



# Arithmetic and Language Proficiency in Spanish/English Bilinguals



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## INTRODUCTION

It has been implied that bilinguals who are highly proficient in one of their learned languages tend to do better in solving word problems than in their second language (Kempert, Saalbach, & Hardy, 2011). Conversely, individuals with lower language proficiency in the second language have less effective problem solving skills (Bernardo, 2002). There is support for the idea that bilinguals with high language proficiency tend to have high scores in academics (Farrell, 2011) and that bilinguals who are highly proficient in both languages outperformed those who are dominant in only one language and those who are poorly proficient in both languages (Riordain and O' Donoghue, 2009). Little is known about how the level of language proficiency of bilinguals correlate with processing speed of exact math tasks.

## OBJECTIVES

A correlation is expected between language proficiency and performance in exact and approximation in arithmetic tasks. If an individual were more proficient in English than Spanish, we would observe a faster reaction time for English task than Spanish task, whereas the Spanish verbal task would be slower with a higher reaction time. Similarly, individuals who were more proficient in Spanish were expected to present faster reaction times in Spanish than in English arithmetic tasks.

Language proficiency was tested with a self reported questionnaire that asked participants to rate themselves in understanding, speaking, reading and writing English and Spanish. Processing speed in arithmetic tasks was tested with triple code model tasks.

The paradigm that was used followed a triple code model that consists of Visual Arabic code (for identifying string of digits), magnitude code (for numeral quantities), and verbal code (for rote arithmetic fact). The investigation would employ simple exact and approximation sums in Arabic code (3 + 4), as well as verbal code English (Three + Four) and Spanish (Tres + Cuatro). We hypothesize that the perceived level of proficiency in one language will correlate with the processing speed of exact math tasks on that language.

## Bilingual Questionnaire

English Language		Spanish	
Understand	1. Virtually nothing 2. Limited 3. Relatively well 4. Quite well 5. Excellent	Understand	1. Virtually nothing 2. Limited 3. Relatively well 4. Quite well 5. Excellent
Speak	1. Virtually nothing 2. Limited 3. Relatively well 4. Quite well 5. Excellent	Speak	1. Virtually nothing 2. Limited 3. Relatively well 4. Quite well 5. Excellent
Read	1. Virtually nothing 2. Limited 3. Relatively well 4. Quite well 5. Excellent	Read	1. Virtually nothing 2. Limited 3. Relatively well 4. Quite well 5. Excellent
Write	1. Virtually nothing 2. Limited 3. Relatively well 4. Quite well 5. Excellent	Write	1. Virtually nothing 2. Limited 3. Relatively well 4. Quite well 5. Excellent

## METHODS

### Participants:

The sample consisted of 17 college students (14 females and 3 males) who were English/Spanish bilinguals with an average age of 25.47 (+/- 7.72).

### Materials:

A computerized software, DirectRT designed by Empirisoft Inc., was used to test the participants on Arabic and verbal tasks to observe reaction times in participants. Participants were to click the left or right shift key to answer the tasks correctly. A questionnaire was also administered for a better understanding of demographics and proficiency.

### Procedure:

Participants are to fill out a questionnaire about demographics, language background information, and are asked to rate themselves on Spanish and English proficiency. The participant will then complete a series of 6 tasks with the same conditions for exact and approximation Arabic, English Verbal, and Spanish Verbal codes. For example: for the Arabic task, the stimulus (1 + 4) is presented and after 600ms of exposure, the response for exact (3 + 5) and approximation (6 + 2) were provided. For the English task, the stimulus (One + Four) was presented for 600ms and the response was presented for exact (Three + Five) and approximation (Six + Two). Lastly, for the Spanish task, the stimulus (Uno + Cuatro) was presented for 600ms and the response for exact (Tres + Cinco) and approximation (Seis + Dos) were then displayed.

## RESULTS/DISCUSSION

Analysis of the current data demonstrated that participants had faster reaction times across all exact arithmetic tasks (Arabic, English and Spanish Exact) than across approximation tasks (Figure 1). Since exact arithmetic is known to be language dependent, we wanted to further analyze if the individual's scores on self-rated proficiency in one language reflected their scores on the language dependent skills using verbal code.

Since this is a correlational study, we focused on the associations between the speed to respond to arithmetic problems in two verbal codes (English and Spanish) and the scores in a self-rated language proficiency questionnaire. Significant positive correlations were found between the speed to respond to the exact arithmetic problems in Spanish and the proficiency scores in understanding, speaking, reading and writing English. Interestingly, no significant correlations were found between English proficiency and arithmetic tasks in English (Table 1).

Spanish proficiency scores showed significant correlations with the scores in the approximation tasks in Spanish (Table 2). No other correlations were significant.

The hypothesis was not fully proven since language dependent Spanish exact arithmetic tasks only correlated with English proficiency. No such pattern was observed with English exact arithmetic and Spanish proficiency.

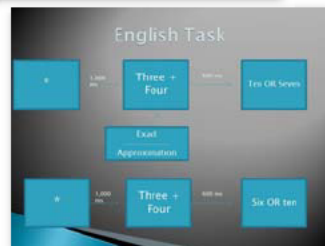


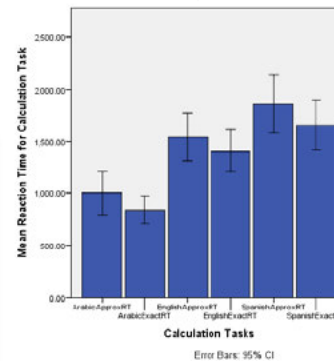
Table 1:

		English Understand	English Speak	English Read	English Write
English Approx	Correlation	.037	-.340	-.299	-.163
English Exact	Correlation	.221	-.041	.341	.217
Spanish Approx	Correlation	.445	.216	.284	.421
Spanish Exact	Correlation	.488*	.484*	.721**	.706**

Table 2:

		Spanish Understand	Spanish Speak	Spanish Read	Spanish Write
English Approx	Correlation	.176	.514*	.638**	.709**
English Exact	Correlation	.034	.278	.345	.448
Spanish Approx	Correlation	-.034	.246	.129	.290
Spanish Exact	Correlation	-.233	-.199	-.057	-.030

Figure 1:



\*. Correlation is significant at the 0.05 level.

\*\* . Correlation is significant at the 0.01 level.

## REFERENCES

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