UNEVEN OR JUST STRANGE? :
ENGLISH-GERMAN TRANSLATION AMBIGUITY

by

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Abstract

This study was designed to examine how second language learners process words with more than one translation, a phenomenon called translation ambiguity. In this study, English-German number-of-translations norms were collected to determine the number of distinct translations for a set of 564 English words. These English-German Number-of-Translations norms provide researchers with a tool that can be used in future studies of second language processing. We examined the number of words that had one versus more than one translation, and compared this to the number of translations for the same words from English to Dutch. More than half of the words were assigned a single translation across participants. German was more translation ambiguous than Dutch. In addition, we conducted a primed lexical decision task with monolingual native English speakers, with the eventual goal of extending this task to primed translation production in bilinguals. We compared reaction times between ambiguous and unambiguous targets, related versus unrelated primes, and the more commonly translated meaning versus the less commonly translated meaning. Overall, unambiguous words were responded to marginally more accurately than ambiguous words, and real words were responded to more quickly and more accurately than nonwords.

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INTRODUCTION

Second language learning encompasses many challenging factors. These can include the learning and memorizing of a new vocabulary, spelling system, grammar, and pronunciation rules. More difficulties arise when words have multiple translations, which is a phenomenon that occurs when a word in one language can be translated into more then one word in another language. Such "translation ambiguity" can be due to the translation having multiple forms with the same meaning as in a synonym (e.g., fruit can be translated in the German equivalents Frucht and Obst) or it can be due to a word having multiple meanings (e.g., odd be translated into ungerade, the uneven number meaning, and into merkwürdig, the strange meaning). Translation ambiguity can also arise due to word class ambiguity such as English noun-verb ambiguity (i.e., the word change could be translated to the verb meaning auswechseln or to the noun meaning Wechsel). Number-of-translations normative studies have provided researchers with a useful tool in research in understanding cross-linguistic production (Tokowicz, Prior & Kroll, in preparation), processing (Tokowicz & Kroll, 2007), and learning (Degani &Tokowicz, in preparation).

Other methods that have been used to examine second language processing include translation priming (e.g., Finkbeiner, Forster Nicol & Nakamura, 2004; Gollan, Forster, & Frost, 1997; Grainger & Frenck-Mestre, 1998; Jiang, 1999) picture naming (e.g. Jescheniak & Schriefers, 1998; Levelt, Roelofs, & Meyer, 1999; Peterson & Savoy, 1998; Scholl,

Sankaranarayanan & Kroll, 1994; Starreveld & LaHeij 1995) and the Stroop task (e.g. Miller & Kroll, 2002). However, the picture naming paradigm is limited to the use of concrete concepts. The translation priming studies have provided evidence that priming effects can occur across languages. Miller and Kroll's (2002) bilingual Stroop study examined interference effects on bilingual processing. These studies, however, have primarily used concrete, unambiguous words or pictures, which explains only a portion of the bilingual mind. Understanding the processing of abstract and ambiguous words would provide a more complete understanding.

Tokowicz, Kroll, de Groot, and Van Hell (2002) collected number-of-translation norms for a set of words from Dutch to English and English to Dutch along with semantic and form similarity ratings for the Dutch-English word pairs. Subsequently, Prior, MacWhinney, and Kroll (2007) collected Spanish-English and English-Spanish translation norms and studied how proficiency and word class influence translation selection. Tokowicz and Kroll (2007) also collected Spanish-English and English-Spanish number-of-translation norms to study the effects of concreteness and ambiguity.

Tokowicz and Kroll (2007) found an effect of ambiguity for abstract words, such that abstract words that were unambiguous were translated faster than abstract words that were ambiguous. Conversely, concrete words showed no effect of ambiguity overall. Tokowicz et. al (in preparation) studied the relationship between factors such as concreteness, translation probability, semantic similarity, and form similarity on translation production. Analysis of the ambiguous words revealed that abstract ambiguous words were translated more slowly than concrete ambiguous words and less probable translations were translated slower than more probable translations.

Spanish-English and Dutch-English number-of-translation norms are, to our knowledge, the only published and available norms of this kind, thus hindering research with translation ambiguity into those languages. In this study we collected English to German number-of-translations norms. The number-of-translations norms for a set of English to German words will provide researchers with another tool for research on second language learning and translation ambiguity.

In addition to collecting English-German translation norms, we used these norms in a cross-language comparison between the number-of-translations from English to Dutch and English to German. Because Dutch, German, and English are all Germanic languages, we predicted a correlation in the ambiguity yielded in these language pairs. Thus, we made comparisons between how the set of English words are translated into Dutch and German and if there were any direct relationships between these languages. We expected that the number-of-translations from English to Dutch would be correlated with the number of translations for English to German and that they would be relatively similar in overall ambiguity because these languages are all West Germanic and also because Dutch and German share many close similarities among their form and phonology (Müller, 2005). Comparisons were also made between the accuracy and the type of responses given by native German participants and native English participants. Based on previous findings (Prior, et. al, 2007) we expected that native German speakers would perform better than native English speakers and native German speakers would yield more words labeled as multiple translations than native English speakers because of their better comprehension of German and therefore greater knowledge of multiple meanings.

The English-German norms will be in used in a primed translation production experiment. This future research will be conducted on translation ambiguity with native English

speakers who are proficient in German. In this experiment, we will examine how words with more then one meaning are translated from English to German depending on how the English word is primed (either by a word related to the more commonly translated meaning or to the less commonly translated meaning). For example, if they are asked to translate the word "CURRENT" and they are primed with the word "recent" they may be more likely to produce the German word "Aktuell" (the up-to-date meaning of current) instead of the more frequently translated form "Strom", which is related to electricity.

