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Analyzing the Relationship Between Vocabulary Size and the Duration and Accuracy of Response of English Learners

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ANALYZING THE RELATIONSHIP BETWEEN VOCABULARY SIZE AND THE DURATION AND ACCURACY OF RESPONSE OF ENGLISH LEARNERS

By

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Abstract

English Learners with slow vocabulary development take longer to comprehend text than English-speaking monolinguals. This is a significant problem for many students who are learning English as a second language and it is important that we best assist English Learners to prevent delays within the classroom. The purpose of this study is to analyze how children's vocabulary size correlates with the duration and accuracy of their response. This study analyzes 20 students ages 5-6, and uses eye tracking technology to measure response time. Contrary to previous studies, a correlation between vocabulary size and duration of response was not found. Our findings did show a correlation between vocabulary size and accuracy of response, and English Learners portrayed a stronger performance than English-speaking monolinguals on the eye tracking task. Through these findings, we are better able to understand the impact of vocabulary size on English Learners to aid English Learners academically and socially.

Introduction

Discovering the most effective way to assist English Learners (ELs) in language development can be a challenging task. An EL is a student whose first language is not English but is in the process of learning English. With an increasing number of English Learner students in the United States it is imperative to know how to help those struggling with a language outside their native country to prevent language delays. This is most efficiently done if we understand how English Learner's learn and how to help English Learners attend to words and process words in their second language.

Although there have been many studies conducted on the vocabulary development of English speakers, few have focused on vocabulary development of Spanish speakers. A notable exception can be found in work completed by Hurtado, Marchman, and Fernald, which replicated a study for monolingual English speakers and analyzed spoken word recognition in native Spanish speakers (2007). They studied 49 Latino children to analyze eye movements for increased understanding in efficiency of speech processing. It was found that older children with larger vocabularies were more proficient in processing spoken language and children whose mothers had less education and smaller vocabulary size, had slower rates of language processing (Hurtado, Marchman, Fernald 2007). Mean reaction times indicated that older Spanish speaking children had a faster reaction time, and these reaction times were strongly correlated with age and expressive vocabulary size. From this study it is evident that individuals with larger vocabulary input have faster rates of language processing.

In existing literature it has been found that children who have a quicker reaction time when identifying spoken language target words have larger vocabularies. In a study done by Fernald, Swingley, and Pinto, lexical growth is strongly correlated with speed and spoken

language understanding (2001). It has been revealed that infants with over 100 words in their vocabulary were more accurate in identifying words than infants with vocabularies containing less than 60 words (Fernald et al., 2001). These results showed that children's speed of processing increases with their age and larger vocabulary aids in identification of words.

One approach to measuring reaction time in word recognition is through the study of eye movements. Anne Fernald's *looking-while-listening* paradigm is designed to analyze the time course and eye movements of children in response to speech (Fernald et al., 2008). The paradigm measures reaction time to continuous speech and word recognition accuracy in children. As children's age increases, the speed and efficiency of word recognition increases significantly This finding has been demonstrated in experiments that require children to look at a pair of pictures while their eye movements are analyzed. Individual differences in speech processing can be attributed to lexical and grammatical development and can also help show how children use perceptual and linguistic features of speech (Fernald, Zangl, Portillo, Marchman 2008).

In addition to this, previous studies have found that vocabulary size can impact spoken word recognition of Spanish- English bilingual children. A study done by Marchman and Fernald in 2008 obtained the correlation between the speed of spoken word recognition and vocabulary knowledge. They studied 24 two-year-old bilingual children by showing them a target word and competitor. Using eye-tracking technology they could analyze the speed in which children identified the target word in English and in Spanish. It was found that response times for identifying the English target word were strongly correlated with English vocabulary while the response times for identifying the Spanish target word were strongly correlated with Spanish vocabulary. However, response times for English targets did not correlate with Spanish vocabularies, and likewise Spanish target words had no correlation with English vocabularies.

This showed that efficiency in spoken language understanding and vocabulary knowledge are correlated within each language (Marchman and Fernald, 2008).

