TRANSLATION AMBIGUITY AND INDIVIDUAL DIFFERENCES IN L2 VOCABULARY LEARNING BETWEEN MONO- AND BILINGUALS

by

Griffin E. Koch

Submitted to the Undergraduate Faculty of

Dietrich School of Arts and Sciences in partial fulfillment

of the requirements for the degree of

Bachelor of Philosophy

University of Pittsburgh

2015

UNIVERSITY OF PITTSBURGH

DIETRICH SCHOOL OF ARTS AND SCIENCES

This thesis was presented

by

Griffin E. Koch

It was defended on

December 4, 2015

and approved by

Ana Schwartz, Ph.D., University of Texas at El Paso, Dept. of Psychology

Alba Tuninetti, M.S., University of Pittsburgh, Dept. of Psychology

Tessa Warren, Ph.D., University of Pittsburgh, Dept. of Psychology

Thesis Advisor: Natasha Tokowicz, Ph.D., University of Pittsburgh, Dept. of Psychology

TRANSLATION AMBIGUITY AND INDIVIDUAL DIFFERENCES IN L2 VOCABULARY LEARNING BETWEEN MONO- AND BILINGUALS

Griffin E. Koch

University of Pittsburgh, 2015

This study investigates if a cognitive advantage exists for bilinguals over monolinguals in learning translation-unambiguous and translation-ambiguous vocabulary in an unknown language. In this study, participants learned German vocabulary words, which had 1, 2, or 3 English translations. Two separate groups participated, a bilingual group (14 participants), defined as having English as a native language in addition to another language taught at home since childhood, and a monolingual group (25 participants), defined as being native speakers of only English. Behavioral methods were used to assess adults' language performance using both accuracy scores and reaction times. Two tests provided results for assessing language learning: a translation production task in which participants said the English translation of a German word presented on a computer screen and a semantic judgment task in which participants decided if a German translation semantically made sense within the context of an English sentence. This study provides additional evidence supporting difficulties of learning translation-ambiguous words compared to translation-unambiguous words. No significant differences existed between the monolinguals and bilinguals in the individual difference tasks or tests of German vocabulary learning. Additionally, correlation analyses indicate that participants with higher English vocabulary knowledge had improved performance in tests of German vocabulary learning.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....IX

INTRODUCTION.....1

Predictions.....6

METHOD.....7

Participants.....7

Design.....9

Materials.....9

Procedure.....9

Training.....10

***Stimuli*.....11**

Individual Difference Tasks.....12

***PPVT-IV*.....12**

***Operation-word span*.....12**

***Ravens matrices*.....12**

***Picture naming*.....13**

***Language history questionnaire*.....13**

Testing.....13

***Translation production 1*.....13**

***Translation production 2*.....13**

***Semantic judgment*.....14**

RESULTS.....15

Analyses of Variance.....15

Correlations with PPVT-IV.....22

DISCUSSION.....27

Limitations.....31

Further Study.....32

REFERENCES.....33

APPENDIX A.....37

APPENDIX B.....38

LIST OF TABLES

Table 1. Participant demographic information.....**8**

Table 2. Overview of the study's procedure.....**10**

Table 3. Mean reaction times of responses for all participants in semantic judgment task.....**21**

Table 4. Correlations of translation production accuracy scores with PPVT-IV scores collapsed across all responses.....**23**

Table 5. Correlations of translation production accuracy scores with PPVT-IV scores separated by order of translation produced.....**23**

Table 6. Correlations of semantic judgment accuracy with PPVT-IV scores.....**24**

Table 7. Correlations of translation production RT with PPVT-IV scores collapsed across all responses.....**25**

Table 8. Correlations of translation production RT with PPVT-IV scores separated by order of translation produced.....**25**

Table 9. Correlations between semantic judgment RT and PPVT-IV scores.....**26**

LIST OF FIGURES

Figure 1. Accuracy to produce translations as a function of number of translations.....**16**

Figure 2. Accuracy to produce first translations as a function of number of translations.....**17**

Figure 3. Accuracy to produce translations for three-translation words as a function of order of translation.....**18**

Figure 4. Accuracy of response for various numbers of translations.....**20**

Figure 5. Mean reaction time within various word types in semantic judgment task.....**21**

ACKNOWLEDGMENTS

I would like to thank my thesis advisor, Natasha Tokowicz (University of Pittsburgh) for her support, guidance, and help in developing this project. I would also like to thank my committee, Ana Schwartz (University of Texas at El Paso), Alba Tuninetti (University of Pittsburgh), Tessa Warren (University of Pittsburgh). Additionally I would like to thank Chelsea Eddington (University of Pittsburgh) for her mentoring and Peter Gianaros (University of Pittsburgh) for his input on our socioeconomic status data. I would also like to thank the members of the PLUM Lab (University of Pittsburgh) who helped me collect and code data.

INTRODUCTION

Learning a second language can be a door to new and exciting opportunities, but it can also be a challenge. Research in the area of linguistics and cognitive psychology has identified difficulties among adult learners in language processing, learning, and representation of a second language (Tokowicz, 2014). One of the most intriguing components of language acquisition involves issues at the lexical level, specifically *translation ambiguity*. This term refers to the fact that some words can be translated into another language in more than one way (Degani & Tokowicz, 2010). As an example, the word "trunk" in English has multiple different meanings. Upon hearing the word "trunk", some people might immediately think of the long snout protruding from an elephant, whereas others might think of the base of a tree, or even further, others might think of a large box used for storing and transporting clothes. These three very different definitions are all represented by just one word in English: "trunk". However, when this word is translated into German, for example, there are three distinct words: *Rüssel* (elephant trunk), *Baumstamm* (tree trunk), and *Koffer* (luggage/suitcase).

Language is constantly surrounding us; yet given the context and many facets of language, it is often difficult for native speakers to notice just how prevalent translation-ambiguous words are. As shown in separate studies by Tokowicz, Kroll, De Groot, and Van Hell (2002), Prior, MacWhinney, and Kroll (2007), and Tseng, Chang, and Tokowicz (2014), translation-ambiguous words make up a significant portion of language. Tokowicz et al. showed that in a sample of 1,003 Dutch-English translation pairs, at least 25% of the words had multiple translations in both directions (from English into Dutch and from Dutch into English).

Additionally, in a study involving English and Spanish translation pairs, Prior et al. found that almost 50% of the Spanish words and 60% of the English words had more than one translation. Furthermore, Tseng et al. focused on translation pairs between Mandarin and English and found that more than 67% of the English words had multiple translations into Mandarin. Tseng et al. further highlighted types of errors and how prevalent such errors are as a result of translation ambiguity.

Not only are translation-ambiguous words widespread throughout language, they are also harder to learn for someone who is not a native speaker of that language. Degani and Tokowicz (2010) and Degani, Tseng, and Tokowicz (2014) provide evidence supporting this claim in a study involving teaching native English speakers novel Dutch vocabulary. The researchers observed greater difficulty among participants in learning translation-ambiguous words than in learning translation-unambiguous words as measured by translation production and recognition tests.

