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Honors Capstone Proposal Project

The Effect of Proficiency Level on the Neural Responses of Students Learning Spanish
as a Second Language

HONR 330

Haley West

Exposure to the first language is critical, and leads to certain behavioral and cognitive changes, even in children who are a few days old (Friedmann & Rusou, 2015). Children are thought to learn language through a combination of observation and innate aptitude for lingual structure. There are stages for the acquisition of language in children, beginning at babbling, which does not involve any grammar, but is instead imitation in fragments. The child then begins to make words, and word combinations, along with gestures. This is followed by learning how to converse and use language to get what they want. Comprehension is normally further developed than production, and this is true in learning a second language as well (Clark, 2009).

Proficiency in a second language is achieved through a combination of learning and acquisition. The learning/acquisition hypothesis states that while children acquire language implicitly, adults can learn explicitly *and* acquire language. Learning is a more rule oriented process, while acquisition is an implicit, non-conscious, powerful and efficient process, as described earlier (Krashen, 1982; VanPatten & Benati, 2010). The acquisition process in adults typically occurs when they are immersed in the environment of the language. There are three more accepted hypotheses about acquisition in adults, as described in Krashen (1982), the first being the “natural order hypothesis.” This simply states that there is an order of acquisition of specific lingual objects such as grammatical structures. The order in which these objects are acquired is not rigid, but tends to be similar across individuals. The adult acquisition order is similar to the child acquisition

order, usually regardless of L1. The next hypothesis governing acquisition is the “Monitor hypothesis.” This hypothesis connects the process of acquisition to the process of learning. It suggests that *learned* knowledge can modify or edit the product of *acquisition*. This places acquisition in the central role, while learning only acts on the periphery. The final hypothesis is the “input hypothesis,” and it aims to explain the process of acquisition. Acquisition occurs by using contextual or extra-linguistic information to build upon existing knowledge. It suggests acquisition comes from understanding the “meaning” of the language first, and the “structure” follows after (Krashen, 1982). Regardless of how language is acquired as an adult, that acquisition contributes greatly to proficiency, which will be the focus of the experimental portion of this project.

While it is a long standing theory that a “critical window” exists for successful language acquisition, several studies have proven that even those who begin learning later in life can attain high levels of fluency, which is a characteristic of proficiency, generally associated with speaking (ACTFL Proficiency Guidelines, 2012). This is dependent on the environment as well as intrinsic motivation. Though the “ease” of learning a language does decline with age, the exact amount varies greatly from person to person (Palea & Boștină-Bratu, 2015). The gender gap of language acquisition seems to favor females in speaking and writing, in one very large Dutch study (van der Slik, van Hout & Schepens, 2015). However, in another French study in children, the gender gap disappeared when the family socioeconomic status was high enough (Barbu et al., 2015).

Research is not conclusive on whether this gap is caused by gender, or a result of gender, but it is an influential factor.

Learning a second language in the classroom obviously has its limits: large class size, limited time, or test-driven curriculum. However, the wide range of available technologies and multimedia applications make the process more immersive now than it ever was (Richards, 2015). For Canadian students learning French, the Core French instruction, which was the standard class of 30 to 40 minutes per day, led them to perform below their peers in an immersion program on every aspect of language proficiency. In fact, the Immersion learners were very close to bilingual speakers, approaching native-like abilities (Lappin-Fortin, 2014). The immersion program is closest to the natural environment in which acquisition occurs, and this explains the more positive results. A more natural atmosphere is most focused on the content of the language, and not the form of the language (ie: ordering the correct thing from a menu vs verb conjugation). This natural approach supports the powerful subconscious acquisition, while the formal approach relies on learning (Dulay, Burt, & Krashen, 1982). Of course both types of learning are important to achieve fluency.

The focus of second language education is proficiency in the target language (Ruiz-Funes, 2002). Proficiency can be defined in many ways, but the American Council on the Teaching of Foreign Languages (ACTFL) has a set of proficiency guidelines to help standardize measures of acquisition. The stages of proficiency go from novice to intermediate to advanced to superior to distinguished, and there are different categories

for the different types of communication: written, oral, auditory and reading, though reading and oral proficiency were not tested in this study. The guidelines are examples of abilities that should be present at that stage. For example, “novice” proficiency speakers should be able to convey short messages with words that they have memorized, while “distinguished” proficiency speakers should be able to communicate with direct, precise, effective and efficient language (ACTFL Proficiency Guidelines, 2012).