Before conducting the English-German primed translation experiment, we first conducted a baseline priming experiment (part II) using native English speaking monolinguals. In a semantic priming study, using a lexical decision task, we examined the reaction time differences between the priming of ambiguous words (homographs) to either the more commonly translated meaning or the less commonly translated meaning. We also examined differences for reaction times between related and unrelated words and ambiguous words with multiple meanings versus unambiguous words with a single meaning and a single translation. In this experiment, we used a similar masked-priming paradigm to the one used by Forster and Davis (1984) in which the masked prime is presented first with a forward mask consisting of lowercase consonants (e.g. tfvlw) and is followed by a similarly formed backward mask. We tested two versions of the experiment—one in which the prime preceded the target (forward priming condition), and one in which the prime followed the target (backward priming condition). In addition to serving as a pilot study for the primed translation production task, this experiment will provide insight on how monolingual native English speakers process ambiguous words.

Previous research in semantic priming have revealed that ambiguity affects lexical decision latencies (e.g. Chwilla & Kolk, 2003; Copland, de Zubicaray, McMahon, & Eastburn

2006; Simpson, 1981). Simpson (1981) found that homograph primes paired with the dominant form target (e.g. BANK – MONEY) led to faster latencies than when paired with the subordinate target (e.g. BANK-RIVER) suggesting that ambiguous words are represented in memory in a hierarchical way. Copland et. al (2006) found similar results in an fMRI study pertaining to dominance of homograph primes. Simpson (1981) however used the ambiguous word itself as the prime for the dominant or subordinate meaning target, whereas we used the words related to the two different meanings as primes to the ambiguous word. In this arrangement we can observe how the one meaning compared to the second meaning activates the ambiguous word and see if there are differences between the two. This arrangement was also developed because it is a preliminary study to the English-German primed translation study where participants would translate the ambiguous target word.

Chwilla and Kolk (2003) and Copland et al. (2006) used the same format as the current study in which the target is the ambiguous word and is primed by either meaning of the target word. Chwilla and Kolk examined semantic priming effects of ambiguous words using a lexical decision task. In the ambiguous conditions they presented participants with two primes (one on either side of the screen). On some trials, both primes were related to the target (one related to one meaning, the second related to the other meaning; e.g. hand-tree-palm), and, on others, only one prime was related to the target (e.g. mail-tree-palm). Their reaction time analysis in the lexical decision task revealed that participants were faster to respond when both primes were related to the target than when only one was. In addition, the effects for ambiguous and unambiguous words were additive, meaning that the priming effects of each word presented individually equaled the effect when presented together. Chwilla and Kolk also found more errors in the ambiguous conditions than in the unambiguous conditions.

The previously-mentioned semantic priming studies used unmasked lexical decision paradigms whereas we chose to use a masked priming paradigm. Presenting the prime at a sub-conscious threshold reveals more automatic processes rather than strategic processes (Forster & Davis, 1984).

Based on previous semantic priming studies (e.g. Chwilla & Kolk , 2003; Fischler, 1977; Hogaboam & Perfetti, 1975; Lupker, 1985; Schreuder, Flores d'Arcais, & Glazenborg, 1984; Seidenberg, Waters, Sanders, & Langer, 1984; see Neely, 1991 for an extensive review) I expect that reaction times will be faster when the prime is related to the target than when it is unrelated. I also expect that ambiguous words will have slower reaction times than unambiguous words. I also expect that participants will be more accurate in responding to words than nonwords and that they will be more accurate when presented with unambiguous words than with ambiguous words. The monolingual study could provide interesting results on within language priming effects of ambiguity and relatedness. The study also provides a preliminary test and a baseline for the masked priming paradigm that will be used in the future English-German primed translation production study.

PART I: ENGLISH-GERMAN NUMBER-OF-TRANSLATION NORMS

Number-of-Translation norms were collected to determine the total number of possible translations for a list of words. The words were tranlsated from English to German in isolation following the procedure of Tokowicz et al. (2002). From the translations, we determined the number of meanings of the English words that were translated into German. For example, the English word "power" can be translated into the German word "Kraft" which is associated with the strength meaning, and it can be translated into the word "Strom" which is associated with the electricity meaning. Both translations are correct but they represent different meanings. Some words can also be translated into different forms that indicate the same meaning. For example, the English word "delay" can be translated into both "Verspaetung" and "Aufenthalt." Both translation forms directly relate to the meaning to be late or postponed, but have different word forms (i.e., they are synonyms).

The English-German number-of-translation norms were conducted in the same manner as the Tokowicz et al. (2002) norming study. Each participant was to give only one translation for each word in only one direction. The number of possible translations was obtained by calculating the total number of distinct correct responses by all participants. Another possible method the number-of-translation norms could be found is by listing all the translations given in the dictionary. This method however has the limitation of not indicating what the average bilingual actually knows. The number-of-translations norms give researchers a tool in understanding how

bilinguals translate a word from one language into another language. A dictionary listing of all translations would not be able to provide information about how frequently a specific translation is given or which translation is the most dominant form. Although the dictionary lists the translations in an order, it cannot be assumed that the first translation is the most common or dominant translation. With the method we chose to calculate the total number-of-translations per word, we can also understand the more commonly used form of the translations across participants.

METHOD

Word Sample

The 564 English words were obtained from a previous normative study (Tokowicz et al., 2002). Corresponding German translations were found using a Pons English-German, German-English Dictionary (1997). Each English word was translated into the first suggested noun or adjective German equivalent; these words were considered the expected responses used for coding responses as correct.

Participants

The participants were 3 German-English bilinguals and 6 native English speakers who were highly proficient in German. Participants were paid for their participation or volunteered their time. Three of the native English speakers were removed from the data due to low accuracy

(below 70%). Participants were asked to complete a language history questionnaire about their previous second language experiences and skills (Tokowicz, Michael, & Kroll 2004); the results are shown in Table 1.

Table 1. Language History Questionnaire Data

	Native English		**Native German**	
Measure	M	SD	M	SD
Number of Participants	3		3	
Age (years)	25.33	4.93	26.00	0.00
Age began L2 (years)	19.00	6.56	12.67	1.53
Time Studied L2 (years)	6.67	2.89	11.50	3.77
Time Abroad in L2 country (months)	9.67	5.86	10.33	6.66
L1 Reading ability	10.00	0.00	9.67	0.58
L1 Writing ability	9.67	0.58	9.00	1.00
L1 Conversation ability	10.00	0.00	10.00	0.00
L1 Speech comprehension ability	10.00	0.00	9.67	0.58
L2 Reading ability	8.33	0.58	7.33	0.58
L2 Writing ability	7.33	1.15	7.00	1.73
L2 Conversation ability	8.00	0.00	7.67	2.31
L2 Speech comprehension ability	4.33	2.52	8.00	1.00

Note: L1 and L2 reading, writing, conversation and speech comprehension abilities are measured on a 1-10 Likert scale with 10 being the highest in ability and 1 being the lowest in ability.