When a person is faced with the challenge of learning a novel language, multiple factors including translation-ambiguity can increase the difficulty of grasping the new language. To assess the influence of translation ambiguity, a study conducted by Tuninetti, Tokowicz, Warren, and Rivera-Torres (2015) focused on the issue of learning translation-ambiguous words in a novel language. They taught native English speakers thirty-two German words, some translation unambiguous and others translation ambiguous. Sixteen words had only one English translation. Eight words had two English translations. The final eight words had three English translations. For the words with only one translation, half were trained typically, whereas the other half were trained as “fake triples”. These “fake triple” words were presented to participants three times as

often as the typical single translation words in an effort to control for repetition effects; these repetition effects arise because translation-ambiguous and unambiguous words are matched in terms of the number of presentations of the German word.

Participants were tested on various translation tasks of these newly-learned words. During the translation production task, participants saw each German word and had to produce its English translation. During the semantic relatedness task, participants judged whether a presented English word was semantically related to the trained German word. During this task, "yes" responses were made for both direct translations and for semantically-related words, whereas "no" responses were made for unrelated words. This task was used to measure semantic processing of the newly-learned words.

Initial findings indicate the advantage and ease of learning unambiguous words over ambiguous words, based on the result that words with only one translation were more accurately translated than words having multiple translations. In addition, a positive correlation was observed between vocabulary knowledge and translation ability: participants with higher English vocabulary knowledge had higher accuracy than individuals with lower English vocabulary knowledge in the translation production task; however, this result was not observed for the "fake triple" condition. During the semantic relatedness task, English vocabulary knowledge correlated negatively with accuracy for three-translation words, but positively (though non-significantly) with translation-unambiguous words.

Based on these findings, vocabulary knowledge of a first language plays a role in learning a novel language, specifically translation-ambiguous and unambiguous words, however it is not entirely clear whether these somewhat surprising results would be found if similar tests were conducted again.

It is evident from previous literature that these translation-ambiguous words are worthy of further study, and the question remains if these words are equally difficult and challenging for everyone to learn. Previous research by Kaushanskaya and Marian (2009) indicates that bilinguals, people proficient in two languages, have an advantage in various cognitive processes, including novel word learning. In a study involving English-Spanish bilinguals learning a novel language, Kaushanskaya and Marian observed an advantage for the bilinguals over English monolinguals, particularly on tasks to test their word learning. They theorized that interference during mapping when learning words impacted the monolinguals more severely than the bilinguals, given that the monolinguals only had experience with phonemes from the English language, whereas the bilinguals had experience with phonemes from the English language as well as the Spanish language. In addition, the learning advantage for bilinguals was more reliably observed when novel words were learned through hearing and seeing than when words were learned through hearing alone. This study supports the idea of a "cognitive advantage" for bilinguals (e.g., Kroll & Bialystok, 2013) and hints that word learning might not be as difficult for some as it is for others.

The concept of a bilingual advantage is pertinent to not only the field of language acquisition, but also to many other areas involving cognitive processes. In a review paper by Kroll and Bialystok (2013), two major components of bilingualism are discussed: language and cognitive processing. Kroll and Bialystok note that bilinguals activate and use information from both languages, even when just in the context of one language. This parallel activation of both languages to aid in the processing of one language provides benefits when the two languages converge, even when bilinguals are unaware that they are using the second language. It is evident that bilinguals can process two languages at once, but is this also possible for other cognitive

processes? In their paper, Kroll and Bialystok discuss evidence that supports this as a distinct possibility in areas of executive control, specifically in tasks of ignoring irrelevant information, task switching, and resolving conflict. They indicate that although the two areas of language- and cognitive processing may only seem distantly related, it appears that effects involving both are present and advantageous for bilinguals.

The idea of a bilingual advantage has been studied in adults as well as in children. In a study involving Turkish-Dutch monolingual and bilingual children, the bilinguals showed more cognitive gains in verbal working memory tests than monolinguals (Blom, Küntay, Messer, Verhagen, & Leseman, 2014). This evidence in the area of working memory supports ideas presented by Kroll and Bialystok (2013) that a bilingual advantage is present in various cognitive processes, not just language acquisition.

Although the theory of a bilingual advantage has many supporters and has been shown in numerous studies (Blom et al., 2014; Kroll & Bialystok, 2013), not everyone agrees with it. Paap and Greenberg (2013) argue against the idea of a bilingual advantage based on their studies involving monolinguals and bilinguals in which no identifiable main effect of group was observed. They also suggest that special linguistic demands may account for previously observed differences between monolinguals and bilinguals in studies investigating a bilingual advantage in executive processing.

The present study extends this research and focuses on the differences between monolinguals and bilinguals in learning a novel language, German. Previous literature has focused on the bilingual advantage in areas such as inhibitory control and working memory ability. This study investigates further the idea of a bilingual advantage by assessing the degree to which participants effectively process and learn translation-ambiguous words in a novel

language. Additionally, this study aims to use an adapted semantic relatedness task to further answer questions raised in a previous study concerning L1 ability and its role in novel L2 learning (e.g., Tuninetti et al., 2015). Using behavioral methods to evaluate language performance and through a variety of tests, the aims were to determine whether other factors play a role in facilitating more effective learning: intelligence and socioeconomic status (e.g. Hackman & Farah, 2008), in addition to the difference of being monolingual or bilingual. This study helps to explore a new area of inquiry into the question of whether bilinguals are at an advantage for cognitive processing, and whether a bilingual advantage exists in novel word learning. At present, analyses are complete to address the question of a bilingual advantage; future analyses will further examine the role of intelligence and socioeconomic status in novel word learning.

Predictions.

Existing research has not yet addressed how bilinguals would fare when facing the many difficulties associated with translation-ambiguous words. Therefore, I examined this situation in comparison with monolinguals, a combination of the previously discussed studies.

In particular, I was most interested in testing three predictions.

1) Bilinguals will perform more accurately on tests of German vocabulary acquisition and will learn translation-ambiguous words more effectively than monolinguals.

2) Participants' responses will be less accurate when producing translations and answering semantic judgments about translation-ambiguous words compared to words with only one translation.

3) Participants with higher first language (English) vocabulary knowledge will be better at learning novel language (German) vocabulary, specifically translation-ambiguous words.

METHOD

Participants

The participants were 39 undergraduate students at the University of Pittsburgh. Participants earned participation credit toward a requirement for an introductory psychology course for participating in this study. There were two separate groups of participants; each completed the same procedures and tests. The monolingual group consisted of 25 students whose only language was English. In the bilingual group, 14 participants identified English as their native language, but also were proficient in a second language, due to speaking this language at home during childhood. No restrictions were made about which language this second language could be, as long as it was in addition to English. To be included in this study, all participants needed to be 18 years of age or older, have normal or corrected to normal vision and hearing, and have had no previous experience learning German or Dutch. Participants completed a language history questionnaire on which they reported language and demographic information and rated their first language (L1) and second language (L2) skills (Tokowicz, Michael, & Kroll, 2004). See Table 1 for demographic information about the participants.

