INTRODUCTION

Research has shown that abstract words and concrete words are coded differently in the brain. The Left Hemisphere (LH) is initially responsible for processing analytical verbal codes, while the Right Hemisphere (RH) is initially responsible for processing holistic image-based codes (Kiehl et al., 1991). Because the brain is organized contralaterally, words presented to the right ear initially activate the LH and words presented to the left ear initially activate the RH.

Paivio proposed a dual coding theory which states that abstract words and concrete words have different methods of activation (Binder et al., 2005; Paivio, 1991). Concrete words are words that can literally be visualized, such as table, dog, etc. Abstract words are words that have only verbal codes and do not evoke an image in our heads, such as the concepts of truth, justice, etc.

Paivio theorized that concrete words should activate both the LH and RH equally because concrete words have both verbal and image-based codes, which implies that concrete words activate both hemispheres of the brain. In contrast, abstract words do not have visual codes to activate the RH and, therefore, are primarily processed by the LH. As a result, abstract words presented to the right ear (LH) should be recognized faster than abstract words presented to the left ear (RH). While there are a few contradicting theories that oppose Paivio’s dual coding theory, we believe that this theory accurately accounts for the discrepancies in reaction time associated with auditory lexical decision tasks. The vast majority of research on Paivio’s dual coding theory has been conducted using English speakers. While it can be assumed that most Latin-based languages are processed in a similar manner, it cannot be assumed that other languages are processed the same way as well. Therefore, the current study extends prior research by presenting words in both English and Gujarati.

Gujarati is an Indian language that is predominantly spoken in the state of Gujarat. The Gujarati language is significantly different from English in that it is not only rooted in a unique script, but the sounds of Gujarati words are intrinsically different from those of the English language. The primary objective of this research was to determine whether hemispheric differences in word recognition times associated with abstract and concrete words in English replicate when the words are presented in Gujarati. We hypothesize that abstract words presented to the right ear (LH) should be processed faster than abstract words sent to the left ear (RH). At the same time, we believe that concrete words should be processed similarly regardless of the ear they are presented to. This hypothesis is in line with Paivio’s dual coding theory.

METHODS

Participants:

Thirty right-handed Gujarati-English bilinguals above the age of 18 were chosen to participate in this research study. All of the participants were proficient in Gujarati and English, but half (15) reported English as their native/dominant language and half (15) reported Gujarati as their native/dominant lan-
guage. The participants that were chosen were required to be able to comprehend both English and Gujarati.

Materials and Procedure:

Participants listened to 80 auditorily presented stimuli and indicated whether the stimuli were words or nonwords in Gujarati and English. This type of task is known as a lexical decision task. Each word/nonword was randomly presented via headphones to the right or left ear. Stimuli were counterbalanced such that half of the participants heard a specific word/nonword presented to the right ear while the other half had that same word/nonword presented to the left ear. Half of the real words were concrete words (e.g., carrot) and half were abstract words (e.g., truth). Language was blocked such that some participants listened to a list of Gujarati words/nonwords first and the English word/nonword list second, or vice versa. Abstract and concrete words were matched for word length. English abstract and concrete words were also matched for word frequency. The majority of the abstract and concrete words were taken from Binder et al. (2005). Nonwords were legal and followed pronunciation rules for English and Gujarati. Table 1 provides examples of a few stimuli that were used in this experiment.

After completing the lexical decision task, participants were given an English vocabulary test and a language history questionnaire. This information provided insight about each participant’s mastery over the English language. The language history questionnaire also provided information about the participant’s native language. After completing these forms, the participants were paid $10/hr.

<table>
<thead>
<tr>
<th>Stimulus Language</th>
<th>Word Type</th>
<th>Stimulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Concrete Word</td>
<td>Lemon</td>
</tr>
<tr>
<td>English</td>
<td>Abstract Word</td>
<td>Justice</td>
</tr>
<tr>
<td>English</td>
<td>Nonword</td>
<td>Ruggage</td>
</tr>
<tr>
<td>Gujarati</td>
<td>Concrete Word</td>
<td>Kabutar</td>
</tr>
<tr>
<td>Gujarati</td>
<td>Abstract Word</td>
<td>Satya</td>
</tr>
<tr>
<td>Gujarati</td>
<td>Nonword</td>
<td>Nrkash</td>
</tr>
</tbody>
</table>

Table 1: Example English and Gujarati Stimuli.

RESULTS

An ANOVA was performed to examine lexical decision times as a function of Word Language (English, Gujarati), Word Type (Concrete, Abstract), Presentation (Left ear, Right ear) and Language Dominance (English, Gujarati). Analyses were based only on real words because the nonwords were simply vehicles that were used to employ the lexical decision task. There were no significant differences in decision times based on Presentation (Left ear, Right ear). While significance was not found, the p value for Word Type X Word Language X Presentation was equal to 0.058. Nonetheless, there was a significant Language Dominance X Word Language interaction (p < .05). As shown in Table 2, native English speakers responded faster to English stimuli whereas native Gujarati speakers responded faster to Gujarati stimuli.