The two hemispheres of the brain have different functional specialization, but for complex tasks both hemispheres work together (Barth et al. 2012; Costanzo et al. 2015; Selpien et al., 2015). Some tasks, such as auditory linguistic and spatial positional processes, are highly lateralized, but others, such as spatial quantitative, and visual lexical processes have no significant hemispheric specialization (Boles, Barth & Merrill, 2008). Listening to actual parts of speech, rather than just passive sounds, correlates with a significantly higher activation in the left hemisphere (Zatorre & Evans, 1992). Some lateralization is innate and present at birth such as newborns’ propensity to process music in the right hemisphere (Perani et al., 2010). While there is still much debate, it is fairly accepted that the left hemisphere contributes to the semantic part of language, and the right hemisphere is in control of the pragmatic, or contextual part of language. However, the majority of language related deficiencies are correlated with left hemisphere damage (Hellige, 1993).

Beginning as sound, language is first processed in the brain by the auditory cortex, where speech is differentiated from other sounds, though there is much debate about where exactly this occurs. The next step of processing is intelligibility, or

understanding the words that are said. The superior temporal sulcus has been shown repeatedly to be involved in this, as it is midway through the auditory stream, but it is more active for intelligible speech and less active for non-intelligible speech. One model for the actual understanding of speech is the syntax first model. It suggests that words are first put into categories in an initial stage and later the connections and actions between words are established. This model is presently the most supported, though there are models of interaction which do not separate the two steps. This process of building structure in language has been localized work between the frontal operculum and the superior temporal gyrus. One common way to study language in the brain is to observe the difference in processing erroneous and correct sentences, and then correlate the types of errors with the brain areas that do not overlap. This is a measure of the complex facets and parts of language. Many of these studies have pointed to Broca's area, thus its reputation for importance to language (Friederici, 2011).

There is some research examining Spanish and a second language, or L2, and the hemispheric differences between the native language and L2. It is already established that the right hemisphere plays some role in L2 processing (Reiterer, Pereda & Bhattacharya, 2009). It has also been shown that those who learn a language later have a greater right hemisphere involvement in processing that language, as opposed to those who learn a second language in childhood (Evans et al., 2002). The participants in this particular study will be learning Spanish well after childhood, so we will expect some level of right hemisphere involvement. In another study, it was found that bilinguals used their left hemispheres more when they were presented with semantic errors (Proverbio, Čok &

Zani, 2002). But the extent and scope of right hemisphere involvement is widely disputed. For instance, inexperienced learners of an L2 could potentially rely on the right hemisphere more, to provide contextual clues for the semantics they have not learned, or they could rely on the right hemisphere less, to call on semantics they do know to fill in for the context which they have not been able to absorb yet. This can also provoke questions about advanced speakers of an L2, and how their brain works in respect to hemispheric specialization. There is a lack of research which looks at the progression, or the difference in experience between those in the beginning and advanced stages of Spanish proficiency.

There is much less consensus in the processing locations of the second language. This is largely due to the vast number of languages and structures. One cannot expect Mandarin to be processed in the same way as English. There is some overlap of course, early in the auditory stream. The other complication is that learning a second language changes the connectivity patterns of the brain; it is not a static process. Connectivity patterns can be altered even in as little as six weeks of learning a new vocabulary (Yang et al., 2015). Interestingly enough, an fMRI study showed that if the second language is not very similar to the native language, then processing tends to be similar, on the left. But if the language is similar, then processing tends to be lateralized more on the right (D'Anselmo et al., 2013)

One way to analyze differences in hemispheric processing is electroencephalography (EEG). EEG is a way to measure brain activity from minimally

invasive electrodes that are placed on the scalp. This type of measurement is a good representation of activity in time frames, (Davidson, Jackson, & Larson, 2000). These activity has regular oscillations which can be measured in frequencies. The data were recorded in the form of alpha waves, a certain type of rhythmic wave that usually occurs when the brain is in a resting state: 8 to 13 hertz (Sucholeiki, 2014). When these alpha waves are disrupted, it is called desynchronisation, and this can be connected in time to specific events (Davidson et al., 2000). Desynchronisation occurs when greater focus and attention are needed from the brain, such as while listening to a second language (Rogers et al., 1977).