Procedure

The words were presented on a computer screen, or on one page on an online web survey. Each participant was instructed to type the first translation that they thought of for each word and

to only translate words from English to German. The participants were instructed to skip a word if they did not know the translation and to not go back and fill in missing responses. After translating the list of words the participants completed a language history questionnaire to produce additional information about their language background.

Scoring

The responses were coded for accuracy with a Pons English-German, German-English Dictionary (1997), and by a native English speaker who is proficient in German. The responses were coded as correct if they were an expected response (the first noun or adjective translation in the dictionary), a synonym of the expected response, an other meaning translation, a verb translation, an acceptable unclassified correct response (responses given that did not fit in any other category), or a colloquial word. The responses were coded incorrect if they were omitted, incorrectly spelled, a pluralization of the word, a form related error (incorrect translation due to error in word recognition e.g., the English word cave translated into the German word for cage, or were an incorrect translation. After coding the responses for accuracy and type the number of distinct translations was computed for each word.

RESULTS

Data Trimming

Data from three native English speakers were excluded because of low accuracy when translating the words from English to German. The data from three native English speakers and three native German speakers are included in the analyses .

English to German Norms

The data show that of the 564 English words, 59.21% were given a single translation.There were 27.30% of words with two distinct translations, 9.5% had three translations and 3.72% had four or more distinct translations. Of the translations given, the majority of responses were the expected translations, and approximately a third of the responses were synonyms. Of the responses given, 3.79% were coded as other meaning translations (see Table 2). Of all the words with more than one translation 76.6% were synonym translation and 15.6% were other meaning translations.

Table 2. Number-of-Translations Norms for 564 Translation Pairs

	English to German	
Measure	M	SD
Number of distinct translations	1.57	.83
Number of meanings translated	1.08	.28
Percentage of expected translations	71.02	45.38
Percentage of synonym translations	32.97	47.02
Percentage of other meaning translations	3.79	19.09
Percentage of verb translations	1.52	12.26
Percentage of unclassifiable acceptable translations	1.52	12.25
Percentage of colloquial translations	0.24	4.85
Percentage of pluralization errors	1.53	12.29
Percentage of incorrect translations	9.39	29.17
Percentage of omitted translations	17.14	37.69
Percentage of form related errors	1.28	11.25
Percentage of spelling errors	4.08	19.79

Comparison between Native English and Native German speakers' responses

Native German speakers were more accurate than native English speakers (see Table 3). Across the types of responses, native German speakers produced more expected translations (M= 65.55, SD = 17.20) than native English speakers (M = 51.97, SD = 54.16), t (4) = 2.79, p = .05. Native German speakers also gave more other meaning translations (M = 2.89, SD = .37) than native English speakers (M = 1.00, SD = .27), t (4) = 7.16, $p < .01$. Both native English and German speakers gave similar percentages of synonym translations (see Figure 1). Overall native German and native English speakers gave approximately the same number of distinct translations but Native German speakers produced more single distinct translations than native English speakers (see Figure 2).

Table 3 Accuracy for Number-of-Translation Norms by Language Dominance

	Native German	Native English
Mean	90.55	76.84
SD	4.14	8.52

Note: Means reflect percentage of correct responses across participants.