Many English Learners behind in vocabulary development are slower to comprehend text than English-speaking monolinguals. It is important to figure out how to best assist English Learners to prevent delays within the classroom. The purpose of this study is to examine if there is a relationship between children's vocabulary size and the speed and accuracy of response. By knowing how reaction time relates to identification of the correct response, we are better able to understand how to support English Learner's not only in the classroom environment but also in social settings. This study also investigates if vocabulary scores can serve as a predicting factor for accuracy of response. As shown in previous studies there is a significant association between speed and accuracy of spoken word recognition therefore our hypothesis is that we expect to find a significant correlation between vocabulary size and duration of response and accuracy of response. The null hypothesis states that there is not a correlation between vocabulary size and duration of response and there is not a correlation between vocabulary size and accuracy of response.

Methods

Participants

Our sample consisted of 20 kindergarten students, between the ages of 5 and 6. Of these students, 12 were English-speaking monolinguals and 8 were English Learners. This study was conducted within two public rural, low-SES elementary schools in Northern Florida. Several of the participating children were from Latino families and several of the researchers were bilingual and able to speak both English and Spanish. Families were recruited available participating classrooms or a convenience sample. The selected Kindergarten classrooms were given consent

forms in both English and Spanish to fill out and return to their teachers. None of the children had diagnosed developmental delays, hearing loss, and all English Learners were from a Spanish speaking background.

Prior to participating in the study children were given a hearing screening to assure that they would be able to correctly hear the instructions. In addition to this, children were administered a Primary Test of Nonverbal Intelligence to determine the non-verbal intelligence; both EL and English-speaking monolingual mean scores were within the range of the test's normative average. Phone interviews were also conducted with the parents to provide further information on the child's language abilities and parent's language abilities.

Measures

The students were given two vocabulary tests (one expressive and one receptive) to quantify the vocabulary skills of each child: The Receptive One-Word Picture Vocabulary Test- 4th Ed., Spanish-Bilingual Edition (ROWPVT-4 SBE), which has a Cronbach's coefficient alpha of (.96) at age 6, and an Expressive One-Word Picture Vocabulary Test- 4th Ed., Spanish-Bilingual Edition (EOWPVT-4 SBE), which has a Cronbach's coefficient alpha of .94 at age 5. There were two scores calculated for each child: the English-only score and the English plus Spanish conceptual score. The English- only score consisted of the number of correct responses recorded in English while the English plus Spanish conceptual score consisted of the number of correct responses recorded in English and Spanish. The average score for children ages 5-6 based on the national normative sample is 100.

The children were then given an eye tracking measure. Each array of items presented four pictures: the target word, competitor, and two random pictures drawn from our previously

selected pictures. All pictures were realistic photos with equal dimension and resolution. There were three possible competitors: a Spanish cohort (i.e., phonologically-similar in Spanish), English cohort (i.e., phonologically similar in English), or semantic competitor (i.e., similar meaning). Each array included a different target word with one of the competitor types. A total of 33 arrays were shown to each child and in total we completed 580 trials. Children were randomly assigned to one of three different types of array sets to determine the order which the competitors would be presented. Within each type of competitor there were 4 different sets (A-D) which determined the order the pictures of the cohorts would be presented.

For the eye tracking exam the child was in a silent classroom where they were asked to select a target word on the computer through headphones. All target words were pre-recorded by the same individual and spoken in equal duration and volume. The research assistant placed a black and white sticker above the child's left eyebrow to identify the location of the child's eye. There was a two second preview for the child to see all pictures on the slide and then a one second recording of the target word and one second to view the pictures before selecting the word. The eye tracker recorded the student's response times from the end of the 4 second preview until the child clicked on a response.

After eye tracking, students were given a set of receptive identification probes which asked them to point to specific pictures. This probe tested all pictures included in the eye tracking exam to evaluate the child's understanding of each competitor picture. The student was asked in English to point to the target picture and in another section they were asked in Spanish to point to the target picture. This was done to assure that the children knew the strategic competitor of the pictures in the eye tracking exam. The pictures that were not correctly

identified, were eliminated from the child's individual sample. This was done to improve the construct validity in eye tracking measure.

