Fabian R. Eckert

German-English Translation Priming: A Lexical Decision Experiment Researching the Reciprocal Influence of L1 and L2 processing

Abstract

The current study investigates English and German word processing in German-English bilinguals, using a translation priming experiment. Its aim is to find out whether general tendencies in the translation priming paradigm can be replicated with German native speakers and thus provide more empirical data to the field. An original study was conducted using the data of 27 German natives with high English proficiency. Non-cognate noun pairs were used as stimuli and both the influence of English primes on the processing of German targets and vice versa was studied. In both languages, correct translation primes elicited a faster reaction by participants than incorrect ones. Moreover, the bilingual asymmetry is supported by these findings, as participants displayed generally longer reaction times to English targets in comparison to German ones. The results of this study suggest that two languages in a bilingual brain are interconnected rather than singular entities, due to their reciprocal influence on another. Consequently, this study provides empirical research in Psycho- and Neurolinguistics, and further research might provide implications for Applied Linguistics, specifically Second Language Acquisition.

Table of Contents

I. Introduction

Research in bilingual word processing has gained traction and interest in recent years. Bilinguals typically possess multiple lexical representations of the same concepts, for example a German and an English word signifying the same object (e.g. *Tisch* and *desk*). The current study looks at the interaction and reciprocal influence of these two representations. Therefore, the *translation priming* methodology will be used, which has been employed by other researchers studying the influence of cross-language priming (e.g. Davis, Sánchez-Casas, Guasch, Molero & Ferré, 2010; van Hell & Dijkstra, 2002). This paradigm has been used to investigate the influence of L1 on L2 processing, and vice versa, for more than two decades. Several recurring patterns have been detected and will be re-evaluated over the course of this report. In general, this study replicates translation priming experiments but in German-English bilinguals, a participant group which has not been investigated before.

Bilingualism as a term itself deserves some attention, as its definition seems to be hardly agreed upon. Francis (1999) discusses several different definitions in her work and mentions Grosjean's (1992, p. 51) attempt to define the term as follows: "Bilingualism is the regular use of two (or more) languages, and bilinguals are those people who need and use two (or more) languages in their everyday lives." Therefore, bilingualism "implies both regular use and communicative competence" (Francis, 1999), meaning that everyone who is proficient in and uses another language is considered bilingual. A much more exclusionary definition of bilingualism, also often used in lay conversation, is employed by Bloomfield (1935), who states that bilinguals are those people, that grew up simultaneously learning two (or more) languages. In this paper, the former definition by Grosjean (1992) will be used as most of the bilinguals in this study did not grow up learning both German and English but were formally educated in the latter.

1. The Current Study & its Hypotheses

This paper will take an approach similar to Schoonbaert, Duyck, Brysbaert & Hartsuiker (2009), who investigated the influence of an L1, Dutch in their case, on the processing of an L2, English, and vice versa. The methodology of this paper will rely heavily on the approach of their study along with several others (e.g. Jiang & Forster, 2001; Jiang, 1999). Unlike already conducted research on this topic, the current study is concerned with German translation priming, an area which has not been studied as of yet. In doing so, the findings of previous researchers in other languages (e.g. Lee, Jang & Choi, 2018 in Korean; Nakayama, Ida & Lupker, 2015 in Japanese) will be replicated using the German language, providing further insight into the nature of language representation in the brain and word processing. Bhatia & Ritchie (2014) argue that there are more bilinguals than monolinguals in the world, proving further that insight into bilingual language processing will provide meaningful and useful information, especially for second language acquisition and teaching.

