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Pilot Study of Empathy in Bilingual Adults

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Abstract

Empathy is of critical public health importance due to its association with relationship satisfaction and well-being (Davis & Oathout, 1987; Davis, 1983). There is growing evidence that bilingual individuals may have higher levels of empathy (Javor, 2016). One potential mechanism for this relationship is that bilingual individuals tend to have higher levels of executive functioning (Costa et al, 2008), which is linked to higher empathy because individuals are able to more easily adopt others' perspectives. Previous studies examining this question have largely relied on self-report questionnaires assessing empathy as a general tendency (i.e., trait). No studies have examined differences in the empathic experience in the moment (i.e., state empathy) in monolinguals versus bilinguals. Furthermore, while there is much known about the neural underpinnings of executive function, the degree to which bilinguals show greater neural recruitment of executive function regions during the experience of empathy is not well understood. A primary purpose of this study is the development of materials to induce empathy in the moment in bilingual individuals through reading about an event designed to evoke empathy in their primary language and their secondary language. A secondary purpose of this study is to examine the effects of the empathy induction in the primary and secondary language on bilingual individuals through collection of behavioral and neuroimaging pilot data. Pilot data collection included measurement of empathy as a trait and state through self-report questionnaires. Brain activation in response to the empathy task was measured using functional near infrared spectroscopy.

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Empathy

Empathy has been critical in understanding successful communication and has been shown to be linked with well-being and rewarding relationships between individuals (Davis & Oathout, 1987). Empathy can be split into two different facets: trait empathy and state empathy. “Trait empathy refers to the capacity for empathic reactions as a stable feature of personality” (Wallmark, Deblieck, & Iacoboni, 2018). Trait empathy can be divided into both emotional empathy and cognitive empathy. Aside from trait empathy, state empathy is situational and is associated with the reactions of others. In prior studies, trait empathy is associated with prosocial behavior (Balconi, & Canavesio, 2013; Litvack-Miller, McDougall, & Romney, 1997). It is relevant to study both trait and state empathy to assess prosocial behavior, emotional empathy, cognitive empathy, empathy as a personality feature, and empathy as a situational element. Empathy has been shown to be associated with mirror neurons and imitation in the brain located in the “higher-order visual area (the posterior part of the superior temporal sulcus) and by the fronto-parietal mirror neuron system” (Iacoboni, 2009). Due to lesion studies of the brain and neuroimaging, prior research has shown that empathy is related to two different neural networks in the brain: the inferior frontal gyrus and the inferior parietal lobule, which are associated with emotion contagion and emotion recognition (Shamay-Tsoory, 2011). More areas associated with empathy are the anterior cingulate, anterior insula, amygdala, and ventromedial prefrontal cortex for emotional empathy and the dorsomedial prefrontal cortex, temporal pole, posterior superior temporal sulcus, and hippocampus for cognitive empathy. One uses empathy daily during conversations, through media, involving moral

reasoning, and when processing information related to social interactions. Empathy allows individuals to understand behavior and increase our knowledge of others' feelings and emotions.

There are many different ways that empathy takes shape. Empathy contains both cognitive and emotional components that contribute to the overall outcome of an interaction (Baron-Cohen, & Wheelwright, 2004). There are also numerous roots of empathy in evolutionary ideas, social psychology, and cognitive neuroscience, which all have differing ideas of the way one processes and defines empathy (Decety, & Lamm, 2006). Empathy can be seen in human interactions by sharing feelings with another person, understanding thoughts and feelings of others, having an emotional experience similar or equal to another person's, and/or responding to empathic situations through affective responses, for example (Decety, & Lamm, 2006). This is seen in perspective taking, altruistic and prosocial behavior, and theory of mind. Many people take on the role of others by imagining that they are in some else's shoes, which allows for more effective communication.

Bilingualism

As more people are coming together to unite different cultures, races, and ethnicities in the United States and abroad, understanding empathy in many different contexts can be more difficult to comprehend, but also more important to focus on. Cultural variation can be found in different ways of processing emotion and cognition, as well as cultural beliefs and differing priorities for communication. People of different cultures have different perspectives than others and do not share a common worldview (Pedersen, 2001). The norms of a culture define interactions, therefore, these norms can

allow for communication barriers and missing connections between emotions, thoughts, and beliefs.