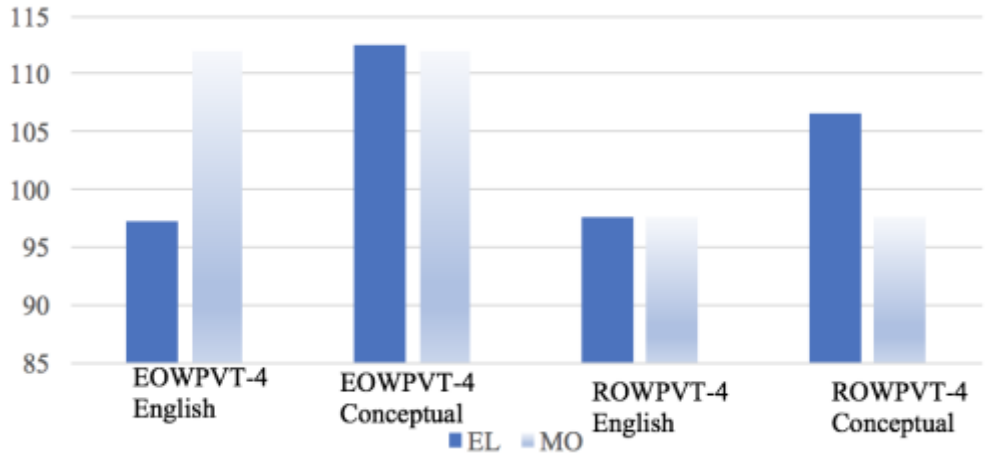
Results

Table 1: Mean and Standard Deviation of English Learners v English-speaking Monolinguals Expressive and Receptive Vocabulary Scores

	EOWPVT-4 English Score	EOWPVT-4 Conceptual Score	ROWPVT-4 English Score	ROWPVT-4 Conceptual Score
English Learner Mean	97.23	112.57	97.55	106.54
English Learner Standard Dev.	14.95	7.88	8.07	8.86
Monolingual Mean	111.98	111.98	97.56	97.56
Monolingual Standard Dev.	15.48	15.48	9.86	9.86

From Table 1 we are able to see a 14.75 point difference between the ELs and English-speaking monolinguals EOWPVT-4 English-only standard score. This was expected due to the differences in language exposure at home but once we compare the English-speaking monolinguals' expressive English-only score to the English Learners expressive conceptual score we are able to see only a .59 point difference.

Graph 1: English Learners vs Monolinguals Average Expressive and Receptive Vocabulary Score



We see nearly the same score between English-speaking monolinguals and ELs in their receptive English-only score at only a .01 point difference but once compared to the ELs receptive Spanish and English conceptual score in Graph 1 we see that ELs have a higher score by 8.98 points.

Table 2: Correlation Table for Total Participants

	Duration	EOWPVT-4 English Score	ROWPVT-4 English Score
Duration	1	0.032	**0.111***
EOWPVT-4 English Score		1	**0.578****
ROWPVT-4 English Score			1

* Correlation is significant at the .05 level (2-tailed)

** Correlation is significant at the .01 level (2-tailed)

Table 2 shows a significant correlation at the .05 level between duration and ROWPVT-4 English-only score at .111. There is also a significant correlation at the .01 level between the EOWPVT-4 English-only score and ROWPVT-4 English-only score at r = .578.

Table 1: Correlation Table for English Learners

	Duration	EOWPVT-4 English Score	ROWPVT-4 English Score	EOWPVT-4 Conceptual Score	ROWPVT-4 Conceptual Score
Duration	1	-0.039	-0.032	-0.026	-0.027
EOWPVT-4 English Score		1	**0.624****	**0.681****	**0.427****
ROWPVT-4 English Score			1	**0.514****	**0.835****
EOWPVT-4 Conceptual Score				1	**0.441****
ROWPVT-4 Conceptual Score					1

** Correlation is significant at the .01 level (2-tailed)

The Table 3 Correlation Table for English Learners shows several correlations at the .01 level. There is a correlation between the EOWPVT-4 English-only score and ROWPVT-4 English-only score at $r = 624$, $p < .01$ level with the EOWPVT-4 Spanish and English conceptual score and ROWPVT-4 conceptual score. Most notably, we see that there is not a significant correlation with duration and vocabulary size among ELs.