The hypotheses and research questions of this study revolve around the reciprocal influence of L1 and L2 processing. Priming German target words with their English translations, or vice versa, should facilitate processing and therefore accelerate the response time in the lexical decision task. This *Congruence Hypothesis* goes hand in hand with the *Incongruence Hypothesis*, which states that priming a target with an incorrect translation or unrelated word will delay processing due to the need of reconsideration. Thirdly, The *Proficiency Hypothesis* predicts that bilinguals which are more proficient will exhibit stronger priming effects than less proficient ones. Lastly, a concept called the *Bilingual Asymmetry* will be tested in the *Bilingual Asymmetry Hypothesis*, which will be explained later. Deciding whether these assumptions apply, or not, as well as discovering other noteworthy effects regarding the conducted experiment will be the main focus of this study.

II. Theoretical Background

1. Previous Studies

As already mentioned, a number of studies were conducted in this field concerning a variety of different languages. Among these are Davis et al.'s (2001) study concerning a translation priming experiment with Spanish-English bilinguals or van Hell and Dijkstra's (2002) variation examining Dutch-English bilinguals. More recent implementations of this method include studies about bilinguals using English and Korean (Lee, Jang & Choi, 2018) or Japanese (Nakayama, Ida & Lupker, 2015). There is also research concerning translation priming without English as one of the target languages, e.g. the study by Voga & Grainger (2007) which deals with Greek-French bilinguals. Although there are methodological differences, for example the cognate status of words (Gollan, Forster & Frost, 1997 vs. Nakayama, Ida & Lupker, 2015), most mentioned studies display a significant methodological overlap and are therefore comparable concerning their results. One of the earlier studies in this field is by Jiang (1999) whose methodology inspired several following researchers (Jiang & Forster, 2001; Schoonbaert, Duyck, Brysbaert & Hartsuiker, 2009), as well as this study's method.

One common result of the majority of these studies is that if the prime is a correct or congruent translation of the target, reaction times are shorter than if the prime is not. Targets with a preceding congruent translation should therefore be identified faster. As a result of these findings, the *Congruence* and *Incongruence Hypotheses* of this study were formulated. The *Proficiency Hypothesis* was also inspired by the work of e.g. Lee, Jang & Choi (2018) who solely studied low proficiency Korean-English bilinguals. Whether proficiency has an impact will be in part investigated by the experiments of this study, as proficiency will be measured as an independent variable. The different kinds of proficiency which will be assessed include formal and subjective proficiency as well as usage. Unlike Lee, Jang & Choi' s study (2018), the current one will include intermediate to advanced proficiency bilinguals, which might provide insight into the effect of language proficiency on translation priming effects.

Despite their differing approaches and target languages, previous researchers have found that there is a significant influence from one language to the other in translation priming. While some studies were only interested in one direction of influence (e.g. L2 on L1 in the case of van Hell & Dijkstra, 2002; Lee, Jang & Choi, 2018), most were concerned with the bidirectional influence of L1 and L2 processing (Davis et. al., 2001; Jiang & Forster 2001). Therefore, the influence of an L1 on L2 processing seems to be greater than the other way around, which is commonly referred to as the *Bilingual Asymmetry*.

2. Bilingual Asymmetry

Bilingual Asymmetry usually suggests that L2 processing is more affected by an L1 than L1 processing by an L2. This case is made by several previous studies investigating both directions and eventually coming to this conclusion (Schoonbaert, Hartsuiker & Pickering, 2007; Duyck, 2005; Jiang, 1999; Keatley, Spinks & de Gelder, 1994). Therefore, the *Bilingual Asymmetry Hypothesis* of this study concerns itself with studying this phenomenon in German-English bilinguals. The prediction in this case is that priming English targets with German translations elicits a greater effect than priming German targets with English translations. In order to investigate this, two experiments have been conducted, one for each direction of influence. Schoonbaert et al. (2007) argue that this asymmetry may be rooted in a fundamentally different representation of words in a speaker's L1 and L2. Different models have been proposed as to what exactly this difference in representation is, such as the *episodic model* by Jiang and Forster (2001). They argue that L1 words are represented in semantic memory, while L2 words are represented in episodic memory. In contrast to this theory, Kroll & Stewart (1994) proposed that both L1 and L2 are represented in semantic memory in their *revised hierarchical model*. The difference, according to them, lies in the mapping of lexical representations onto semantics. L1 words are therefore directly connected to semantics, while L2 words are rather bound to their L1 translation equivalents. Whichever explanation for the bilingual asymmetry offers the most sensible explanation will however not be tested in this study, only its consequences will.

