural knowledge has been disrupted. Distinguishing between these two possibilities appears to be a fairly large question in the aphasia literature. Lesions studies have shown that musical harmonic relations and syntax can be selectively impaired. One possibility is that aphasic patients suffer from domain-specific knowledge deficits in syntax, not general deficits of structural integration. My hypothesis is that aphasics that suffer from syntactic deficits will not elicit a normal P600 when presented with syntactic anomalies, but will elicit a normal P600 when presented with musical phrase anomalies. Thus, I predict these patients suffer from domain-specific deficits, not a general deficit in structural integration.

In order to test this hypothesis, a group of agrammatic aphasics capable of sentence-level processing would need to be identified. These aphasics should have the ability to make accurate acceptability judgments on simple active and passive sentences. The first experiment will present agrammatic aphasics with normal active, incongruent active, and incongruent passive sentences. My prediction is that an abnormal P600 response will be detected in this group of patients which may be due to either a deficit in the knowledge of syntax or a deficit in structural integration.

In order to test which of these explanations holds true for aphasics, a second experiment is proposed. The second experiment will present musical phrase anomalies similar to Patel et al (1998). If aphasics demonstrate a normal P600 in the musical task but an abnormal P600 in the linguistic task, this would suggest that they have preserved general structural integration processes and most likely deficits in the structural knowledge of syntax. However, if aphasics also demonstrate an abnormal P600 response in the musical stimuli, then this would suggest that aphasics have a more general deficit

in structural integration used by multiple knowledge-based systems. This last finding, however, would not rule-out an additional knowledge-based deficit of syntax.