The first logistic regression model containing only English Learners, allowed correct prediction of 68.3% of the ELs' responses to the eye tracking measure. The omnibus test of the logistic regression predicting English Learners' response, given their conceptual vocabulary scores, was significant, χ^2 (2) = 26.417, $p < .001$. Children were correctly predicted to respond

correctly with 80.0% accuracy, but prediction of incorrect responses was lower at 50.0%. The model summary predicted 12.3% of the variance in EL's responses, whether correct or incorrect.

Table 4: Logistic Regression Predicting Eye-Tracking Response for English Learners

	B	SE	Wald	Sig.	Exp (B)
EOWPVT-4 Conceptual	.064	.018	12.18	<.001	1.07
ROWPVT-4 Conceptual	.026	.016	2.52	.112	1.03
Constant	-9.47	1.99	22.64	<.001	0
Model χ^2 =	26.42 (p<.001)				
Pseudo R^2 =	.123				

Note. Response was coded as 0 = incorrect response and 1 = correct response

The intercept for the model in Table 4 was B = -9.47, Wald $\chi^2(1)= 22.637$, $p < .001$. ELs' receptive conceptual vocabulary scores did not significantly contribute to predicting their correct/incorrect responses Wald $\chi^2(1)= 2.523$, $p = .112$. The participants' expressive conceptual vocabulary scores, however, did significantly predict correct/incorrect responses Wald $\chi^2(1)= 12.182$, $p < .001$. For every 1-point increase in ELs' English-only scores on the EOWPVT-4, the children were .064 (SE = .018) times more likely to respond correctly to any given item on the eye tracking measure.

A second logistic regression model was done for our total participants, English-speaking monolinguals in addition to English learners. The omnibus test of the logistic regression predicting English Learners' and English-speaking monolinguals' response, given their Spanish plus English conceptual vocabulary scores, was significant, $\chi^2 (2) = 50.665$, $p < .001$. The model summary predicted 14.0% of the variance in EL's responses, whether correct or incorrect. The logistic regression model allowed correct prediction of 69.1% of the ELs' responses to the eye

tracking measure. Children were correctly predicted to respond correctly with 90.8% accuracy, but prediction of incorrect responses was lower at 19.6%. This indicates that children responded correctly to the items with relatively high frequency (338 total correct responses compared to 148 total incorrect responses).

Table 5: Logistic Regression Predicting Eye-Tracking Response for the Full Sample

	B	SE	Wald	Sig.	Exp (B)
EL/MO Status	-1.060	.27	15.36	<.001	.35
EOWPVT-4 Conceptual	-.001	.009	.023	.88	1.00
ROWPVT-4 Conceptual	.070	.017	17.44	<.001	1.07
Constant	-5.11	1.23	17.43	<.001	0.01
Model χ^2 =	50.67 (p<.001)				
Pseudo R^2 =	.140				

Note. Response was coded as 0 = incorrect response and 1 = correct response. For EL/MO status, 0 = English learners, 1 = English-speaking monolinguals.

The intercept for the model was B = -5.114, Wald $\chi^2(1)= 17.426$, $p < .001$. ELs' English-only receptive vocabulary scores did significantly contribute to predicting their correct/incorrect responses Wald $\chi^2(1)= 17.443$, $p = .000$. The participants' expressive English-only vocabulary scores, however, did not significantly predict correct/incorrect responses Wald $\chi^2(1)= .023$, $p = .879$. For every 1-point increase in ELs' English-only scores on the ROWPVT ss ENG, the children are .070 (SE = .017) times more likely to get items correct.

Discussion

This study analyzing the correlation between vocabulary size with accuracy and duration of response, found several conclusions. When comparing ELs' conceptual expressive vocabulary scores against English-speaking monolinguals' we do not see a notable difference. But when

comparing ELs' conceptual receptive vocabulary scores with English-speaking monolingual's we see that ELs actually have a higher mean score than English-speaking monolinguals by nearly 9 points. While it is true that the English-only score for expressive vocabulary was significantly lower in ELs, this reaffirms that while English Learners may appear to have a smaller vocabulary size than English-speaking monolinguals but ELs vocabulary understanding is larger when looking at ELs conceptual vocabulary score because it includes their primary language. Therefore, when comparing English only vocabulary scores we can predict that the Spanish vocabulary and conceptual vocabulary scores will be even greater.