Bilingual individuals have shown cognitive and emotional differences in prior studies compared to monolingual individuals. Bilingual individuals have higher conflict resolution and executive control compared to monolinguals when they completed tasks in those areas, like the Stroop and Simon tasks (Bialystok, & Craik, 2010). There have also been numerous studies that show a positive effect of bilingualism and executive function with attentional advantage in selectivity and inhibition (Bialystok, & Craik, 2010; Costa, Hernández, & Sebastián-Gallés, 2008; Javor, 2016; Dewaele & Wei, 2012; Davis, 1980). Bilinguals also possess "better inhibitory control for ignoring perceptual information than monolinguals", which is an aspect of executive control and perceptual analysis (Bialystok & Martin, 2004; Bialystok & Shapero, 2005). This system is located in the prefrontal cortex and develops as one ages. The effects of increased executive function can be seen throughout the life span because the processes of executive function can decline with age. Comparing younger and older individuals, younger individuals, both monolingual and bilingual have out-performed older individuals in executive functioning tasks because many of these are affected by aging, but when looking at the effect of language, bilinguals still had an increased advantage to monolinguals in executive control, no matter the age (Bialystok, Craik, & Luk, 2008). Bilinguals use a conflict-management system in the brain, which allows them to select the proper terms in both languages during language and nonlanguage tasks, that enhances function of executive control (Bialystok, & Craik, 2010).

Bilingual individuals process emotion differently as well, especially depending on the age of acquisition of the second language. For early bilingual individuals who learned their first and second languages either simultaneously or prior to the language boom, which occurs in adolescence, research has shown that there is no difference in the emotional reaction between the two languages (Harris, 2004). There was a difference, however in late acquisition, which would mean the bilingual speakers show that they have a more emotional response in their native language. There is also a processing advantage for bilingual individuals for emotional words, which can lead to higher executive function as well (Ponari, Rodríguez-Cuadrado, Vinson, Fox, Costa, & Vigliocco, 2015).

The bilingual brain not only has executive function differences, but structure and function changes compared to monolingual individuals. Depending on the age of acquisition, bilingual individuals have increased density of grey matter in the left inferior parietal cortex with structural reorganization (Mechelli, Crinion, Noppeney, O'doherty, Ashburner, Frackowiak, & Price, 2004). Higher proficiency in both languages and earlier age of acquisitions cause increased structural plasticity of the brain (Perani, Paulesu, Galles, Dupoux, Dehaene, Bettinardi, & Mehler, 1998). Bilinguals proficient in both languages activate the same areas of the brain when perceiving language, but show activation of the left caudate nucleus due to sensitivity in the meaning of words (Crinion, Turner, Grogan, Hanakawa, Noppeney, Devlin, & Usui, 2006). “Positron emission tomography activation techniques and functional magnetic resonance imaging assess localized increases in cerebral blood flow associated with mental processes” (Fabbro,

2001). There have been many differences in brain function and structure between bilinguals and monolinguals, which have led to behavioral differences.

Interactions between Bilingualism & Empathy

There is growing evidence that bilingual individuals have higher levels of both cognitive and emotional empathy compared to monolinguals due to their higher executive functioning (Costa, Hernández, & Sebastián-Gallés, 2008; Javor, 2016; Dewaele & Wei, 2012; Davis, 1980; Ponari, Rodríguez-Cuadrado, Vinson, Fox, Costa, & Vigliocco, 2015; Bialystok & Craik, 2010; Bialystok & Martin, 2004; Bialystok & Shapero, 2005). Bilingual individuals show greater activation in the left anterior frontal lobe while using their second language during syntactic processing of sentences compared to monolinguals (Scherer et al., 2012). Previous studies examining the relationship between bilingualism and empathy have primarily used self-report questionnaires to assess empathy as a general tendency (i.e., trait). No studies have examined differences in the empathic experience in the moment in monolinguals versus bilinguals. Furthermore, it is not known whether bilinguals show different functional brain activity in response to an empathy induction in their primary versus secondary language. A primary purpose of this study is the development of materials to induce empathy in the moment in bilingual individuals through reading about an event designed to evoke empathy in their primary language and their secondary language. Empathy is an important tool for communication, thus, bilingual individuals could have increased relationship satisfaction with others depending on the language the other person could be using. A secondary purpose of this study is to examine the effects of the empathy induction in the primary and secondary

language on bilingual individuals through collection of behavioral and neuroimaging pilot data.