3. Translation Priming Experiments – Conventions

In general, a translation priming experiment follows several steps, which are not extensively variable between different studies. An example methodology of a typical translation priming experiment will be given below, explaining Schoonbaert et al.'s (2009) approach. Altarriba & Basnight-Brown (2007) give several methodological suggestions on what should be employed or can be improved in such a study. In translation priming experiments, or cross-language priming, several concepts recur and need to be established first before discussing Altarriba & Basnight-Brown's (2007) suggestions. The cognate status of words is often carefully considered as an important methodological decision, researchers must decide whether to exclude or include cognates. *Cognates* are words that share an etymological background and therefore often appear similar in orthography or pronunciation in two

languages. Like cognate status, orthographical and phonological overlap between translation may play a role in the selection of stimuli. The *relatedness proportion* (RP) describes the "proportion of related prime-target trials out of all the prime-word-target trials" (Altarriba & Basnight-Brown, 2007, p. 2) and is therefore a number between 0 and 1. Thus, more congruent translation pairs increase this value. According to them, the priming effect increases the higher this proportion is, i.e. the more congruent translation pairs there are in the stimulus set. Another concept is the *nonword ratio* (NWR), which describes how many nonword targets there are in comparison to word targets. Whether the nonword targets outweigh word targets or vice versa has an effect on the expectation of participants, resulting in different reactions patterns (Altarriba & Basnight-Brown, 2007). Another concept worth mentioning is whether the primes are masked or unmasked, significantly impacting subjects' perception of the experiment. While masked primes are not perceptible due to their short display time, participants may catch a glimpse of unmasked primes because of their longer display time. Lastly, the *stimulus onset asynchrony* (SOA) requires some further explanation, as a common place of variance between cross-language priming studies. The SOA is defined as the time span between displaying the prime and target, therefore describing the time participants have to process the prime word before being confronted with the target. Some studies use both longer and shorter SOAs to study this phenomenon and make inferences on its effects on translation priming (Lee, Jang & Choi, 2018). Altarriba & Basnight-Brown (2007) give several suggestions for conducting cross-language priming experiments concerning NWR, RP, SOA, word length and frequency, cognate status and other methodological considerations, which will be presented and discussed for the purpose of the current study in the following section:

On the topic of **cognates**, Altarriba & Basnight-Brown (2007) propose that "Since these words [cognates] are so similar in both languages, it is important that they be excluded from word stimuli of automatic and pure priming effect are being investigated". They assert that cognates do not belong in any stimuli list that wishes to investigate purely priming effects. Other researchers include cognates, however, to specifically investigate the difference in reaction times to non-cognates (e.g. Gollan, Forster & Frost, 1997). The exclusion of cognates as stimuli seems to be the best approach when not specifically researching their influence on the priming effect. Optimally, a sample should not accidentally include cognates but be either completely free of them or intentionally include them.

Word length and **frequency** are two additional variables which will need to be controlled for as they heavily influence word processing. Naturally, the length of a word influences how long its processing takes, which is why this has to be either controlled for or taken into account in the later analysis. Regarding word frequency, Balota & Chumbley (1990) point out that "the frequency with which one sees a word, retrieves a concept associated with a word, and retrieves information associated with a pronunciation of a word should have an influence on each of these components of word processing." By now, it is apparent that frequency does play a role in processing, and that more frequent words are more easily processed. As a consequence, frequency needs to be regarded as an important

factor when planning a translation priming experiment as well. Altarriba and Basnight-Brown (2007) agree that both variables are necessary to be controlled for and should at least be mentioned in studies in this field.