Methods

Participants: 16 Students were recruited from Augustana College to undergo an EEG during a listening task. Students were all college age (18-23) and native English speakers. The Edinburgh Handedness inventory (Oldfield, 1971) was administered, and those who did not have a right handed preference were excluded from analysis (n=5).

Process: All participants were seated in front of a computer and given consent forms, as well as the handedness inventory. Two simple measures of category proficiency were then given (from Costanzo, 2015) with a time limit of 60 seconds each. Proficiency tasks were simply to write as many words as possible that begin with a specific letter, F for English, P for Spanish. The EEG cap was then placed on the participants, and four electrodes filled with conducting gel: 2 occipitotemporal sites on each side of the head. The participants were then to listen to two stories in Spanish and English, the order was automated and randomized using MatLab. The stories were both children's stories, and

fairly simple. The English story was If You Give a Mouse a Cookie, and the Spanish story was Cinderella. The participants were instructed to close their eyes until prompted to open them. This allowed for the recording of a 30 second baseline. The story started automatically while the participants eyes were closed, and and running time was close to 2 minutes 30 sec for both stories. When it was finished, they were prompted to open their eyes and answer three simple questions in English about what they heard. Then the next block began, following the same order but in the alternate language. After the second set of three questions, participants were free to go.

Analysis: Data was recorded using Labchart, and the 2 channel inputs were spectrally filtered for total alpha power (8-13hz) as measured in volts squared. All data points were 3 second averages, and the 10 data points of the baseline were averaged to get a single value for each language for each hemisphere for each participant. All raw data from the listening portion was divided by the appropriate baseline to form a ratio of Listening alpha power to Baseline Alpha power.

Results

Analysis suggests no significant main effects or interaction. Main effect of hemisphere $F(1,10)=.472, p=.508$. Main effect of language $F(1,10)=.012, p=.916$. Interaction of hemisphere and language $F(1,10)=1.849, p=.204$. Small sample size and high variance contributed to the lack of significance.

A trend is visible in the interaction, of similar alpha power during the Spanish task, and elevated and highly variable alpha power in the left hemisphere during the English task (see figure 1).

Discussion

While the original intention was to demonstrate correlation between processing hemisphere dominance and high and low proficiency, the sample recruited did not allow for equally sized groups, and for that reason, data was analyzed as one group, with ratios of Spanish:English proficiency from .2 to .7, and a large concentration around .2. This data does not support the hypothesis of a more active right hemisphere in L2 processing. It does, however, show support for the hypothesis that the languages are not processed in the same left dominant manner. The English language condition yielded a difference in alpha activity between hemispheres while the Spanish language condition showed more similarity between hemispheres. The alpha ratio for the left English condition was found to be widely variable, when it was predicted to be low. Recent studies have found that increased alpha activity while listening to English may indicate inhibition of irrelevant processing areas in the left hemisphere (Palva & Palva, 2007). This would mean that the variable ratios would be caused by different levels of inhibition, or some mix of inhibition and inactivation. The inactivation might be explained because it is the “natural” function of the left hemisphere, requiring less involvement. This is even more relevant if we consider the earlier topics of acquisition and learning. A study has shown that with a dummy language, the brain differed in processing depending on implicit or explicit learning (Morgan-Short et al., 2012). Therefore, the lower left hemisphere activity can be explained by natural inactivation, and the difference between English results and Spanish results can be explained by differences between learning and

acquisition. In all, the data supports the hypothesis that the second language is processed differently from the first language.

Variability in results could be due to equipment malfunction or human error, though every precaution had been taken to avoid those types of error. Future analysis will focus on the broad spectrum of frequencies outside of the alpha range, to more fully understand hemispheric differences, and how they affect other types of waves, such as delta waves. Though the sample started at a fair size of sixteen, an unusually large number of participants were left handed and therefore had to be excluded. The inclusion of more participants would likely lead to a more clear trend of activity.

In conclusion, a clear correlation was not seen between hemispheric processing and proficiency, but a trend of difference was seen. This difference could be explained as the difference between learning and acquisition, because the participants acquired English, but they were being instructed (learning) in Spanish.

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Figure 1