Duration

While there is a weak significant correlation between duration of response and English-only receptive vocabulary scores in our combined sample of participants, there was not a significant correlation with English Learners' duration. In previous studies, it has been found that processing speed is associated with vocabulary size and lexical growth is strongly correlated with speed and spoken word recognition (Fernald et al., 2001) and speed of spoken word recognition and expressive vocabulary are parallel in English-speaking monolinguals and bilinguals (Marchman et al., 2009). In our study the weak positive correlation can be attributed to the English-speaking monolinguals in our sample since there is not a correlation between duration of response and ELs. This was the opposite of what we expected to find.

Seeing that our findings were not supported by prior research, it is possible that this can be attributed to our small sample size of English Learners but it is more likely that our findings are attributed to the flaws within our eye tracking task. It is probable that our eye tracking exam did not truly measures duration since we were observing click reaction time compared to eye

movements. Furthermore, we also didn't tell children to answer as quickly as possible. In addition to this, some children seemed to take longer but were more accurate when they took their time. Because of this we accept part of the null hypothesis: vocabulary size is not correlated with duration of response in English Learners. Further research must be done to investigate if there is indeed a correlation between response time and vocabulary size.

Accuracy of Response

These analyses also showed a greater likelihood that English learners would respond to an item correctly, when their Spanish and English expressive vocabulary scores are higher. This increase in accuracy of response due to increased vocabulary size can be associated with the ability to eliminate incorrect answers, or knowledge to have the specific target word in their existing vocabulary. When highly exposed to a language, spoken language processing in bilinguals helps in learning more words and could enable several systems of organization for greater lexical access across languages (Marchman et al., 2009).

We also see in the logistic regression for our entire sample, that ELs did better than English-speaking monolinguals on the eye tracking task. The ELs demonstrated a stronger likelihood of answering any given item correctly compared to their English-speaking monolingual peers. This gap between English-speaking monolinguals and English Learners was surprising but the concept of inhibitory control offers a possible explanation. Inhibitory control is the ability to disregard competing perceptual information and focus only on the relevant aspects of the input. In cases of inhibitory control ability, bilingual children can often perform better than English-speaking monolinguals (Marian, 2012). Theoretically, due to inhibitory control, bilinguals would be at a greater advantage for process of elimination.

Moreover, this difference between English-speaking monolinguals and bilinguals can be attributed to ELs Spanish vocabulary. Since some of the distractors were Spanish based it is possible that ELs were at an advantage in the process of elimination because they know those specific Spanish words. It may have been easier for ELs to eliminated the Spanish cohort as the answer while English-speaking monolinguals struggled to make this distinction. There is not strong evidence directly explaining why English Learners would perform significantly better than English-speaking monolinguals so further research must be done to determine the purpose behind this gap.

Taken together, these findings suggest that there is a correlation between correctly identifying words and the vocabulary size of English Learners. In our study, having a larger vocabulary size could have helped students in process of elimination to determine which picture to select, increasing their ability to select the correct response. Additionally, it appears that English Learners with large conceptual vocabularies can be at an advantage when learning new words, but further research must be done to confirm this. This could serve as an encouragement among parents and teachers to continue exposing their English Learners to a large variety of vocabulary to increase their academic performance.

In contrast to previous studies, a significant correlation between vocabulary size and duration of response was not observed. While this could be attributed to the small sample size it is more likely to be attributed to the eye tracking measure not being the most accurate method of testing. Previous eye tracking studies analyzed eye movement-based tasks which are a more accurate measure of response time. It is evident that 20 students, only 8 of which are English Learners, is a small sample size so we must be cautious of generalizing our results to all students.

Further research should include analyzing duration of response in a larger sample size of English Learners and the reason English Learners were at an advantage in vocabulary identification.

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