Figure 1 Native English vs. Native German Comparison of Type of Translations

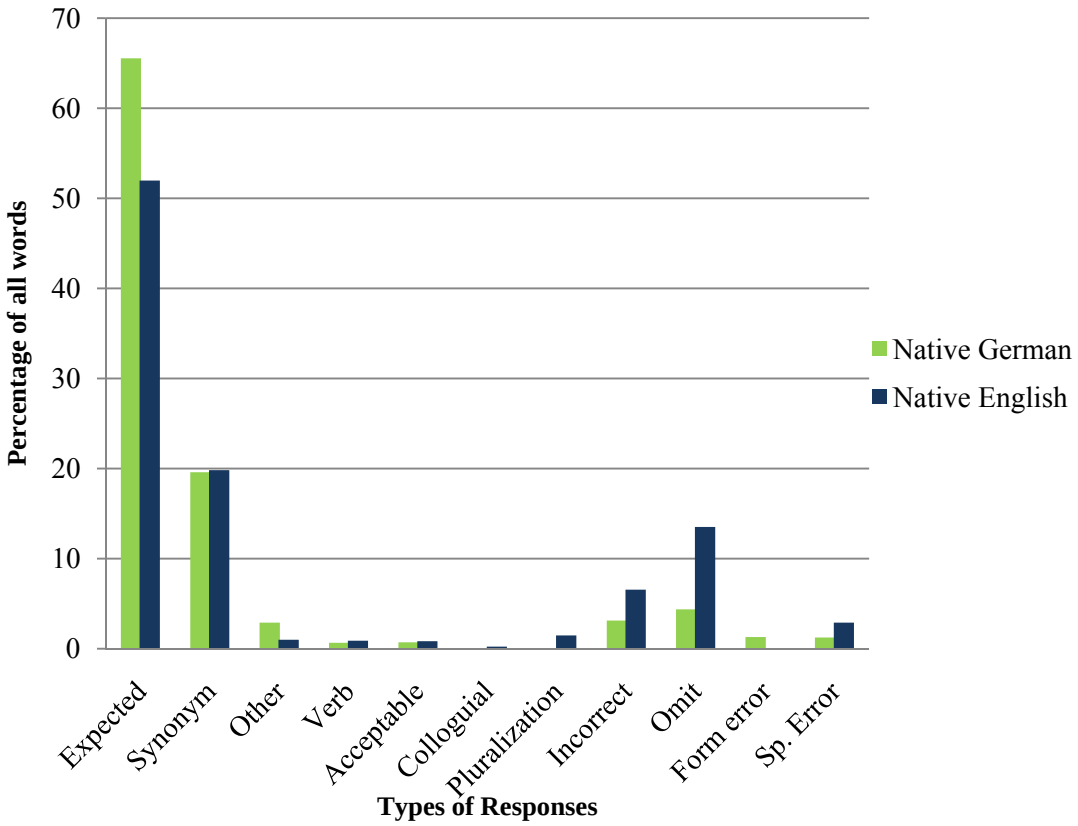
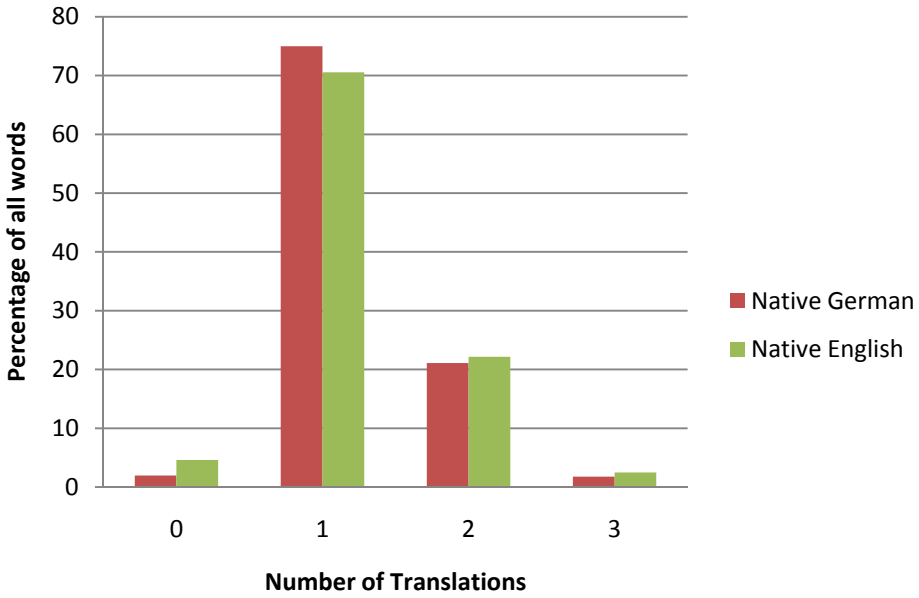


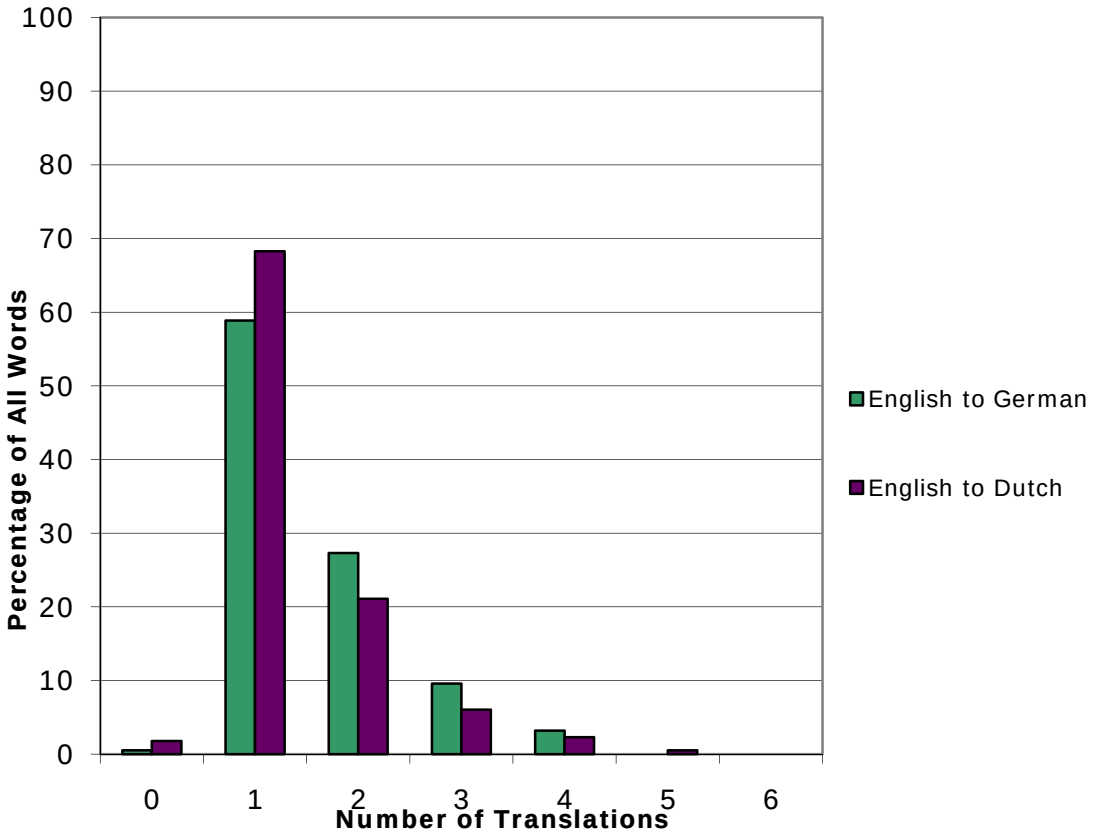
Figure 2 Native English vs. Native German Comparison of Number of Translations Given



Cross-Language Comparison: English-Dutch and English-German Norms

We made comparison between the English-Dutch number-of-translations norms collected by Tokowicz et al. (2002) and the current English-German norms. A nonparametric chi-square test revealed that there were significantly more words with multiple translations from English to German than from English to Dutch, (χ^2, N = 550) = 12.69, $p < .001$. The number of distinct transitions from English to German did not correlate with the number of distinct translations from English to Dutch, r (563) = -.022, $p = .606$. Thus, there was no direct relationship between the number of translations for a given word from English to German and the number of translations from English to Dutch (see Figure 2).

