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Cogs 13

Final Project Proposal

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Selective Speech Recovery in Bilinguals

I. Question and Hypothesis

Aphasia is a common yet complex and multifaceted disorder that manifests itself in people with traumatic brain injuries. It is characterized by a loss of ability to understand or express speech, yet it does not impact other processes that relate to cognition and critical thinking. The focus of my observational study is to understand how bilinguals are impacted by aphasia and the extent to which they recover their first or second language. Specific research on how aphasia impacts bilinguals hold secrets regarding how multiple languages are stored and accessed in the brain, and may help develop better rehabilitation methods to help individuals impacted by the condition. Simply, the extra dimension of being multilingual when studying aphasia may offer new insights, benefitting our understanding of the brain's linguistic functions. Research to date has identified parallel and nonparallel recovery types, but no conclusions have been drawn as to what directly causes the variations in bilingual aphasics' recoveries. This experiment will seek to study the extent and degree to which aphasics can recover their most used language after a serious brain injury, and tests if the frequency of language use impacts whether it is recovered. I hypothesize that bilingual people will score higher on the BAT and will show greater proficiency in whichever language they used the most frequently prior to the brain injury. As a bilingual person myself, I hope to demonstrate and learn about the nuances of the brains of bilinguals and how speech between languages is modulated in the brain.

II. Background

Research conducted thus far on the topic has documented the different types of recoveries that bilingual aphasics tend to experience. The two most studied are parallel recovery, where both languages recover simultaneously and to the same extent and selective recovery where one language recovers better than another. In either case, language abilities are diminished, though these effects can be uneven for bilinguals. The focus of my experiment will be on selective recovery and the process by which a particular language is recovered. Specifically, I want to understand if the most used language is the one that has a higher chance of being recovered. Before attempting this, I consulted previous research on the topic.

Other research has sought to answer these questions and has yielded some statistics on how often each type occurs. In 2001, Franco Fabbro at the University of Udine conducted an experiment on the language recovery of 20 bilingual Friulian–Italian aphasics. Researchers conducted tests in both languages and found that thirteen patients (65%) showed parallel recovery where each language is affected, four patients (20%) showed greater impairment of their second language, and three patients (15%) showed greater impairment in their first language (Fabbro, 2001). A follow-up study conducted by Michel Paradis at McGill university found that out of 132 cases published between 1990 to 1999, 61% of bases showed parallel improvement (Paradis, 2001). Despite these results, little has been found to explain why these findings occur. The native language, the most familiar to the patient, the most socially useful, or, still, the language of the environment has not proven to recover first or best. Nor does it seem to be a matter of whether the two languages were acquired and used in the same context as opposed to different contexts, at different times of development (Fabbro, 2001). The reality is, we still do not know how this process works, so to follow up on this study, I seek to look more specifically at the intricacies of selective recovery and how the extent of a language's use impacts it.

Several scientists have come forth with theories to explain how selective recovery works. In 1895, Albert Pitres studied selective recovery in patients and understood it using Ribot's law, which states that newer memories deteriorate faster than old ones. Pitres suggested that a multilingual person recovering from aphasia caused by a stroke or cerebral injury will recover the language most used by the person prior to the onset of the aphasia (Pitres, 1895). This motivates my hypothesis that the most used language will recover to a fuller extent. Another suggested theory involves the control centers in the brain. Bilinguals are required to suppress whichever language they are not using, and are able to switch languages on or off (Borragan, 2018). If this control mechanism gets damaged due to a stroke or brain trauma, the individual will no longer be able to selectively control the use of one language over another.

Another proposed theory is the importance of emotional attachment to a language. Jürg Schwyter, a Professor of English Linguistics at the University of Lausanne got to study speech aphasia first hand after suffering a stroke. He explains that in his own experience that languages are differentiated based on purpose. Some languages are instrumental and necessary to get ahead in life, whereas others are integrative and invoke a desire to assimilate. Schwyter states, languages with high integrative motivations foster greater emotional attachments and are more likely to recover following the onset of aphasia (Schwyter, 2013).