The **relatedness proportion** (RP) should be kept as low as possible according to Altarriba and Basnight-Brown (2007), which will emphasize the significance of any found priming effects. Since a higher RP leads to a stronger priming effect, any effects that are still present with a low RP are especially noteworthy. The RP of the current study will be presented in its methodology and regarded in the following analysis.

The **stimulus onset asynchrony** (SOA) of cross-language priming studies is usually very short according to Altarriba & Basnight Brown (2007), with several studies choosing 50ms as SOA (Gollan, Forster & Frost, 1997; Jiang & Forster, 2001). Other researchers also chose a SOA of 0, in which the target immediately follows the prime (Nakayama, Ida & Lupker, 2016; Davis et al., 2010). An example of a study with a longer SOA is the study by Schoonbaert et al. (2009) who used both a 250ms and 100ms SOA condition. In general, a longer SOA shows greater priming effects and might activate conscious thought patterns such as checking for the relatedness of words (Altarriba & Basnight-Brown, 2007). Therefore, their suggestion is to keeps the SOA short if automatic processing is to be investigated. Which SOA should used thus depends on what kind of study is to be conducted.

Another proportion to consider is the **nonword ratio** (NWR) of a study, which, if disbalanced, could lead to strategies employed by participants while conducting the experiment. If there are more nonwords than words in the list of stimuli, participants will be inclined to give the answer "nonword" more than the alternative and vice versa. Therefore, a balance between word and nonword targets should be achieved (Altarriba & Basnight-Brown, 2007). McNamara and Holbrook (2003) also mention that most researchers use the same amount of word and nonword targets for this reason. A NWR of 0.5 is consequently considered as the aim of a translation priming study and should, in any case, be reported and considered.

One example of a possible methodology is Schoonbaert, Duyck, Brysbaert & Hartsuiker's from 2009: In their study, the forward masked priming procedure by Forster & Davis (1984) is adapted. Schoonbaert et al.'s (2009) 250ms SOA condition was conducted as follows: A row of hash marks was displayed as a forward mask for 500ms, followed by the prime for 50ms. After a blank period of another 50ms, a backward mask in the form of a row of hash marks was displayed for 150ms followed by the target. In this methodology, the SOA between display of prime and target is 250ms. This methodology is identical to the one used by Jiang (1999) and Jiang & Forster (2001), who adapted the procedure by Forster & Davis from 1984. The longer SOA in these studies is justified by increasing the available processing time before target onset. However, if employing this method, the possible risks of a longer SOA will need to be kept in mind as mentioned above. The current methodology will draw on these

influences and include the considerations by Altarriba & Basnight-Brown (2007). In the following chapter, participants, stimuli and exact procedure of the study will be described.

III. Data & Method

1. Participants

The participants in this study were 27 German native speakers with advanced to native English proficiency. Convenience sampling (Podesva & Sharma, 2012) was used to acquire these participants, as a randomised acquisition was not possible. No compensation was offered, subjects participated out of their own free will. All subjects remarked that their answers were truthful and that they took the experiment seriously. The mean age of participants is 22.22 (*SD* = 2.55), sex was not surveyed due to its irrelevance. Being brought up in Germany, all of the participants received a formal English education at least up until level B1 according to the European reference framework. Most of the participants are university students, 22 of the total 27, while other occupations included being in school, teaching at school, studying to become a teacher, being an apprentice and being an educator, each with 1 participant. A large portion of the sample was not only bilingual in German and English, but also proficient in French (13), Spanish (11) or other languages, such as Russian (2), Portuguese (1) or Hebrew (1). The whole sample declared to have either normal or corrected-to-normal sight.