Figure 3 Comparisons of English to German and English to Dutch Number-of-Translations Norms



DISCUSSION

The Number-of-translations norms provided descriptive information about the total number of translations from English to German. The norms also supply information about the different types of multiple translations: synonyms, other meaning, and verb translations. The words with more than one meaning can be used in additional research to examine how language

learners process these ambiguous words. The number-of-translations norms also provided information on the dominant or more frequently given translation and subordinate translation form for each of the words with multiple translations.

The cross-language comparison between English to Dutch and English to German translations showed that German is a more translation ambiguous language than Dutch .There were more words with a single translation from English to Dutch than from English to German. There were also more words with more than one meaning from English to German than from English to Dutch. Words with more than one meaning may be more difficult to learn (Degani & Tokowicz, in preparation), suggesting that German may be more difficult to learn as a second language for native speakers of English.

PART II: PRIMED LEXICAL DECISION TASK

The second part of this study consisted of testing the priming effects for the English words with multiple meanings translated into German, which will be used as a baseline for an English-German primed translation production study. The targets were selected from the set of English words in the translation norms study that were coded as having more than one meaning and additional words coded as having a single meaning. Related and unrelated primes were normed for relatedness to the target. We chose to use a masked priming paradigm in which the prime would be masked and presented at sub-threshold duration (50ms) so that the participants would not consciously be aware of the prime. In one condition, the prime was presented before the target (forward priming) and in the other condition (backward priming); it was presented after the target. The prime was always preceded and followed by a mask consisting of lower case letters.

METHOD

Participants

Forty-seven undergraduate students at the University of Pittsburgh received class credit for Introduction to psychology, or were paid for their participation.

Stimuli

The stimuli were a set of 396 English words. One hundred and eight English words derived from the English-German Number-of-Translations Norm study served as the target words in this experiment. Of the 108 target words, 36 were defined as having multiple meaning translations, and 72 were defined as having a single meaning (36 words with synonym translations, 36 words with a single translation). For the purpose of this monolingual study the singular and synonym translated targets were treated as the same in the single meaning group. There was a total of 288 prime words (144 related, 144 unrelated). The target words coded as having multiple meanings had 36 related primes for the more commonly translated meaning (meaning one) and 36 for the less commonly translation (meaning two), and 36 unrelated words for each meaning. An additional norming study was used to determine relatedness for each prime-target pair.

Relatedness norming study

In the relatedness norming study, ratings were collected for how related each prime was to the target. First the related words were obtained from the University of South Florida's Free Association Norms (Nelson, McEvoy, & Schreiber, 1998). Two related words for each target were selected, and for the words with multiple meanings, two related words were found for each meaning. Four counterbalanced list versions were created so that each participant rated a target word pair with only one of the possible related words. The participants rated on a one through seven Likert scale the related words for each meaning; meaning one and meaning two (see appendix A for instructions). The ratings given by the participants determined which word was

most related to the target, and that word was used in the priming study. Then unrelated words were chosen that matched to the selected related words on word length and Kucera-Francis word frequency (see Table 4). Two possible unrelated words for each target word were selected, and ratings were obtained using the same procedure at the related words pairs to determine which word was most unrelated to the target.

From the selected stimuli, four counterbalanced word lists were generated so that each target was paired with a related or unrelated word and multiple meanings were primed with a related or unrelated word for meaning one (M1) or meaning two (M2). The four lists were matched on word length, relatedness ratings and the log Kucera-Francis frequency. In addition, 108 nonwords were also part of each list. The average length of the nonwords was matched the list of target words (M= 5.17, SD= 1.44). Each target and prime was presented only once to each participant.

Table 4 Word versus Nonword Reaction Time Data

Measure	Related M1 (Mult.)	Related M1 (Sing.)	Unrelated M1 (Mult.)	Unrelated M1(Sing)	Related M2	Unrelated M2
Length (# Letters)	5.56 (1.99)	5.81 (1.61)	5.56 (1.99)	5.82 (1.60)	6.33 (2.24)	6.33 (2.24)
Log word frequency	3.35 (1.86)	2.38 (1.54)	3.45 (1.54)	2.43 (1.51)	3.45 (1.97)	3.39 (1.81)
Relatedness Rating	5.63 (.72)	5.65 (.71)	1.42 (.28)	1.28 (.28)	5.23 (.92)	1.46 (.36)

Note: Relatedness ratings are based on a scale of 1 – 7, 7 being highly related and 1 being not related at all. Standard deviations are in parentheses. Ratings for the related meaning one multiple translations were higher than the meaning two words, t (70) = 1.94, p < 055. This is most likely due to the dominant meaning being more related to the target word then the

subordinate meaning of the word. Word length is measured in number of letters, log frequency is measured as the natural log of number of occurrences per million.

Procedure

Participants were instructed to determine if the capitalized letter string was a real English word or a not. They were first presented with a fixation cross until they pressed the 'Y' button on the button box. In the forward priming condition, first a forward mask would be presented for 50ms, which consisted of a lowercase consonant letter string equal in length to the prime (see Figure 4). Then the prime would be presented for 50ms, followed by a backward mask for 50ms consisting of lower case consonants, again the same length as the prime. A target would then be presented in capital letters for 200ms. A blank screen would appear until the participant made their response or until 3000ms elapsed. In the backward priming condition, the masked prime followed the target (see Figure 5). In both conditions the participants were instructed to press the left button (marked as 'N") on the button box if it was a not an English word and the right button (marked as 'Y") if it was a real English word. A second blank screen was then displayed for 100ms prior to the next fixation. The stimuli were presented and reaction time and accuracy were recorded using E-prime software. After completing the lexical decision task participants completed a short language history questionnaire.