Methods

Participants for this study included two healthy adults between the ages of nineteen and forty years. With these participants, one of them was monolingual with English as their primary and only language that they are fluent in, and one bilingual individual that was fluent in both Spanish and English. The bilingual individual had at least ten years of experience in both languages. Both participants were females within the age group that had some college experience. These participants underwent pilot data collection, which included measurement of empathy as a trait and state function through self-report questionnaires that analyze language experience and proficiency, empathy, cognition, executive function, and mood in the present time. In order to determine state empathy, participants underwent an empathy induction in which empathic emotions was elicited through reading notes written in either Spanish or English from a confederate, either neutral or empathy. The bilingual individual received notes only written in Spanish while the monolingual individual only received notes written in English. The neutral induction is a note written by a person describing their day while running errands and the empathy induction is a person writing about their worries with their recent diagnosis of skin cancer. Participants then completed a questionnaire assessing the degree to which they experienced empathic emotions and basic emotions through an emotional response questionnaire with a positive and negative affect schedule. This questionnaire has been shown in previous studies to effectively measure empathy (Beadle, Sheehan, Dahlben, &

Gutchess, 2013). This emotional response questionnaire was used before and after each note induction.

While participants were reading each note induction, in either Spanish or English, they wore a functional near infrared spectroscopy (fNIRS) cap to measure brain activation in response to the empathy and neutral tasks. This non-FDA approved fNIRS cap measured oxygenated, deoxygenated, and total hemoglobin in the brain using near-infrared light and associated areas of activation in the brain with empathy and bilingualism. This method of brain imaging is a portable, non-invasive, and comfortable alternative to other imaging methods. With neural activation, there was increased metabolic demand and increased blood flow to the area that is activated, thus an increase in oxygenated hemoglobin to the area.

Following the induction and measurement of brain activation, the participants engaged in prosocial behavior towards the empathy and neutral confederates by giving money to the opponent in the context of an economic game. This game involved a participant allocating $9, which they can split between themselves and the confederate in one-dollar increments of their choosing. Empathy was measured through the Interpersonal Reactivity Index (IRI), emotional empathy through the empathetic concern sub-scale, cognitive empathy through the perspective taking sub-scale, and prosocial measure through the dollar amount of their choosing for the monetary offer in the economic game (Doherty, 1997; Davis, 1980).

Results

Following inductions of both participants, the data was analyzed by comparison between the two subjects. Pictures of the fNIRS data were taken at 60 seconds for each participant during both the neutral and empathy inductions (Figure 1-4).

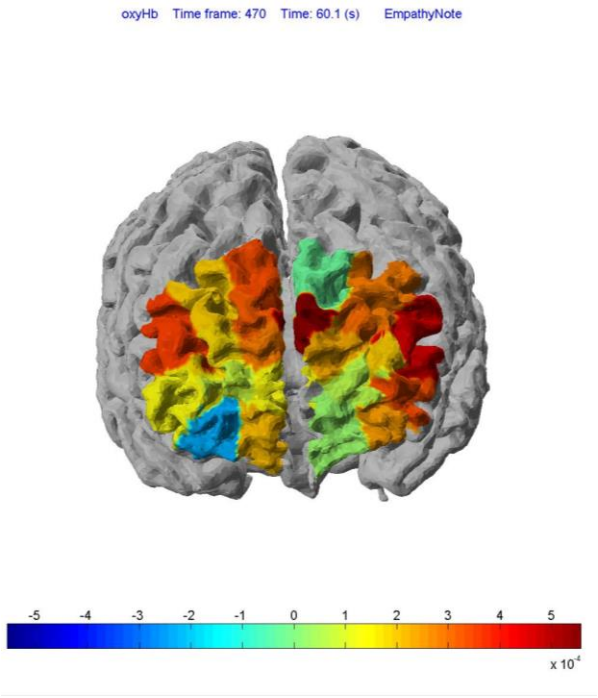

Figure 1: fNIRS frontal cortex results at 60 seconds during the Spanish Empathy Induction. of the bilingual brain.