Concerning their language proficiency, the mean formal English education was at 4.78 (*SD* = 0.85) which roughly translates to between level B2 and C1 according to the European reference framework. With this level, all participants in the sample can be considered to have received a good formal education in English. The mean subjective English level, judged by the participants themselves, is at 3.71 (*SD* = 0.76) out of 5, which translates to *intermediate/advanced* to *advanced*. Most people tended to judge themselves high in their English proficiency. The usage of English, which subjects were to rate, was divided into four different areas of use: home, work, education and entertainment, all ranging from 1 (*never*) to 5 (*always*). The participants rated their usage of English in these areas as follows: home with a mean of 3.22 (*SD* = 1.01), work with a mean of 2.67 (*SD* = 1.27), education with a mean of 3.11 (*SD* = 1.05) and entertainment with a mean of 3.59 (*SD* = 1.05). 44.4% of the sample (12) reported having been to an English-speaking country for a period longer than three months. Among these, five have been to the US, two each in New Zealand and England and one person each to Australia, Canada and Korea.

2. Stimuli

In this study, a total of 100 different stimuli were used. These stimuli are divided equally into five conditions for each of the two blocks, German and English. Per condition and language, 10 trials were conducted. There are 60 target word stimuli, while 40 are nonword targets, resulting in a NWR

slightly skewed in direction of actual word targets. The five different conditions of stimuli are the following:

1. Congruent Prime: correct translation prime to German/English target
2. Incongruent Prime: incorrect translation prime to German/English target
3. No prime: no prime, just the target word
4. Nonword: no prime, just the target nonword
5. Nonword Prime: prime in English/German to target nonword

For three of these conditions, specifically conditions 1, 2 and 5, prime words are necessary, 30 in English and 30 in German. These were either commonly accepted translations of their counterparts or unrelated words. Both words and nonwords were sampled by using the WordGen program by Duyck, Desmet, Verbeke & Brysbaert (2004), which uses the CELEX database of Baayen, Piepenbrock & Van Rijn (1993). The selected target words are exclusively nouns, due to the difference in processing of different word types (Altarriba, 2004), with a length of exactly five letters. Their frequency ranges from 100 to 1000 occurrences in one million words, with a mean of 228.99 (SD = 154.52). The translation primes were restricted to be three to seven letters long and were carefully selected by the researcher. Translation and target are noncognates, meaning that they are orthographically and phonetically different to each other. In practice, this restriction means that the translation prime and target could not share more than two common letters in order to assure orthographical difference. Nonwords were also designed using Duyck et al.'s (2004) WordGen program with a length of exactly five letters for both German and English. A full list of stimuli used in this study is provided in the appendix (cf. *table 1* in the appendix).

3. Procedure

Before beginning the survey, participants were informed about the conditions of the study and had to give their expressed consent to take part in it. Before the experiment, three questions concerning age, occupation and spoken languages were asked, the results of which were presented in chapter III.1 of this paper. The experiment itself lasted for about 10 minutes and consisted of 4 blocks, 2 training blocks and 2 experimental blocks. Each experimental block was preceded by the corresponding training block, for both German and English. Only the experimental blocks will be regarded in the analysis. The sequence of events was identical in all blocks: 10 hash marks (#) were presented as a forward mask for 500ms followed the prime and a blank period, each for 50ms. In conditions 3 and 4, 10 hash marks in place of the prime and a blank period were each displayed for 50ms. After the prime, a backward mask of 10 hashmarks was presented for 150ms followed by the display of the target (non)word. As a result, the experiment has an SOA of 250ms and uses an unmasked priming design. Pauses were possible between each block. After the experiment concluded, participants were given the opportunity to write about any suspicions they had regarding the intent of the study and whether they encountered any

difficulties. Followingly, several questions concerning the English level of participants, such as usage, formal and subjective proficiency, were posed, the results of which will be reported in chapter IV.1. The experiment, as well as the entire survey, was designed using PsyToolkit, an online tool for designing psychological experiments by Stoet (2010 & 2017). This survey was conducted and shared online via a link and all participants took part on their own devices (PC or Laptop). The language of instructions and survey questions was German, as all participants are German native speakers.