Figure 4 Procedure: Timing of Events for Forward Priming

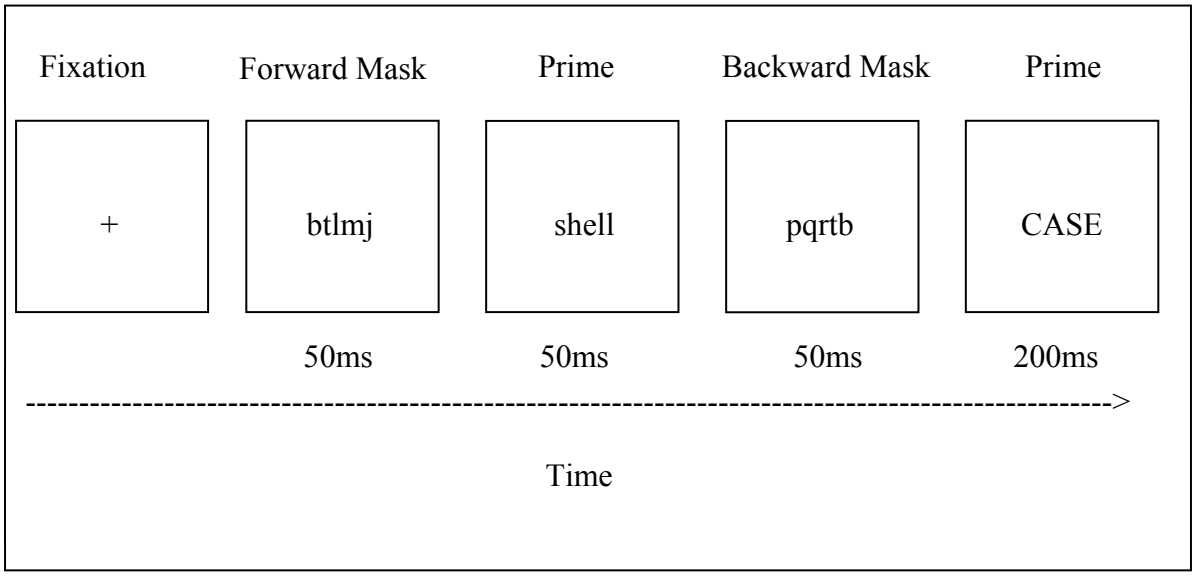
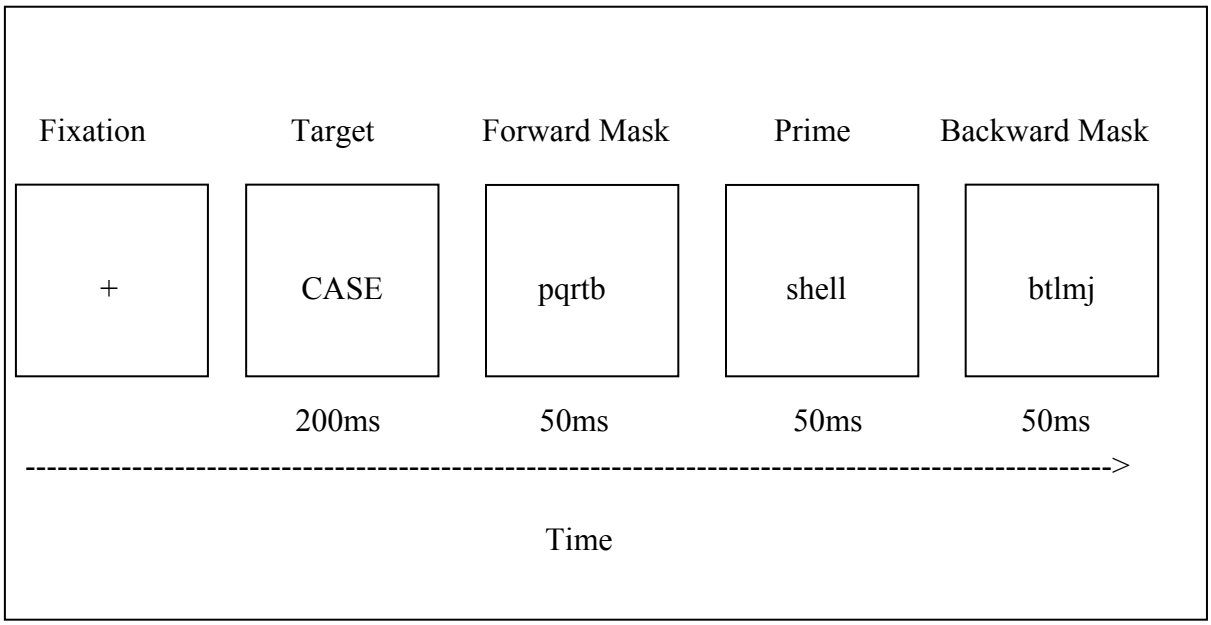


Figure 5 Procedure: Timing of Events for Backward Priming



RESULTS

Data Trimming

Data from incorrect trials were removed from the reaction time analyses. Response latencies below 300ms and above 3000ms, or 2.0 times the standard deviation above or below the mean were, for correct trials, removed from the analysis for words and nonwords separately. Eight participants were excluded due to accuracy below 80% in the backwards priming condition. Although all participants in the forward condition met the accuracy criteria, three participants were excluded from the analyses to balance the number of participants in each list version. The data were therefore analyzed from 16 participants from the backward priming condition (4 in each list version) and 20 from the forward priming condition (5 in each list version). In addition, we used the Huynh-Feldt non-sphericity correction for effects that had more than one degree of freedom in the numerator and reported the uncorrected degrees of freedom, the corrected p-value, and the mean square error values of the Huynh-Feldt correction.