Table 1. Participant demographic information

	Monolinguals		Bilinguals	
Gender	M	F	M	F
N	12	13	7	7
Age (years)	18.92 (0.69)		19.39 (1.14)	
Time in USA (years)	18.60 (0.65)		17.71 (2.43)	
	Self-rated proficiency			
L1 Reading	9.68 (0.56)		8.36 (2.87)	
L1 Writing	9.36 (0.95)		8.00 (3.19)	
L1 Speaking	9.88 (0.33)		9.36 (1.39)	
L1 Listening	9.84 (0.37)		9.79 (0.43)	
L2 Reading	4.67 (2.16)		5.64 (3.10)	
L2 Writing	3.46 (1.79)		4.43 (3.11)	
L2 Speaking	3.29 (1.90)		8.36 (1.34)	
L2 Listening	4.08 (2.24)		8.79 (1.37)	

Note: All participants identified L1 as English, except three bilinguals who identified L1 as Spanish, Arabic, and Russian.

Approval for this study was obtained from the Institutional Review Board at the University of Pittsburgh.

Design

This mini-longitudinal study consisted of a 2 participant group (monolingual vs. bilingual) x 4 number of translations (single, two, three, and "fake triples") mixed-design. Participant group was a between-subjects variable and was determined based on language background. Number of translations was a within-subjects variable. In addition, individual differences were studied.

Materials

Materials consisted of German training, testing, and individual difference tasks, as well as a language history questionnaire. All tasks were computerized. A button box with voice key relay and digital audio recorder were used to collect participants' responses during various tasks.

Procedure

The study was conducted in two separate sessions. Each session consisted of different tasks and tests and each lasted between one and two hours. The second session occurred two days after the first session. Participants were required to complete both sessions, otherwise their data were discarded. See Table 2 for an overview of the tasks given on each session.

Table 2. Overview of the study's procedure

Session 1	Session 2 (2 days later)
	Translation production task 2
Introduction/Obtain consent	Semantic judgment task
Training	Ravens matrices task
PPVT-IV task	Picture naming task
Operation-word span task	Language history questionnaire
Translation production task 1	Debriefing and compensation

Training

To teach all participants the novel language, German, the training sessions included repetition and pairings with English translations. Each German-English translation pair was shown to participants on the computer screen for eight seconds. Participants were instructed to read the pair aloud while a digital audio recorder collected the response to ensure compliance. Pairs were shown to each participant in a random order until all pairs had been seen once. At this point, a new cycle began in which all pairs were shown again to the participant. There was a total of three cycles of training for the participants to learn the German-English translation pairs. In connection with previous research involving multiple translations (Degani et al., 2014), the multiple translations of translation-ambiguous words were shown on consecutive trials during the training cycles because they were shown to have improved performance compared to when multiple translations were shown on separate days. Half of the participants were shown the multiple translations of translation-ambiguous words in order of most to least-commonly given

translation (based on Eddington, Degani, & Tokowicz, 2015, norms); the other half of participants were shown the multiple translations of translation-ambiguous words in order of least to most-commonly given translation (e.g., Tuninetti et al., 2015).

Stimuli. Thirty-two German words from Eddington et al. (2015) were taught to participants in this study. Sixteen of the German words had one English translation (e.g., the German word *Anzug* means *suit* in English). Eight of these translation-unambiguous words were presented to participants as single translation words and eight were presented as "fake triples" during training. Although these "fake triple" words only have one translation, they were presented to participants three times, in the same manner as the words with multiple translations (as in Tuninetti et al., 2015). Each participant saw the same sixteen translation-unambiguous words, however, their presentation (either as a single translation or as a "fake triple") differed between versions. Two different versions were used to ensure that presentation of words was equally rotated across participants. To see a detailed list of which words were presented as single translations and which words as "fake triples" in each version see Appendix A. By including "fake triples", we were able to control for and study effects of repetition. Eight of the German words each had two English translations (e.g., the German word *Blatt* means *sheet* and *leaf* in English). And, Eight German words each had three English translations (e.g., the German word *Gleis* translated means *track*, *rail*, and *platform* in English). All of the stimuli were nouns. The three differing groups, based on number of translations, were matched for frequency (taken from Brysbaert & New, 2009), concreteness (taken from Wilson, 1988), and relatedness between translations (taken from Bracken, Degani, Eddington, & Tokowicz, 2015). In total, 56 different German-English translation pairs were presented to participants. To see a complete list of the German words and their English translations see Appendix B.

Individual Difference Tasks

PPVT-IV. The Peabody Picture Vocabulary Test, Fourth Edition (PPVT-IV) was used as a measure of English vocabulary knowledge (Dunn, Dunn, & Pearson Assessments, 2007). Participants heard an English word (read aloud) and were prompted to choose which one of four pictures best corresponded to the word.

Operation-word span. The operation-word span task is a test of working memory (Turner & Engle, 1989). During this task, participants were asked to determine if given answers to basic arithmetic operations were correct or not. Responses of either "yes" or "no" were registered by the button box. After a response for the arithmetic portion had been submitted, an English word not previously seen in the study flashed onto the screen. After seeing the word, the participants performed another arithmetic operation followed by a different word flashing onto the screen. This pattern repeated until between two and six words had been seen by the participants. At this point, participants were prompted to type as many words as they could remember seeing during the previous portion. This task tests working memory by requiring people to do the mathematical processing task while still trying to remember and recall the previously seen words.

Ravens matrices. The Ravens matrices task is a measure of non-verbal intelligence and pattern-identification ability (Ravens, 2000). During this task, participants saw eight boxes, each containing a specific shape or design. The objective for the participants was to select which one of the eight different boxes best fit the pattern depicted by the original eight boxes.

Picture naming. The picture naming task is a measure of vocabulary knowledge. Similar to the PPVT-IV task, the objective for the participants was to correctly name the picture depicted on the computer screen. Monolinguals completed this task in English, whereas bilinguals completed this task by responding in their non-English native language.

Language history questionnaire. This task involved the participants answering a series of questions about their language background (Tokowicz et al., 2004) and previous experiences with foreign language. It also consisted of questions pertaining to socioeconomic status

Testing

Translation production 1. A translation production test was included during the first session to reinforce learning (the "testing effect"; Roediger & Karpicke, 2006). During the first translation production test, participants saw an English word on the computer screen and were prompted to type the German translation of the English word. Minimal information was provided because previous research suggests that providing less information during testing enhances later retention (Carpenter & DeLosh, 2006). After typing the German translation, the participant was presented with the correct German translation on the screen. Feedback was given because a study by Butler and Roediger (2008) demonstrated that feedback enhances testing effects, albeit with a different form of testing. After seeing the correct German translation, the participant was presented with a new English word. This pattern was repeated until all previously learned words had been shown, signaling completion of the task. The English words appeared in a random order, different from how they had originally been learned during the training session.

Translation production 2. During the second translation production test, participants saw a German word on the computer screen and were prompted to speak aloud the English translation of the German word into a microphone attached to a voice key relay. A digital audio

recorder was placed nearby to capture the actual vocal responses which were coded offline. This pattern repeated until all previously learned words had been prompted, signaling completion of the task. The German words appeared in a random order, different from how they had originally been learned during the training session, with the exception of the German words with multiple translations. For these words, the same German word appeared either two or three times in a row, depending on how many English translations it had. The participants were prompted to produce a different translation each time one of these multiple-translation words was presented (e.g., presented with *Gleis*, say *track*. Then see *Gleis* again, but this time say *rail*. Lastly, see *Gleis* for a third time in a row, say *platform.*)

Participants' verbal responses were coded and scored separately by two different researchers. Codes and scores were then compared. Any discrepancies in codes or scores were resolved by the principal investigator to form final codes and scores. These were then used for data analysis.