IV. Results

Considering the critical stimuli, specifically the two conditions *congruent* and *incongruent*, both the condition itself and the difference in block has a significant effect on reaction time (RT). The distractor conditions (*nonword* and *primed nonword*) and non-critical condition (*no prime*) will not be considered in this analysis as they are not relevant to the hypotheses of this study. In the critical conditions, participants reacted to English targets with a mean speed of 627.92ms (*SD* = 78.83ms). The mean reaction time to German targets was quicker with 597.17ms (*SD* = 74.59ms) in a significant way with $F = 5.45$ and $p = .021$. Likewise, whether the translation prime was congruent or incongruent had a significant effect ($F = 9.96$, $p = .002$). The mean RT to congruent word pairs was 591.75ms (*SD* = 72.21ms), while the mean RT to incongruent word pairs was significantly slower with 633.32ms (*SD* = 78.51ms). The interaction effect between condition and block, however, does not significantly affect reaction time ($F = 1.31$, $p = .255$).

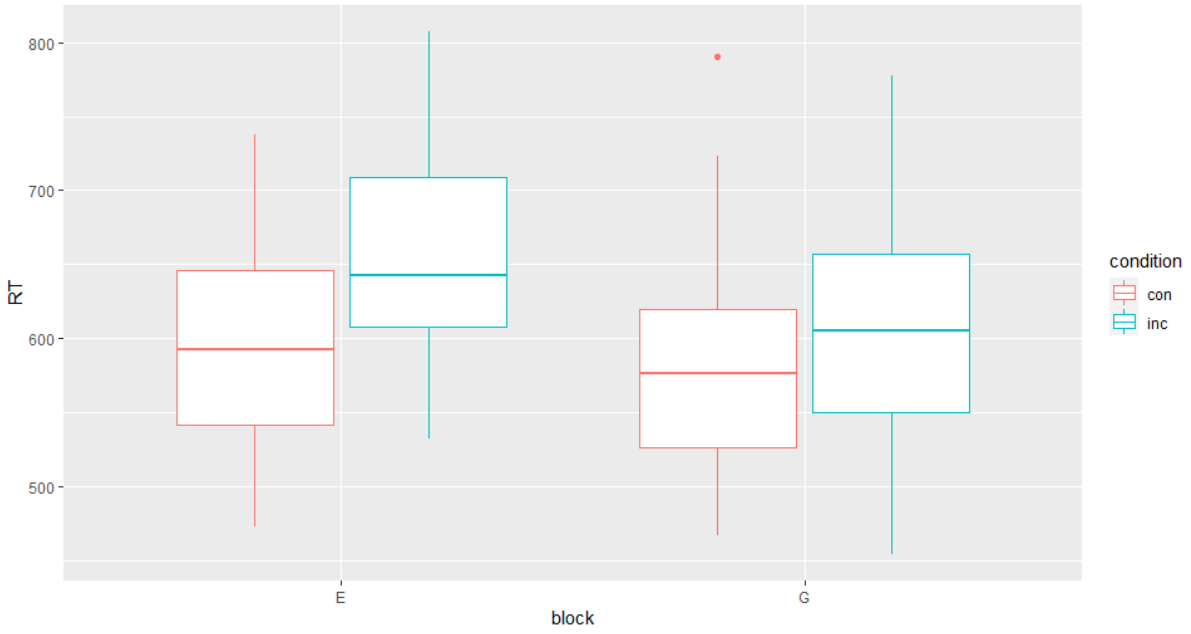

Fig. 1: Box Plot of reaction time (RT) by block (English (E) or German (G)), colour by condition (congruent or incongruent)

These general findings are displayed concisely in figure 1, which shows box plots of the participants' reaction times separated by both language and condition. The blue boxes, displaying the

RTs for the incongruent condition, show longer reaction times in both languages, and both boxes presenting the RTs in the English experimental block are respectively higher than those of the German experimental block. There is one outlier in the congruent condition of the German block, otherwise all included RTs lie within statistical normality. Any RTs above 1000ms were excluded as they can no longer be considered as immediate reactions. As laid out above, all of these differences show significance when tested, using an analysis of (co)variance.