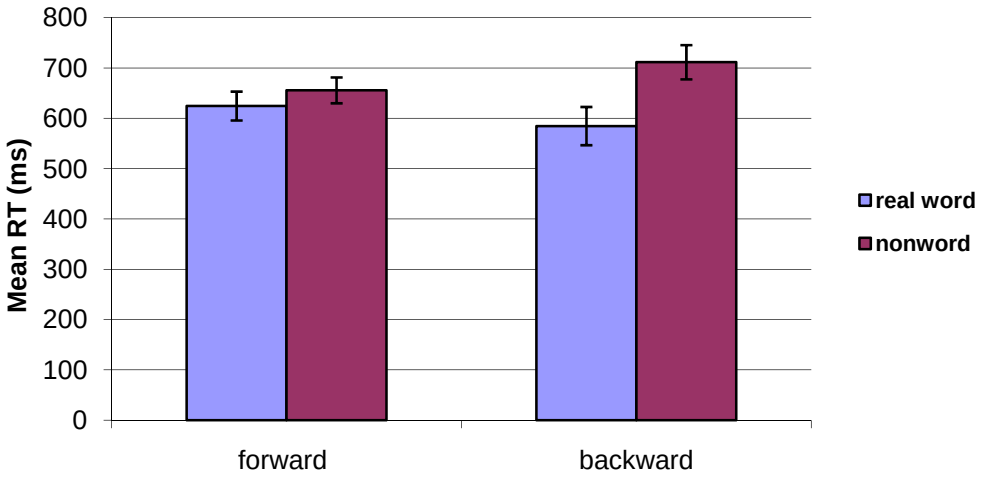
Real Words versus nonwords

Reaction Times and Accuracy Data

An analyses of variance (ANOVA) was performed in testing the average RT and accuracy for words and nonwords across participants. Real words were responded to faster than nonwords, F (1, 34) = 45.169, MSE = 2462.11, $p < .01$. Participants were also more accurate when identifying words than nonwords, F (1, 34) = 7.167, MSE = .001, $p < .01$, and were more

accurate in the forwards condition than the backwards condition, F (1, 34) = 16.539, MSE = 2462.14, $p < .01$.

Figure 6 Word versus Nonword Reaction Time Data



Ambiguous versus unambiguous words

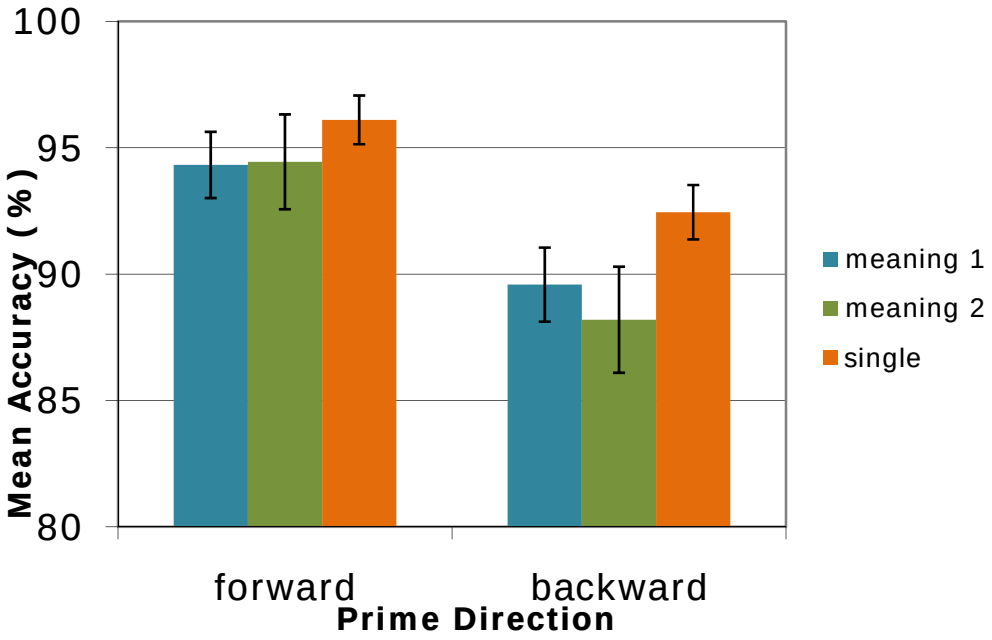
Reaction times and accuracy data

Of the ambiguous words, no significant effects for RT were found between multiple meanings (M1, M2), relatedness (related, unrelated), and order (backward, forward), all Fs < 1. No significant main effects of relatedness or type (M1, M2) or an interaction were found, all Fs < 1. However, a significant main effect of prime order was found in analysis of accuracy of ambiguous words, F (1, 34) = 8.37, MSE = .013, p < .01.

An ANOVA was performed to analyze the average RT and accuracy across subjects in comparing ambiguous (M1, M2) versus unambiguous (single) words, relatedness (related,

unrelated) and order (forward, backward) of prime presentation. Overall, unambiguous words were responded to marginally more accurately than ambiguous words, F (2, 68) = 2.79, MSE = .07, p = .07 (see Figure 6). Also participants were more accurate in the forward condition than in the backward condition, F (1, 34) = 10.30, MSE = .012, p < .01. No significant main effects were found for relatedness nor was there an interaction, all Fs < 1. An ANOVA revealed no significant effects for type, relatedness, or order by average RTs, all Fs <1.

Figure 7 Ambiguous Meanings versus Unambiguous Accuracy Data



DISCUSSION

Our predictions that related words would elicit faster RT's than unrelated words and that ambiguous words would be responded to faster than unambiguous words were not confirmed. Related primes were not responded to significantly faster than unrelated primes, and ambiguous words were not responded to faster than unambiguous words. However, as predicted, ambiguous words were responded to more accurately than unambiguous words. Participants were also more accurate in the forward priming condition than in the backward priming condition. Also as predicted, yes (real word) responses were also more accurate and responded to faster than no (nonword) responses. Given that this experiment served as a preliminary study and baseline for a future experiment it can be concluded that the current paradigm requires modifications. More experimentation on the modified masked priming paradigm will be necessary. Because priming effects for lexical decision tasks have been found in other investigations (e.g., Chiwilla, Kolk, 2003; Copland et al., 2006; Fischler 1977; Lupker 1985; Schreuder et al., 1984; Seidenberg et al., 1984) it would be productive to continue research to find an adequate paradigm that produces significant priming effects of relatedness for the selected stimuli. A more comprehensive inspection of the effects and null effects will be discussed in the general discussion.