These studies into the mechanism of selective recovery give some background as to how aphasia works in bilingual people. This background research is complimented by my learnings in my neuroscience classes about memory. I learned in my neuroscience classes that long-term memories aren't stored in a particular place and are rather distributed across the cortex. Our memories are reactivated over time and when we relive them, think about them, or dream about them, and we strengthen the connections in our neurons for these memories (Kiyonaga, 2020). By integrating this with the background research above, I believe there is a strong case to be made that selective recovery is influenced by how often a bilingual person used the language prior to the event.

III. Validation

To ensure scientific validity, I have assessed my experiment across several criteria. Ecological validity refers to the degree to which the research addresses naturally occurring processes. Essentially, it looks at the degree to which the research actually maps real-world cognitive challenges. Our test takes ecological validity into account by including different kinds of aphasics in our tests. We chose not to discriminate our test subjects based on fluent or nonfluent types of aphasia. This makes our experiment more valid as it represents a wider pool of aphasics in the real world. We are also excluding aphasics that experienced their injury less than a year from the test date, as it is important to allow adequate time for recovery. We are also taking ecological validity into account by sampling the caregivers of our test subjects. The feedback from these individuals helps establish ecological validity as, for privacy and practical reasons, the subjects cannot be observed at all times. Their caregivers are therefore valuable resources to understanding subject behavior outside of the lab. Despite the fact we are conducting the experiment in a lab, we feel that the physical limitations of speech aphasia are identical regardless of the environment, and therefore our experiment should have a high degree of ecological validity.

Construct validity refers to the extent to which our research highlights critical factors. It is a measure of whether the relationship between the variables we have chosen accurately highlights the critical factors we want to study. We made sure our experiment has construct validity by using standardized assessments for speech aphasia. Since the tests will be conducted in multiple languages, we want to make sure subjects are assessed for their language competencies relating to aphasia, not relating to their general knowledge of the language. If we created our own test, it might not assess language skills in the motor sense, and it may also be culturally invalid as translations may be used which would disadvantage certain subjects over others. Essentially, one of the ways we will ensure construct validity is by using a standardized bilingual aphasia test (BAT) that has been tried, tested, and implemented by previous researchers (Kock, 2019). We will also ensure construct validity by recording information about the type of lesion or other brain damage the subject has. This will help with construct validity as the area and type of lesion is important to correlate with the obtained results.

Content validity relates to whether our research instrument measures what it purports to. Essentially, it refers to the degree an instrument used in our assessment is representative of the target construct it should measure. In more simple terms, content validity refers to what variables we choose to score, and we want to make sure all relevant aspects of the construct are being measured to make sure our assessment is accurate. To ensure content validity, we want to be recording the media that matter. When it comes to aphasia, the most important data is the audio and video of the subject and their face, as well as all relevant data about the subject's brain damage and habits. We also want to know the type of brain damage, when it occurred, and any symptoms aside from aphasia. To ensure content validity we will record the subjects from multiple camera angles to watch for body movements and both cameras will be recording audio for redundancy. To ensure content validity, we will make sure our subject group contains a large enough sample and that will not be misled by outliers. Lastly, we will review the work of other researchers and experts on aphasia to ensure we record any other variables that are important in understanding the construct.

Predictive validity refers to whether our experiment produces a reliable predictive relationship between the variables. Essentially, it measures whether the findings of our study are valid when it comes to making generalized assumptions from the results. For our test, this represents whether the findings of our study can be used to predict the language ability and recovery of future bilingual aphasics. To establish predictive validity, we will run a two-tailed hypothesis test. Our null hypothesis is that whichever language is used the most will be recovered to a greater extent than the latter. Our alternative hypothesis is that the language most commonly used has no effect on the language that is recovered. Our significance level for the test will be 0.05. We predict that the language used most commonly will recover better than the latter and that this difference will be noticeable based on the latency, rate of speech, and results of the bilingual aphasia test (BAT) for each language.