Several covariates have been included in the analysis, namely a calculated proficiency index and the individual proficiency scores, the amount of errors, the age of participants and the time they have taken in completing the experiment. Among these, the amount of errors and general time taken to complete the experiment showed a significant impact. Naturally, the time taken impacts the RTs of participant with $F = 14.06$, $p < .001$. Similarly, the amount of errors made by participants seems to be significant regarding RT ($F = 4.24$, $p = .042$). Age did not play a significant role with $F = 0.36$ and $p = .548$. No measure of proficiency is significant in connection with RT, neither the calculated proficiency score, nor the individual values. The index for proficiency was formed by calculating the mean of the three values of English usage, subjective and formal proficiency. For this index, an F-value of 3.42 was calculated with a p-value of .068.

Lastly, the difference in RTs within the two language blocks is also worth reporting. While the two conditions did not significantly differ in the German block ($t = -1.31$, $p = .195$) with a mean RT in the congruent condition of 583.91ms (SD = 73.09ms) and 610.42ms (SD = 75.06ms) in the incongruent condition, they do differ in the English experimental block. A significant difference is observed between the congruent condition in the English block with a mean RT of 599.59ms (SD = 71.83ms) and the incongruent one (mean = 656.24ms, SD = 76.43ms) with $t = -2.81$ and $p = .007$. Therefore, the conditions significantly differ in the English block, but not in the German one.

V. Discussion

In addition to the information presented concerning the survey and experiment, two open questions regarding suspicions and difficulties with the experiments were posed after participants completed the lexical decision task, the results of which will be presented in the following. As for suspicions, the majority of subjects had some more or less specific idea concerning what the study was about. This is unsurprising due to the unmasked methodology of the priming task, making the primes conscious and visible for 50ms with an SOA of 250ms. Some participants suspected that these primes were to have an influence on reacting to targets or suspected that the difference in language played some kind of role. A minority of subjects also noted that they did not suspect anything and did not know what was manipulated in the experiment. In summary, most participants were, at least to some degree, aware of the experimental manipulation and correctly assumed what the experiment was about. When being asked about difficulties during the experiments, most participants reported that no problems were

encountered during the experiment. Some subjects pointed out that they made some mistakes in the training blocks when first being confronted with the task. This results in no further consequences as the aim of the training blocks was to clear up any confusion regarding the task. Altogether, no major problems with the experiment or its methodology and implementation have been encountered.

The hypotheses postulated in the beginning of this paper will now be reviewed and (re)considered. Firstly, the Congruence and Incongruence Hypotheses argue that participants would react quicker to congruent word pairs, and slower to incongruent word pairs in general, regardless of language. This prediction is supported by the findings of this study, which suggest that a correct translation prime leads to a quicker response time in comparison to an incorrect translation prime. This apparent facilitation of processing might suggest that the representations of two languages in the brain are indeed connected in some way. If the mental lexica of two languages were to be entirely separate, a correct or incorrect translation prime should have no effect whatsoever on processing speed. However, it does have an effect, which leads to the assumption that the different representations of one concept are bilingually intertwined in the brain. When the German *Stift* gets activated, the processing of *pen* is being facilitated, while priming incorrectly impedes processing. Thus, it can be assumed that the representations of two languages are interconnected rather than singular entities, in this case with evidence gathered from German and English.

The second hypothesis of this report, the Proficiency Hypothesis, dealt with the possibility that the strength of a hypothetical priming effect is moderated by the speaker's bilingual proficiency. The prediction was made that bilinguals who are highly proficient will display greater priming than bilinguals who are medium-skilled. However, the analyses of this study did not show any significance for proficiency at all. It appears that, at least in this sample of German-English bilinguals, proficiency does not impact how quick a decision is made. For the purpose of this study, it has to be assumed that the proficiency of bilinguals, as long as they are intermediate to advanced, has no significant influence on the reaction time of different primes and targets. The Proficiency Hypothesis, therefore, cannot be supported with the help of these results and has to be rejected.