GENERAL DISCUSSION

The English-German number-of-translations normative study provides researchers with another tool to study second language learning and bilingual processing. The majority of the set of English words had single translations. With more than 40% of the set of words having multiple translations, it is clear that German is a highly ambiguous language for native English speakers. As seen with previous number-of-translation studies, (Prior et al., 2007; Tokowicz et al. 2002) translation ambiguity is very common across multiple languages. The norms also provide researchers on the varying types of translations given for each word in this set of words (e.g. expected, synonym, other meaning). In comparisons with English-Dutch translation norms, German is more translation ambiguous than Dutch for native English speakers, having more multiple translations from English to German than from English to Dutch. Ambiguous words are harder to learn than unambiguous words (Degani & Tokowicz, in preparation), suggesting that German may be more difficult to learn than Dutch for native English speakers. More emphasis may be needed on teaching ambiguous words for individuals learning German as compared to Dutch. This comparison also highlights the fact that although two languages may be very similar in form and phonology, (as are Dutch and German) there may be great differences in how second language learners process and learn each individual language.

Not surprisingly, native German speakers translated more accurately than native English speakers. This is most likely due to their longer exposure and instruction in English. Also, the

backward direction of translation is predicted by the Revised Hierarchal Model of bilingual representation (Kroll & Stewart, 1994) to be less difficult. Native German speakers overall produced more single and expected translations than native English speakers. Prior et al. (2007) found similar results with Spanish dominant participants producing fewer multiple translations than English dominant participants from English to Spanish. One possible explanation for these differences explained by Prior et al. (2007) is that less proficient speakers have difficulty retrieving the correct translation and therefore produce a less common but still correct translation. Less proficient bilinguals may have to rely on circumlocution and use of synonyms to express the same concepts as a more proficient of native speaker of the L2 whereas more proficient bilinguals may have the ability to directly retrieve the most correct and common form. It is also possible that the less proficient bilinguals are not aware of the most frequent translation and produce the less common correct form instead (Prior et al., 2007). Native German speakers also produced more other meaning translations than native English speakers, suggesting that a better command of the language relates to a greater knowledge of the translations' multiple meanings and forms.

To obtain a more complete picture of translation ambiguity between English and German, future research will need to examine number-of-translations norms from German to English. Comparisons could be made between number-of-translation from English to German and German to English and to observe how the level of translation ambiguity differs depending on the direction of translation. Comparisons could also asses the differences between how native German and English speakers translate from L1 to L2 and from the L2 to L1. Collection of semantic and form similarity ratings for English-German word pairs would also be useful for future bilingual research to examine effects of semantic and form similarity on second language

processing. Past research has used number-of-translation norms for Spanish-English and Dutch-English second language learning and processing (Tokowicz & Kroll 2007; Tokowicz et al., in preparation). The current study will provide researchers with an important tool in translation ambiguity with English to German translations.

The monolingual masked semantic priming study aimed to test a paradigm to be used in a future English-German translation priming study. The stimuli used in the study were derived from the English-German number-of-translations norms that were coded as having other meaning, synonym, or single translations. The English-German primed translation study intends to investigate how a context with a prime could affect the translation of an ambiguous word presented in isolation. This experiment will examine: a) how a context (with a related prime) could influence translation production of words with more than one meaning, b) the differences between the reaction times (RT) of synonym, singular, and multiple meaning translations, and c) the timing of the processes underlying translation production.

Although the study yielded null effects for relatedness and ambiguity RT analyses, it is still a useful stride in finding a good paradigm for the English-German primed translation study. However, marginally significant effects were found for prime order (forwards or backwards) and type (M1, M2, single) in accuracy analyses. Significant effects were also found for RT and accuracy data of words versus nonwords. Greater differences were found for the RT data in the backward condition than the forward condition for the words versus nonwords analysis. This may be the result of participants being presented with a real word prime during the decision making processing of the target word thus facilitating their response time. In the forward

condition the prime preceded the target and the processing of the target was not interrupted with a word.

As found in past research (Chwilla & Kolk, 2003) participants were more accurate when presented with unambiguous single meaning words than ambiguous multiple meaning words. This suggests that unambiguous words are easier to identify than ambiguous words. The main effects of order revealed that participants were more accurate overall when the prime preceded the target, (forward condition) than when the prime followed the target (backward condition). The analysis of the order of the prime suggests that the forward priming condition would serve as a better construction for our use in the future English-German study.

There are several possible reasons why no priming effects for relatedness were obtained. One may be that the target word presentation duration was too sort (200ms) compared to other similar studies that used a presentation time of 500ms or more (e.g. Chwilla & Kolk, 2003; Forster, 2009; Simpson, 1981). Another explanation may be that the backwards prime mask (the mask following the prime) interfered with spreading of activation. However, this may not be the case considering that Forster (2009) found masked priming effects with an unrelated intervening word between the masked prime and the target. However, Forster used form priming and not semantic priming that may also explain why no effects for relatedness for found. Manipulation of the prime duration and stimulus onset asynchrony (SOA) may also aid in producing significant priming effects. Further research will need to be conducted to find a paradigm that yields significant relatedness effects.

CONCLUSION

In conclusion, the current study provides English –German number-of-translations norms for a large set of words. To our knowledge there are no published number-of-translations norms for English to German, thus we are providing researchers with a new tool for bilingual research. Due to the large amount of ambiguity in translation from English to German, the German language would serve as a prime choice in future research studying translation ambiguity. In addition, these norms were used in a monolingual study testing the priming effects in a masked semantic priming study. A working paradigm will need to be further researched. The application of the working priming paradigm will be used for the English-German primed translation experiment that may give further insight on translation ambiguity.

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APPENDIX A

Instructions for Related and Unrelated Norming

Your task is to rate the similarity between the two words in how they are related to each other. The rating scale ranges from 1 which indicates "completely different" to 7, which indicates "exactly the same."

Examples:

		Meaning						
Word Pairs		Completely Different						Exactly the same
table	chair	1	2	3	4	**5**	6	7
shoe	yogurt	**1**	2	3	4	5	6	7
river	stream	1	2	3	4	5	**6**	7

If you are not sure how to rate a word pair you may just guess or follow your first instinct. Please rate the word pairs in the order they appear in the list. Please do not go back to change your answers or go back to a previous item.

After you have completed the word pair rating please complete the short language history questionnaire. When you have completed all parts of the packet please hand in your packets to the experimenter.