Semantic judgment. During the semantic judgment test, participants saw an English sentence with one word replaced by its German translation (e.g., The businessman wore a new *Anzug* for the meeting). The translated German word was selected from the set of words previously learned during the training session. The participant was asked to respond, "yes" or "no", to indicate whether the sentence semantically made sense (e.g., does the translated word fit correctly into the sentence based on its meaning?). Responses were collected using a button box. Both correctly and incorrectly used translations were presented to participants (e.g., Correct: The student asked for another *Blatt* of paper to continue writing his essay. Incorrect: The train drove on the *Blatt* at a remarkable speed.)

RESULTS

Repeated measures analyses of variance were conducted with subjects as random factors. Number of translations was a within-subjects variable and group was a between-subjects variable. One monolingual participant did not attend the second session of the study, therefore his data were removed from all statistical analyses. Correlation analyses with PPVT-IV scores were also performed.

Analyses of Variance

To assess the first and second predictions, results from the translation production and semantic judgment task were analyzed. As a reminder, the first prediction concerned a difference between groups, indicating that the bilinguals were expected to perform more accurately on tests of German vocabulary acquisition and would learn translation-ambiguous words more effectively than the monolinguals. The only difference observed between groups involved a pattern in the accuracy scores during the semantic judgment task. The second prediction stated that among all participants the responses would be less accurate with translation-ambiguous words when compared to translation-unambiguous words.

Translation production. The translation production 2 task was used as an indicator of how well the novel German vocabulary had been learned. Both accuracy scores and reaction times were used to determine the degree of learning.

Accuracy. Three separate analyses were conducted involving accuracy scores. The first analysis involves the responses for each word collapsed across all translations for that word (see Figure 1). A main effect of number of translations was observed, $F(3, 111) = 25.84$, $p < .01$,

η_p^2 = .41. Bonferroni corrected paired-samples t-tests were then conducted to probe and compare accuracy scores between the different numbers of translations. Responses for the "fake triples" (*M* = .62, *SD* = .22) were more accurate than the responses for the single translation words (*M* = .42, *SD* = .24), t(38)= 6.37, *p*<.01. Responses for the "fake triples" were also more accurate than the two-translation words (*M* = .39, *SD* = .24), t(38)= 7.86, *p*<.01 and the three-translation words (*M* = .36, *SD* = .26), t(38)= 8.34, *p*<.01. No other effects or pairwise comparisons were significant.

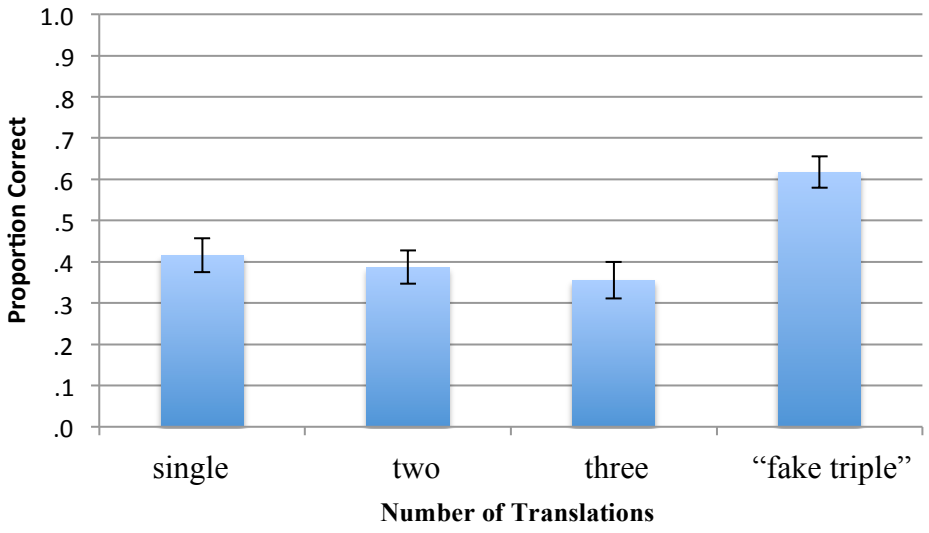

Figure 1. Accuracy to produce translations as a function of number of translations

For the second analysis, a main effect of number of translations on translation accuracy of the first translation for each word was observed, $F(3,111) = 13.70$, $p < .01$, $\eta_p^2 = .27$.A Bonferroni corrected paired-samples t-tests were again used to compare accuracy scores, this time on just the first translation of each word type (see Figure 2). Because we were only focusing on the first translation of each word type, the accuracy scores for the "fake triples" and single translation words did not change from the previous Bonferroni test. However, we did see that responses for the "fake triples" ($M = .62$, $SD = .22$) were again more accurate than the first translation of the two-translation words ($M = .44$, $SD = .26$), $t(38) = 5.10$, $p<.01$. Additionally, the responses for the "fake triples" were more accurate than the first translation of the three-translation words ($M = .43$, $SD = .26$), $t(38) = 5.76$, $p<.01$. No other effects or pairwise comparisons were significant.

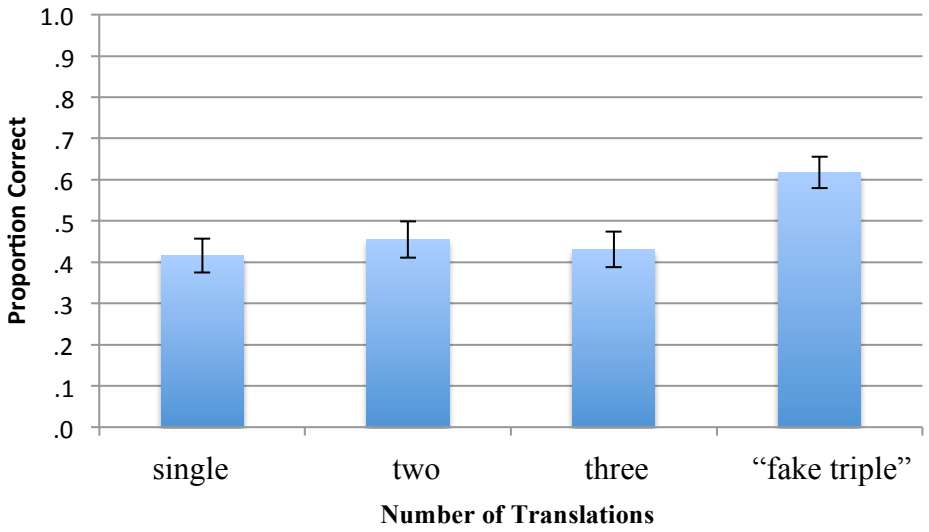

Figure 2. Accuracy to produce first translations as a function of number of translations

The third analysis focused on just the three-translation words. The data reveal a main effect of order of translations, $F(2,74) = 17.53$, $p < .01$, $\eta_p^2 = .32$. Bonferroni corrected paired-samples t-tests were again used to compare accuracy scores, this time on just the first translation of each word type (see Figure 3). The first translation produced for a three-translation word was more accurate ($M = .43$, $SD = .04$) than the third translation produced for a three-translation word ($M = .25$, $SD = .05$), $t(38) = 5.42$, $p<.01$. The second translation produced for a three-translation word was also more accurate ($M = .38$, $SD = .05$) than the third translation produced for a three-translation word ($M = .25$, $SD = .05$), $t(38) = 5.42$, $p<..01$. The comparison between the first translation and second translation produced was not significant.