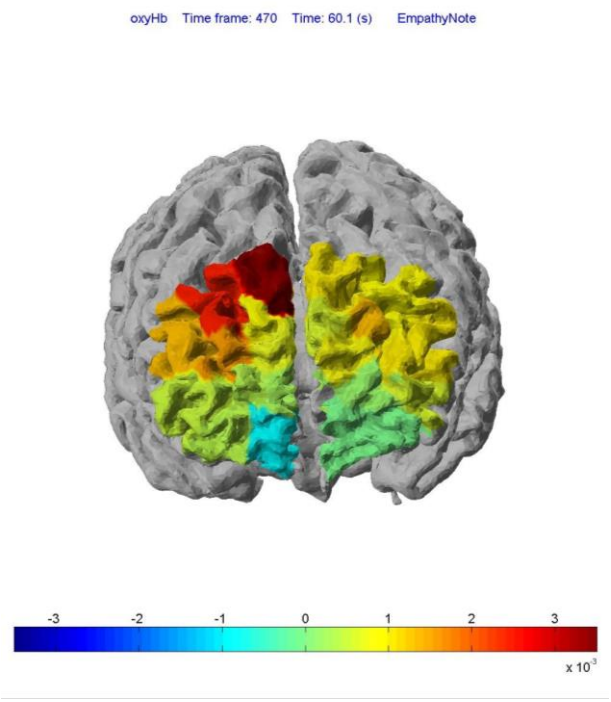

Figure 2: fNIRS fronal cortex results at 60 seconds during the English Empathy Induction of the monolingual brain.

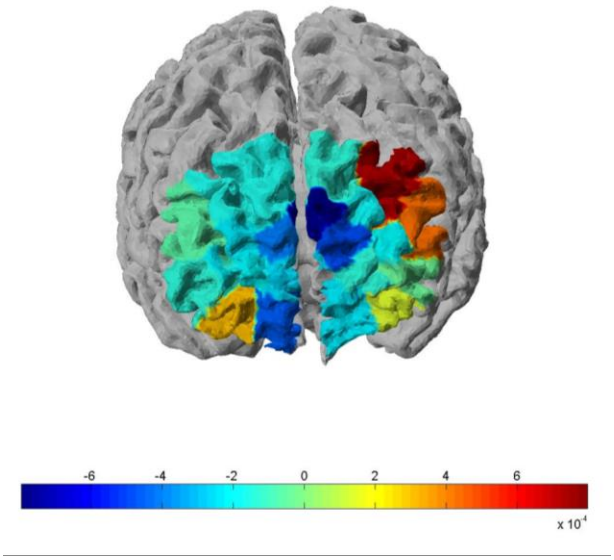

Figure 3: fNIRS frontal cortex results at 60 seconds during the Spanish Neutral Induction of the bilingual brain.

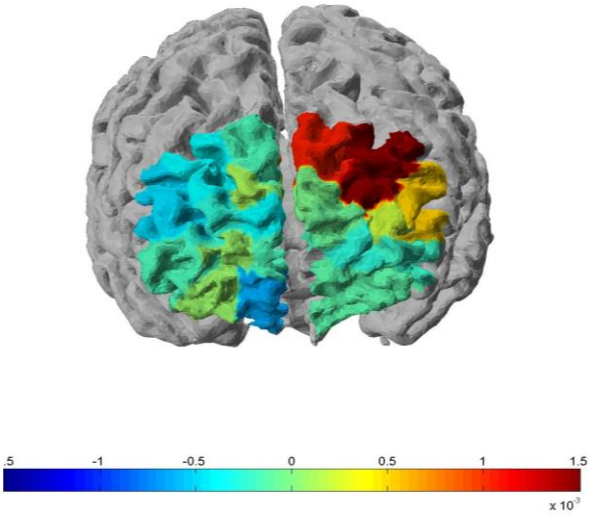

Figure 4: fNIRS frontal cortex results at 60 seconds during the English Neutral Induction of the monolingual brain.