IV. Methods

A single-subject group with fifty participants will be created for the study. It includes bilingual aphasics with different kinds of aphasia. The onset of the aphasia must have been more than a year before the test. We will include aphasics of varying recovery times from one year to ten years.

The test subjects will be observed completing a series of simple tasks in a lab room. The participants will be evaluated by a standardized bilingual aphasia test to avoid problems with translations that would impede the validity of the test. The translation of stimulus items may be culturally inappropriate, culturally incorrect words may be used to describe objects, and these could skew the test by making it more difficult to understand in certain languages. The standardized bilingual aphasia test includes the reading of words, sentences, as well as paragraphs. It includes reading comprehension, naming, sentence repetition, pointing, as well as tests with synonyms and antonyms. The second part of the test will be an object recognition task designed to assess whichever language comes fastest. Participants will be asked to name simple everyday objects that appear on a screen in front of them. Participants will be asked to name the object displayed in one language, then the latter in order to evaluate differences in response times based on the language used.

To collect data on our test, we will record the participants on video from two separate angles. The first will be framed around the participant's face and upper torso with light properly illuminating the subject. The second camera will be placed further away to record the subject's body language. Both cameras will be recording audio as well as video. The researcher will also complete an in-situ checklist evaluating the abilities of the test subject. This checklist will be the same for all participants and will be filled out for each test by the supervising researcher. In addition to the data recorded during the test, a host of other data points will be collected about the subject. We will collect the medical history, details about the cause of the aphasia as well as the brain damage. Most importantly, we will be recording information about the subject's bilingual speaking habits, including which language they learned first, which language they used the most, which language they associate to what things (be it work, or personal life), and how their bilingualism has changed since the onset of aphasia. To further our ecological validity, we will be recording the observations of a third-party caretaker to gather their understanding of the subject's speaking habits at home, and how these have changed since the onset of aphasia.

To analyze our data, we will be using several measures. First, the subjects will have their scores on the bilingual aphasia test calculated and scored. We will pair these with the audio and video of the test in which we will be measuring differences in latency and rate of speech between the two languages to create time-series data. We will do the same thing for the object recognition task. The results of our experiment will be aggregated with the data we have collected on the bilingual speech habits of each subject before and after the onset of aphasia. We will analyze it for any trends and would expect to see lower latencies and higher rates of speech for whichever language the subject used more. In regards to the object recognition test, we expect subjects to be faster at naming the objects in whichever language they used more frequently before the onset of aphasia.

V. The Role of Time

As we learned in lecture, any description of human cognitive activities must include multiple timescales. Studying speech aphasia as a topic is interesting because it has these multiple scales. On the micro-scale, we are studying the very nerve impulses in the brain that are sending signals to create speech. On the macro scale, we are studying bilinguals with brain damage to understand how they recover from aphasia. On the historic scale, we are learning about the brain's language functions by investigating what happens when different parts of it get damaged, and how it is able to recover from this damage years after it occurs. Looking at our lab, time manifests itself on all of these scales as and it is one of the variables that we will score. We investigate the micro-scale in the potential millisecond latency differences we may find between the subject's speech in different languages. We may also study this micro-scale in the number of words a person speaks per second between different languages, and it will manifest itself in the latency between object recognition in either language. We can understand macro-level patterns by creating time-series data and analyzing the differences in this data between different people. We might also gather macro-level data about the subject's long-term term speech habits by surveying the caretakers with whom they spend the most time. Historically, this study could teach us about how the brain modulates multiple languages, how different areas of the brain are responsible for different aspects of speech, and how the brain is able to repurpose itself in the recovery of brain damage like aphasia. The adaptive engagement between the brain and its environment takes place over a large period of time. To properly assess this, it needs to be looked at using multiple timescales, which therefore means that no study has all the answers, and it takes cumulative research to understand issues on the longer term. When we put these multiple timescales together, it is easier to picture and understand the scope of the study through all the levels, all the way from the millisecond time differences we observe to how this fits into the larger puzzle. This study would be a tiny piece of the puzzle, but our results could be important in how we understand language, memory, and bilingualism.

VI. References

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