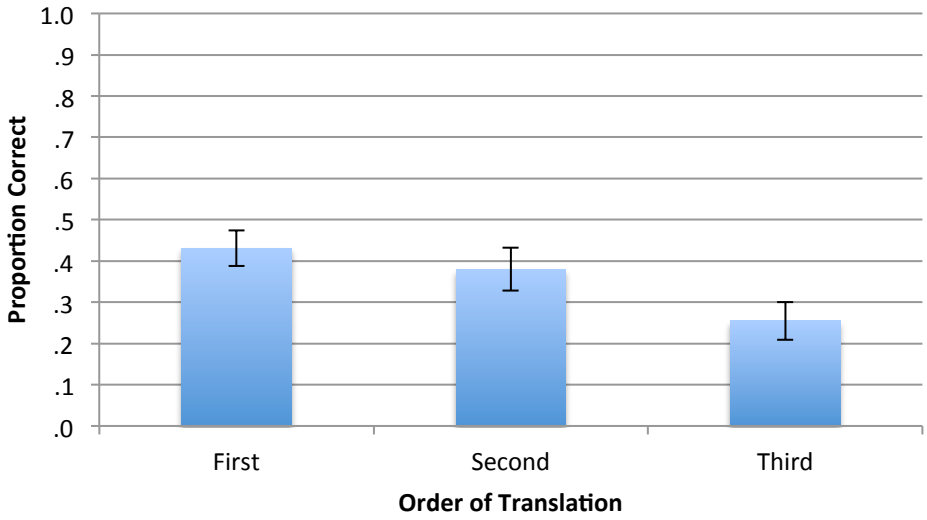

Figure 3. Accuracy to produce translations for three-translation words as a function of order of translation

Reaction Times. In analyzing reaction times for translations produced during this task, no significant effects or interactions were observed when all responses for a word were collapsed across all translations for that word. Additionally, no significant effects or interactions were observed when comparing the first translation of each word type.

In comparisons of only translations for the three-translation words, a main effect of order of translations was observed, $F(2,28) = 7.19$, $p < .01$, $\eta_p^2 = .34$. In examining the 95% confidence interval, the first translation was produced the slowest ($M = 4112$, $SD = 962$). The second translation was produced the second slowest ($M = 2029$, $SD = 418$). And the third translation was actually produced the fastest ($M = 1961$, $SD = 381$). No other effects were found.

Semantic judgment. In addition to using the translation production task as an indicator of German vocabulary acquisition, the semantic judgment task was used to assess how well the novel vocabulary had been learned. Again, both accuracy scores and reaction times in the semantic judgment task were used to determine levels of language acquisition.

Accuracy. In analyzing the accuracy scores in the semantic judgment task, an interaction was observed between no/yes response and group, $F(1,37) = 4.38$, $p < .05$, $\eta_p^2 = .11$. In the bilingual group, "no" trials ($M = .89$, $SD = .03$) were responded to more accurately than "yes" trials ($M = .80$, $SD = .03$), whereas the monolingual group had similar accuracy for "yes" ($M = .84$, $SD = .02$) and "no" ($M = .84$, $SD = .03$) trials. There was also an interaction between no/yes response and number of translations, $F(3, 111) = 7.41$, $p < .01$, $\eta_p^2 = .17$ (see Figure 4). Examination of the means reveals that the responses to translation-unambiguous words (both singles and "fake triples") were more accurate on "no" trials than "yes" trials, whereas no such difference was observed for the translation-ambiguous words. However, Bonferroni-corrected *t*-

tests indicate that the only pairwise comparison that reaches significance is that of the one-translation words (the single translation and "fake triple" words), t (38) = 3.21, $p < .01$. These results qualified a main effect of no/yes response.

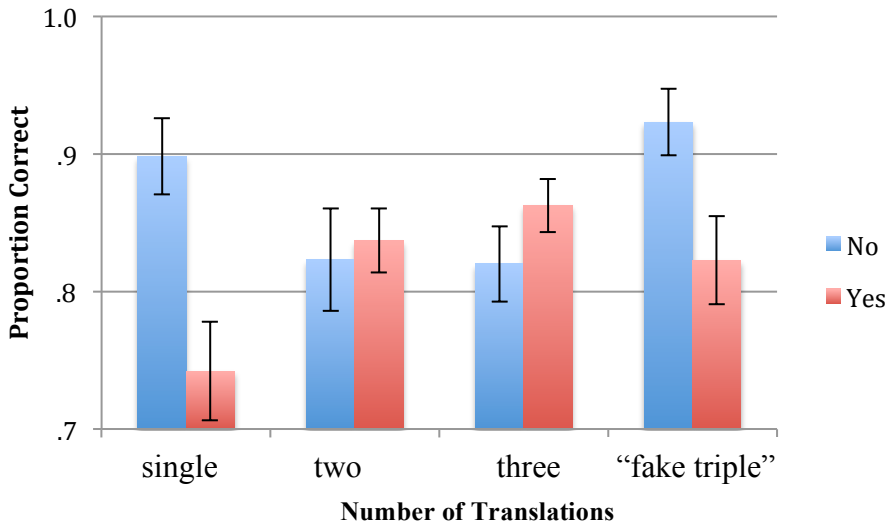

Figure 4. Accuracy of response for various numbers of translations

Reaction Times. In analyzing the reaction times of responses in the semantic judgment task, no significant group differences were observed. However, among all participants a significant effect was observed for no/yes responses, $F(1,37) = 71.21$, $p < .01$, $\eta_p^2 = .66$, indicating that reaction times were different depending on whether the sentence presented was semantically correct or not. Across all participants and all types of words, the "no" responses took longer to respond to ($M = 5426$, $SD = 185$) than the "yes" responses ($M = 4348$, $SD = 148$). A marginal effect was also observed for the number of translations, $F(3,111) = 2.69$, $p = .05$, $\eta_p^2 = .07$, hinting that effects of multiple translations may be influencing the reaction times during this task. See Table 3 for reaction times in each of the number of translation conditions.

Table 3. Mean reaction times of responses for all participants in semantic judgment task

	single translation	2-translation	3-translation	"fake triple"
M (*SD*)	4889 (199)	4974 (170)	5060 (181)	4625 (185)

Examination of the 95% confidence interval (see Figure 5) reveals that "fake triple" words ($M = 4625$, $SD = 185$) were responded to faster than the two and three-translation words, ($M = 4974$, $SD = 170$ and $M = 5060$, $SD = 181$). However, there is not a significant difference compared with mean reaction times of the single translation words ($M = 4889$, $SD = 199$).