The areas of the brain that show more oxygenated hemoglobin, therefore more activation are the areas that are dark red, red, orange, and yellow, with dark red being the highest concentration of oxygenated hemoglobin present, and dark blue being the lowest concentration. Comparing the activation maps in Figures 1 and 2 with Figures 3 and 4, there is a large difference between activation of the brain during the empathy and neutral inductions. This difference gives merit to the empathy and neutral inductions for eliciting a response in the moment. Also, comparing the empathy images of the two participants,

one can notice more areas of activation in the bilingual participant than the monolingual participant.

Aside from brain imaging, the participants showed differences in cognitive empathy through the perspective taking sub-scale of the IRI, and prosocial measure through the dollar amount of their choosing for the monetary offer in the economic game (Figure 5). The bilingual participant scored higher in perspective taking and gave a higher monetary offer in the economic game to the confederate who wrote the empathic induction. The differences in the data in perspective taking and the monetary offer are not statistically significant with p-values of 0.3173 for both data values. Both the monolingual individual and the bilingual individual score the same on empathic concern.

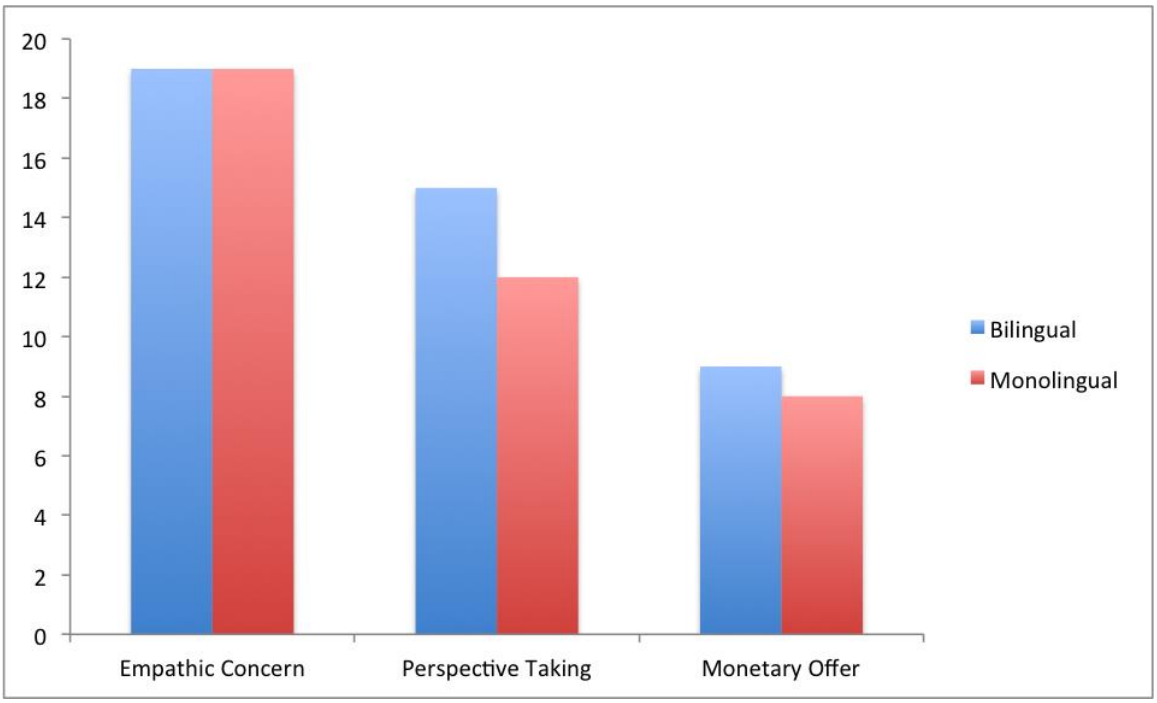

Figure 5: Differences between the responses of the bilingual participant compared to the monolingual participant in certain measures of empathy, including empathic concern, perspective taking, and giving a monetary offer.