Additionally, there was also a significant Language Dominance X Word Language X Word Type interaction (p < .05). As shown in Table 3, native English speakers recognized concrete words faster than abstract words when presented in English (their dominant language) or Gujarati (their nondominant language). Native Gujarati speakers recognized concrete words faster than abstract words when presented in Gujarati (their dominant language). In contrast, native Gujarati speakers recognized concrete words slower than abstract words when presented in English (their nondominant language). Note that the average action time for the Native Gujarati speakers (1221 ms) is longer than the average reaction times for the three other conditions (highlighted in blue in Table 3).

<table>
<thead>
<tr>
<th>Native/Dominant Language</th>
<th>Average English Decision Time (ms)</th>
<th>Average Gujarati Decision Time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>1124</td>
<td>1181</td>
</tr>
<tr>
<td>Gujarati</td>
<td>1221</td>
<td>1129</td>
</tr>
</tbody>
</table>

Table 2: Lexical Decision Times for English vs. Gujarati Dominant Speakers for English Stimuli and Gujarati Stimuli.

DISCUSSION

While significance was not statistically seen for presentation, if the sample size was even slightly increased, significance may have been seen for an interaction of Word Type X Word Language X Presentation. Since this value was so close to significance, it is indeed justified to discuss those results. According to Table 4, it can be seen that, for English stimuli, abstract words presented to the right ear (LH) were processed faster than abstract words sent to the left ear (RH). This is completely in line with the proposed hypothesis. On the other hand, concrete words were processed faster by the left ear (RH). This could imply that the RH, which is associated with image-based codes, processes words faster than the LH, which initially processes verbal-based codes. However, the Gujarati results were completely inverted, which cannot be fully explained without a larger sample size.

Nonetheless, because there were no significant differences based on Presentation (Left ear, Right ear), no conclusions can be made about the lateralization of language in Gujarati dominant speakers compared to English dominant speakers. Critics could argue that significance was not found because of low statistical power (small sample). Another reason could be that the experiment itself – the lexical decision task – was not sensitive. However, the data presented in Table 2 demonstrates that native English speakers responded to English stimuli faster than Gujarati stimuli, whereas native Guja-
rati speakers responded to Gujarati stimuli much faster than English stimuli. While this may seem trivial, it actually implies that the task employed was in fact sensitive to language dominance. However, the data presented in Table 2 demonstrates that native English speakers responded to English stimuli faster than Gujarati stimuli, whereas native Gujarati speakers responded to Gujarati stimuli much faster than English stimuli. While this may seem trivial, it actually implies that the task employed was in fact sensitive to language dominance.

<table>
<thead>
<tr>
<th>Word Language</th>
<th>Word Type</th>
<th>Hemispheric Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Concrete</td>
<td>Right Hemisphere</td>
</tr>
<tr>
<td>Abstract</td>
<td>Left Hemisphere</td>
<td></td>
</tr>
<tr>
<td>Gujarati</td>
<td>Concrete</td>
<td>Left Hemisphere</td>
</tr>
<tr>
<td>Abstract</td>
<td>Right Hemisphere</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Lexical Decision Times for English vs. Gujarati Dominant Speakers for Concrete and Abstract words in both languages.

Most importantly, the results of this study support the conclusion that recognition speed for abstract words and concrete words differs across the two languages based on language dominance. According to the dual coding theory, a person's dominant language determines that concrete words should be processed faster than abstract words. We found this pattern for three of the four primary conditions (see Table 3). As seen in Table 3, native English participants responded to concrete words faster than abstract words regardless of the language of the word that was presented. Also, for Gujarati participants responding to Gujarati stimuli (their native language), they responded to concrete words faster than abstract words. These results are all in line with Paivio’s dual coding theory. However, for English words, native Gujarati speakers recognized abstract words faster than concrete words. This suggests that the Gujarati participants may not have been highly proficient in English, which is one reason why the results may be reversed for this condition. This was determined by examining the language history questionnaires, the accuracy of their responses, and the vocabulary tests. Furthermore, previous research has also produced results that are inconsistent with Paivio’s model (Kiehl et al., 1999). While these results were not fully inconsistent with the dual coding theory, further research must be conducted to determine whether our findings reflect properties of the Gujarati language, a small sample size, or the procedure itself.

ACKNOWLEDGMENTS
This research was funded by the UIC Honors College Research Grant. The author gratefully acknowledges the contributions of Dr. Gary Raney, Associate Professor of Psychology at the University of Illinois at Chicago.

REFERENCES


Sagar Shah is currently a senior in the Honors College at the University of Illinois at Chicago, pursuing a Bachelor of Science in Neuroscience with a minor in Chemistry. His professional goal is to obtain a medical degree and to become a pediatric neurologist. He is currently volunteering at the Midwest Brain Injury Clubhouse – where he has volunteered for the past three years. He is also the Vice-President of UIC OneWorld, the Webmaster for the Society of Future Physicians, and an active member in the Global Learning Community. He has been involved in psycholinguistic research with Dr. Raney for nearly three years. His work in auditory lateralization also merited a first place award at the UIC Student Research Forum in the Social Sciences division.