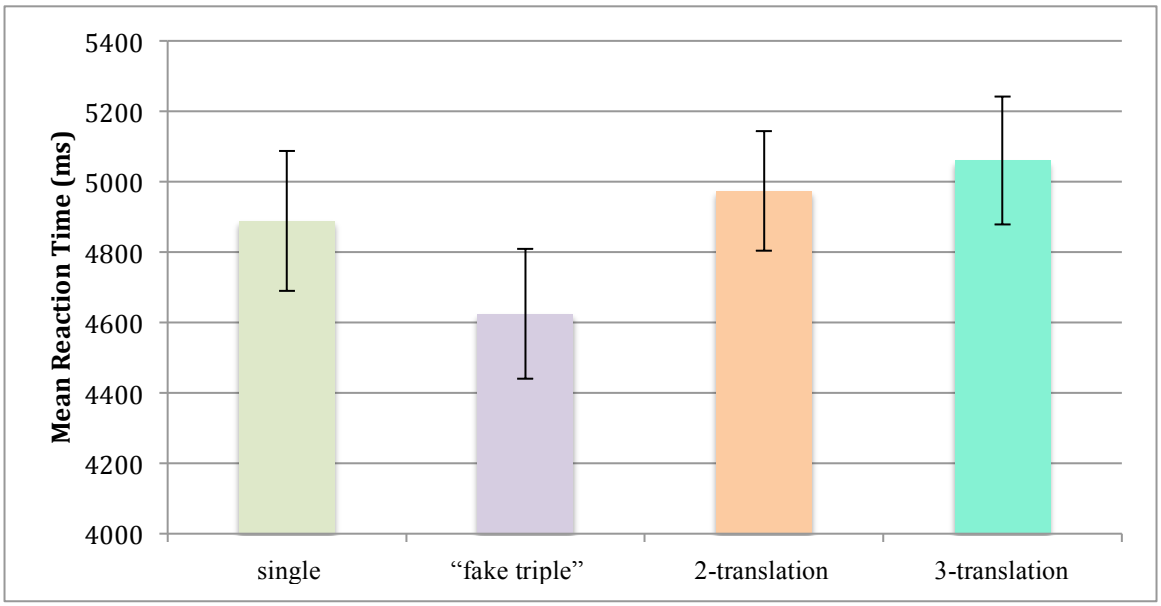

Figure 5. Mean reaction time within various word types in semantic judgment task

Analyses of individual difference tasks (PPVT-IV scores, Ravens accuracy and reaction times, Operation word span scores) revealed no statistically significant differences between the monolingual and bilingual groups. The only observed group difference existed in socioeconomic status (SES). As a measure of educational and financial standing, these data reflect a number of factors related to socioeconomic status in a community. Results indicate that the bilingual participants were raised in wealthier, more educated communities than the monolingual participants, $F(1,26) = 5.47$, $p < .05$, $\eta_p^2 = .17$. Although a difference in SES was observed between groups, no main effects of SES were observed in analyses of the translation production 2 or semantic judgment tasks.

Correlations with PPVT-IV

Accuracy. To assess the third prediction that participants with higher first language (English) vocabulary knowledge would be better at learning German, and specifically the translation-ambiguous words, correlations were performed. Correlations between PPVT-IV scores and translation production accuracy (speaking English translation when presented with German word) were performed. We first tested correlations collapsed across all responses (i.e., single and "fake triple" type one-translation words, the first and second translation of two-translation words, and all three translations of three-translation words). A positive correlation was seen in the three-translation words when collapsed across all responses (see Table 4). Furthermore, when examined separately, accuracy for words that had been trained as "fake triples" were positively correlated with PPVT-IV scores. Also when separated by order of translation produced, the first and second translations produced for a three-translation word resulted in positive correlations. And, the second translation for a two-translation word was

marginally positively correlated with PPVT-IV performance, $p = .06$; the same was true for the third translation for three-translation words, $p = .07$ (see Table 5).

Table 4. Correlations of translation production accuracy scores with PPVT-IV scores collapsed across all responses

Measure	1-translation	2-translation	3-translation
PPVT-IV	.27	.27	.39*

N = 39; *$p < .05$.

Table 5. Correlations of translation production accuracy scores with PPVT-IV scores separated by order of translation produced

	1-translation		2-translation		3-translation		
Measure	single	"fake triple"	1st	2nd	1st	2nd	3rd
PPVT-IV	.18	.32*	.20	.31†	.34*	.44**	.30†

N = 39; †$p > .10$; *$p < .05$; **$p < .01$

The next test compared scores on the PPVT-IV task with each of the eight conditions of the semantic judgment task concerning accuracy for all 39 participants. Only one of the eight correlations was statistically significant: accuracy for two-translation words incorrectly placed in sentences was positively correlated with PPVT-IV scores (see Table 6).

Table 6. Correlations of semantic judgment accuracy with PPVT-IV scores

	single translation		2-translation		3-translation		"fake triple"	
Measure	no	yes	no	yes	no	yes	no	yes
PPVT-IV	.19	.20	.44**	.00	.24	.20	.12	-.10

Note: N = 39;**$p < .01$.

Reaction Time. A final set of correlations assessed the relationship between PPVT-IV scores and reaction times for both the translation production 2 and semantic judgment tasks. A significant relationship with PPVT-IV score and reaction times was observed in both tasks. During the translation production 2 task, both the one-translation words and three-translation words, when collapsed across all responses, correlated negatively with PPVT-IV score (see Table 7). When separated by order of translation produced, both the second translations produced for two-translation words and for three-translation words resulted in negative correlations. The words trained as single translations were marginally negatively correlated, $p = .06$ (see Table 8).

Table 7. Correlations of translation production RT with PPVT-IV scores collapsed across all responses

Measure	1-translation	2-translation	3-translation
PPVT-IV	-.34*	-.25	-.36*

Note: N = 39; *$p < .05$

Table 8. Correlations of translation production RT with PPVT-IV scores separated by order of translation produced

	1-translation		2-translation		3-translation		
Measure	single	"fake triple"	1st	2nd	1st	2nd	3rd
PPVT-IV	-.32†	-.26	-.17	-.42*	-.23	-.35*	-.24

Note: N = 39; †$p>.10$; *$p < .05$

A relationship between PPVT-IV score and reaction times was also observed in the semantic judgment task. Both the "no" and "yes" responses for two-translation words and the "no" responses for the "fake triples" were negatively correlated with PPVT-IV (see Table 9). "No" responses for three-translation words were marginally negatively correlated with PPVT-IV, p =.08.

Table 9. Correlations between semantic judgment RT and PPVT-IV scores

	single translation		2-translation		3-translation		"fake triple"	
Measure	no	yes	no	yes	no	yes	no	yes
PPVT-IV	-.11	-.22	-.45**	-.35*	-.29†	-.25	-.51**	-.24

Note: N = 39; †p>.10; *p < .05;**p < .01

DISCUSSION

In accordance with previous literature involving processing and learning of translation-ambiguous words (Degani et al., 2014; Tuninetti et al., 2015), the results of the current study show a disadvantage in learning translation-ambiguous words compared with learning translation-unambiguous words. However not all predictions of the study were supported.