Comparing the participants' responses to the mean for the IRI, females score around 21.67 for empathic concern and 17.96 for perspective taking (Davis, 1980, 1983). Both women in the study scored a 19 for empathic concern, which is near the average for women. However, the bilingual female participant scored 15, while the monolingual participant scored 12 for perspective taking, both under the expected mean for females.

The results of the fNIRS imaging, the scores of the IRI, and the monetary offer show a mixed difference between the two participants that were involved in the study, with more neural recruitment in the bilingual participant during the empathy induction, but small variations in the behavioral data. This could further lead to differences between bilinguals and monolinguals.

Discussion

The ultimate goal of this research is to understand empathy differences between monolinguals and bilinguals and the degree to which neural and behavioral differences in executive function may be a mechanism for this difference (Bialystok & Craik, 2010; Costa, Hernández, & Sebastián-Gallés, 2008; Javor, 2016; Dewaele & Wei, 2012; Davis, 1980).

There is an increasing amount of evidence that bilingual individuals tend to have higher levels of empathy (Javor, 2016). It is possible that the mechanism for this relationship is that bilingual individuals have higher executive functioning compared to monolingual individuals (Costa, Hernández, & Sebastián-Gallés, 2008; Javor, 2016;

Dewaele & Wei, 2012; Davis, 1980; Ponari, Rodríguez-Cuadrado, Vinson, Fox, Costa, & Vigliocco, 2015; Bialystok & Craik, 2010; Bialystok & Martin, 2004; Bialystok & Shapero, 2005). To further solidify this bond between bilingualism and empathy, this research needs a larger sample size in order to collect more data and be able to make more statistical comparisons between neural activation and behavioral results.

The bilingual participant scored higher in cognitive empathy and gave more money to the person in need than the monolingual participant, however both of the p-values were 0.3173 for the data values, which would make the data not statistically significant. With an increase in the population size, it is likely that there could be a statistically significant difference between monolinguals and bilinguals according to the behavioral data. There were no differences in emotional empathy. Greater cognitive empathy is typically associated with higher levels of executive function. This is consistent with the finding that bilingual individuals tend to perform better on executive function tasks (Bialystok & Martin, 2004; Bialystok & Shapero 2005).

One limitation in the study is that prior research looks at different types of multilingualism with varying languages. In the present study, we focused on Spanish and English due to the prevalence of Spanish speaking individuals in the surrounding community of Omaha, Nebraska, but there could be different outcomes with different languages and cultures if one were to perform the study with bilingual participants in Japanese and English, for example. Looking at Hispanic/Latino culture, Spanish speaking individuals traditionally have a patriarchal structure in the home, come from a collectivist culture, have larger household sizes, and many have children a part of the home (Center

for Disease Control, 2010). All of these factors could affect the empathy or the activation of the brain of the participants due to their upbringings.

The bilingual individual showed greater neural recruitment of the prefrontal cortex during the empathy task relative to the monolingual upon visual comparison. On the activation maps of the prefrontal cortex (Figures 1-4), the empathy induction induced more oxygenated hemoglobin in the brain compared to the neutral induction, giving merit to these inductions to elicit empathy in the moment. Comparing the activation sites between the empathy inductions for both of the participants, one can notice the increase neural recruitment with more areas of oxygenated hemoglobin, and thus more areas of activation in the bilingual participant's prefrontal cortex. This preliminary evidence may reflect the higher cognitive empathy experienced by the bilingual individual and is consistent with the idea of greater recruitment of regions important for executive function, but an increased population is needed (Scherer et al, 2012).

More data is needed to confirm a relationship between bilingualism and empathy, as well as differences in primary and secondary languages of bilingual individuals. The future research plan is to collect numerous additional subjects to further analyze these relationships.

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