The first prediction of the study was focused on the different groups of participants. As seen in previous research (e.g., Blom et al., 2014; Kroll & Bialystok, 2013), bilinguals have an advantage over their monolingual counterparts in a number of different cognitive processes and abilities, however questions remain if this advantage extends to all cognitive processes (e.g., Paap & Greenberg, 2013). The current study looked for a bilingual advantage in the realm of second language acquisition by investigating the results of tasks involving producing and recognizing translations (translation production 2 and semantic judgment). Although there was no overall effect of group, the bilinguals were more accurate in responding to sentences that required a "no" response than sentences that required a "yes" response. Within the monolingual group, no differences between "yes" and "no" responses were observed. Contrary to previous research showing an advantage for bilinguals in second language learning (Kaushanskaya & Marian), no differences between groups were identified in the accuracy or reaction times in either the semantic judgment or translation production task.

The second prediction was that among all participants, responses would be less accurate when recognizing and producing translations for translation-ambiguous words than for translation-unambiguous words. The current study is able to provide support for this prediction given the results in both the semantic judgment and translation production tasks. During the

semantic judgment task, a main effect of the number of translations was observed for the accuracy of responses. Additionally, in examining the reaction times, the "fake triples" were responded to faster than the two- and three-translation words (translation-ambiguous words). Because the "fake triples" only have a single translation, this result highlights that not only is there a difference between the accuracy of someone's response to translation-ambiguous and translation–unambiguous words, but also that it takes a person less time to process his or her response for these different types of words. Because the words with only one translation were responded to faster, it appears that more thought is required to correctly decide if a sentence makes sense or not when the words have multiple possible translations.

Additionally, by examining the results of the translation production task, we not only see an effect of number of translations, but we also see significant differences within the order of responses for translation-ambiguous words. Differences were observed in accuracy scores between the "fake triples" and the two and three-translation words. Because the "fake triples" only have one translation, this supports previous claims that translation-unambiguous words are easier to learn than translation-ambiguous words. An interesting result was found between comparisons of the "fake triples" and single translation words. Both words are considered translation-unambiguous, however, a significant difference between accuracy scores was still observed. This could possibly be due to a type of repetition factor. The "fake triples" were trained differently than the single translation words; each time a single translation word was seen, the "fake triple" word would have been seen three times. Although repetition may impact the accuracy scores between "fake triples" and single translation words, it does not explain then

why there is still a difference between the "fake triples" and the three-translation words, because both were trained the same amount of times. Therefore the previously discussed theory of the difficulties of translation ambiguity is useful to help explain this difference.

In examining solely the first translated word for all types of words, similar results were obtained. There still exists a difference between the "fake triples" compared to the first translation of the two and three-translation words. This result then rules out the possibility or likelihood that a participant was merely just unable to remember all of the possible translations for a word. Even the first produced translation of the translation-ambiguous words was produced less accurately than the translation-unambiguous word.

Furthermore, in investigating only the three-translation words, a difference in accuracy was observed based on the order in which a word was produced. The first and second words produced were more accurate than the third word produced. This ordering effect logically makes sense given that participants produced the first translation that came to mind when they saw the German word on the screen. However, this result raises some interesting questions when compared with the reaction times for the three-translation words. The first word produced was the slowest to be produced, followed by the second word, and finally the third word. This last word was actually the fastest to be produced compared with the previous two. This result appears to suggest possible cueing effects for producing translations. The slower reaction times may mean that the participant needed more time to think of the word initially, however once this word was conceptualized and processed, it then took less time to produce later translations of the word. This possible cueing effect may provide additional support to claims about how words are mapped during the learning process, if they are grouped together during encoding, maybe this would explain why they are grouped together during retrieval.

The third prediction that participants with higher English vocabulary knowledge would be better at learning German vocabulary was supported, but not entirely. It appears that L1 vocabulary knowledge correlates with improved performance in the context of translation production, but not in the realm of translation recognition. A positive correlation was observed between English language knowledge and the ability to produce an English translation of a German word. This positive correlation was seen in production ability of the translation-ambiguous words. Most distinctly was the advantage for the "fake triples" and three-translation words. Specifically, the first and second translations of the three-translation words, but there was still a marginal advantage concerning the third translation for the three-translation words and the second translation for the two-translation words.

Additionally, the correlations concerning the RT for both tasks suggest that participants with higher L1 knowledge have an advantage. Using the RT as a measure of learning, the negative correlations suggest that as L1 knowledge increases, the time it takes to either produce or recognize a translation decreases. Thus this decrease in time indicates the participants were processing these tasks as a faster rate compared to those with less L1 knowledge, therefore these participants can be viewed as having learned better.

However, given the correlations between PPVT-IV scores and accuracy on the semantic judgment task, in which only the "no" responses for two-translation words were significantly correlated, it appears that participants with higher English vocabulary knowledge might not benefit as much as the accuracy and RT results of the translation production task would suggest. If someone's English vocabulary is enhanced, it may help with producing a translation, even if the word has multiple different translations. These effects may be due to a difference in difficulty

between the two tasks, or because each measures a different form of knowledge: production vs. recognition.

These correlations contradict previous findings from Tuninetti et al. During the semantic relatedness task in the previous study, there was a significant negative correlation between PPVT-IV scores and accuracy on the three-translation words. Participants with higher L1 ability performed less accurately in identifying three-translation words. This pattern was not observed in the current study, possibly due to a number of differences between the studies. During the current study, participants were asked to judge if a sentence was semantically correct, not just related (as in Tuninetti et al., 2015). The second notable difference could be due to the ordering and timing of tasks. Tuninetti et al. administered a translation production task at the end of the first session and then the second session began with the semantic relatedness task. The current study involved administration of a translation production task to begin the second session of the experiment, followed by the semantic judgment task.

Limitations

One of the most salient limitations of the study is the difference in sample size between the two groups. Having nearly twice as many monolinguals as bilinguals may have impacted the power in some statistical analyses. An additional limitation of the study may be the choice of stimuli presented to the participants and the possibility for words to be similar in multiple languages. Although this may be advantageous in the real world to learn language, through borrowing similar words from already known languages, it does not help this study to show that there is an advantage in learning a truly novel language.

Further Study

Although the results of the current study do not support the claim of a bilingual advantage, it does raise some questions worthy of further study and investigation. One area that the current study supports is in the realm of the difficulty of learning translation-ambiguous words when compared to learning translation-unambiguous words. However, although this study differentiates between these two types of words, further investigation could delve into any possible differences between types of translation-ambiguous words (e.g., Eddington, 2015). Another interesting area may be to address the concepts of mapping and cueing and investigate further how much impact one translation of a multiple translation word may have on the other translations and how these words are learned.

REFERENCES

Blom, E., Küntay, A.C., Messer, M., Verhagen, J., & Leseman, P. (2014). The benefits of being bilingual: Working memory in bilingual Turkish-Dutch children. *Journal of Experimental Child Psychology*, *128*, 105-119.

Bracken, J., Degani, T., Eddington, C. M., & Tokowicz, N. (2015). *Translation semantic variability: How semantic relatedness affects learning of translation-ambiguous words*. Manuscript in revision.

Brysbaert, M. & New, B. (2009) Moving beyond Kucera and Francis: A Critical Evaluation of Current Word Frequency Norms and the Introduction of a New and Improved Word Frequency Measure for American English. *Behavior Research Methods, 41 (4),* 977-990.

Butler, A. C., & Roediger, H. L. I. (2008). Feedback enhances the positive effects and reduces the negative effects of multiple-choice testing. *Memory & Cognition, 36*(3), 604-616.

Carpenter, S. K., & DeLosh, E. L. (2006). Impoverished cue support enhances subsequent retention: Support for the elaborative retrieval explanation of the testing effect. *Memory & Cognition, 34*(2), 268-276.

Degani, T. & Tokowicz, N. (2010). Ambiguous words are harder to learn. *Bilingualism: Language and Cognition, 13,* 299-314.

Degani, T., Tseng, A. M., & Tokowicz, N. (2014). Together or apart? Learning of ambiguous words. *Bilingualism: Language and Cognition, 17,* 749-765.

Dunn, L. M., Dunn, D. M., & Pearson Assessments. (2007). *PPVT-IV: Peabody picture vocabulary test*. Minneapolis, MN: Pearson Assessments.

Eddington, C.M. (2015). *Effects of Within and Cross-Language Semantic Ambiguity on Learning and Processing* (Unpublished doctoral dissertation). University of Pittsburgh, Pittsburgh, PA.

Eddington, C. M., Degani, T., & Tokowicz, N. (2015). *English and German translation norms: Examining semantic similarity between translations.* Manuscript in revision.

Eddington, C. M., & Tokowicz, N. (2013). Examining English-German translation ambiguity using primed translation recognition. *Bilingualism: Language and Cognition, 16,* 442-457.

Hackman, D. A. & Farah, M. J. (2008). Socioeconomic status and the developing brain. *Trends in Cognitive Sciences*, *13* (2), 65–73.

Kaushanskaya, M. & Marian, V. (2009). The bilingual advantage in novel word learning. *Psychonomic Bulletin & Review, 16 (*4*),* 705-710.

Kroll, J. F. & Bialystok, E. (2013). Understanding the consequences of bilingualism for language processing and cognition. *Journal of Cognitive Psychology*, *25*, 497-514.

Paap, K. R. & Greenberg, Z. I. (2013). There is no coherent evidence for a bilingual advantage in executive processing. *Cognitive Psychology*, *66*, 232-258.

Prior, A., MacWhinney, B., & Kroll, J. F. (2007). Translation norms for English and Spanish: The role of lexical variables, word class, and L2 proficiency in negotiating translation ambiguity. *Behavior Research Methods, 39,* 1029-1038.

Raven, J. (2000). The raven's progressive matrices: Change and stability over culture and time. *Cognitive Psychology, 41,* 1-48.

Roediger, H. L. I., & Karpicke, J. D. (2006). The power of testing memory: Basic research and implications for educational practice. *Perspectives on Psychological Science, 1*, 181-210.

Tokowicz, N. (2014). Translation ambiguity affects language processing, learning, and representation. In R. T. Miller, K. I. Martin, C. M. Eddington, A. Henery, N. Marcos Miguel, A. M. Tseng, A. Tuninetti & D. Walter (Eds.) Selected Proceedings of the 2012 Second Language Research Forum: Building bridges between disciplines (pp. 170-180). Somerville, MA: Cascadilla Press.

Tokowicz N., Kroll J. F., De Groot A. M. B., Van Hell J. G. (2002). Number-of-translation norms for Dutch–English translation pairs: A new tool for examining language production. *Behavior Research Methods, Instruments, & Computers*. *34*, 435–451.

Tokowicz, N., Michael, E. B., & Kroll, J. F. (2004). The roles of study- abroad experience and working-memory capacity in the types of errors made during translation. Bilingualism: Language and Cognition, *7*, 255–272.

Tokowicz, N., Tuninetti, A., Warren, T., & Rivera-Torres, K. (2014, November). *Translation ambiguity and individual differences in L2 vocabulary learning.* Poster presented at the Fifty-Fifth Annual Meeting of the Psychonomic Society, Long Beach, CA.

Tseng, A. M., Chang, L.-Y., & Tokowicz, N. (2014). Translation ambiguity between English and Mandarin Chinese: The roles of proficiency and word characteristics. In J. Schwieter and A. Ferreira (Eds.), *The development of translation competence: Theories and methodologies from psycholinguistics and cognitive science* (pp. 107-165). Cambridge: Cambridge Scholars Publishing.

Tuninetti, A., Tokowicz, N., Warren, T., & Rivera-Torres, K. (2015, May). *Translation ambiguity and individual differences in L2 vocabulary learning.* Paper presented at the Tenth International Symposium on Bilingualism, New Brunswick, New Jersey.

Turner, M. L. & Engle, R. W. (1989). Is working memory capacity task dependent? *Journal of Memory and Language, 28*, 127-154.

Wilson, M. (1988). MRC psycholinguistic database: Machine-usable dictionary, Version 2.00. *Behavior Research Methods, Instruments, & Computers, 20*, 6-10.

APPENDIX A

	For Training Version 1 & 3			For Training Version 2 & 4	
	A	B		A	B
FT	Fluss	Anzug	FT	Dörflein	Eisen
	Hitze	Kehle		Draht	Gehalt
	Dreck	Backe		Höhe	Kreis
	Fliege	Austausch		Kleid	Büro
	A	B		A	B
Single	Dörflein	Eisen	Single	Fluss	Anzug
	Draht	Gehalt		Hitze	Kehle
	Höhe	Kreis		Dreck	Backe
	Kleid	Büro		Fliege	Austausch

APPENDIX B

Number of Translations	German Word	1. English Translation	2. English Translation	3. English Translation
1	Backe	cheek	-	-
1	Dörflein	village	-	-
1	Anzug	suit	-	-
1	Fluss	river	-	-
1	Höhe	height	-	-
1	Gehalt	salary	-	-
1	Dreck	dirt	-	-
1	Kleid	dress	-	-
1	Hitze	heat	-	-
1	Fliege	fly	-	-
1	Draht	wire	-	-
1	Austausch	exchange	-	-
1	Kehle	throat	-	-
1	Büro	office	-	-
1	Kreis	circle	-	-
1	Eisen	iron	-	-
2	Uhr	clock	watch	-
2	Schlange	snake	line	-
2	Tasche	pocket	bag	-
2	Gefängnis	prison	jail	-
2	Scherz	joke	gag	-
2	Blatt	sheet	leaf	-
2	Veranstaltung	event	production	-
2	Verabredung	date	appointment	-
3	Gleis	track	rail	platform
3	Wiese	meadow	lawn	field
3	Ruhe	calm	quiet	silence
3	Stange	pole	stick	rod
3	Dämmerung	dawn	twilight	dusk
3	Schluss	end	conclusion	close
3	Absicherung	security	safety	insurance
3	Gewehr	gun	weapon	rifle