Lastly, the Bilingual Asymmetry Hypothesis, largely building upon the framework of other researchers such as Schoonbaert et al. (2007) or Duyck (2005), predicted that priming from L1 to L2 is stronger than the other direction, from L2 to L1. The findings of this study support this hypothesis, seeing that the difference between the congruent and incongruent conditions is significant for the English experimental block, but not for the German one. The priming from German to English, the English experimental block in this experiment, therefore, seems to be stronger than priming English to German, L2 to L1. This asymmetry in bilinguals can likely be explained due to the fact that the investigated sample consisted largely of unbalanced bilinguals, meaning that one language, German in this case, was known better to the participants than English. Therefore, a stronger influence of the

primary language, rather than a secondary learned one, can be expected. The existence of this bilingual asymmetry can thus be replicated in German-English bilinguals, and the Bilingual Asymmetry Hypothesis supported by empirical data.

In conclusion, this study aimed at exploring translation priming in a German context and replicated findings produced in various other languages. The common result that congruent word pairs require less reaction time than incongruent ones can also be supported by this data. Likewise, the bilingual asymmetry can be found in this current sample, its exact properties or cause can, however, not be explained by this study. Interestingly, proficiency did not show a significant influence on reaction time to primed targets, regardless of measurement considered. While other studies, such as Nakayama, Ida & Lupker (2016) investigated only a certain scale of proficiency, low in their case, this study used a rather heterogeneous sample with various degrees of proficiency. It is possible that this wide variance in proficiency kept the factor from showing a significant influence. Two out of three hypotheses, representing expected findings in a translation priming experiment, can be supported by the data, with only the Proficiency Hypothesis lacking evidence in this study.

VI. Conclusion

Concludingly, insights on different areas within the translation priming paradigm have been gathered, and general findings from other translation priming studies could be replicated. Correct translation primes apparently activate certain connections in the mental lexicon which facilitate the processing of words, while priming an unrelated translation does not. Furthermore, unbalanced bilinguals show a clear bilingual asymmetry, or stronger priming effect from their native language to a secondary one. An interesting approach to advance this research would be to investigate the ongoing processes within the brain during such a task, using a method such as electroencephalography (EEG). Using this technique might provide valuable insights into how exactly priming activates different brain regions and how the facilitation of processing works neurologically. For further research, the methodology of this experiment could be altered to include different SOAs or more trials in general. Also, a higher number of participants is recommended to ensure the validity of the experiment. While proficiency did not appear to be a significant influence in this study, its role should be further investigated. Either a higher number of participants or stricter control in terms of proficiency of participants should provide a clearer picture of whether proficiency is truly irrelevant. Altogether, the findings of this study fit in with previous research in this paradigm and help to further fill out blank spots concerning the word processing of bilinguals. This research on German-English bilinguals aids in creating a more universal view of the interactions of two languages in bilingual brains which might lead to more insights regarding Second Language Acquisition (SLA) or the way several languages are stored and represented in the brain.

Bibliography

Altarriba, Jeanette & Dana M. Basnight-Brown. 2007. Methodological considerations in performing semantic- and translation-priming experiments across languages. *Behavior Research Methods* 39(1). 1–18. https://doi.org/10.3758/BF03192839.

Altarriba, Jeanette & Lisa M. Bauer. 2004. The Distinctiveness of Emotion Concepts: A Comparison between Emotion, Abstract, and Concrete Words. *The American Journal of Psychology*. University of Illinois Press 117(3). 389–410. https://doi.org/10.2307/4149007.

Baayen, H. R., R. Piepenbrock & H. van Rijn. 1993. *The CELEX lexical database*. Philadelphia: University of Pennsylvania: Linguistic Data Consortium.

Balota, David A. & James I. Chumbley. 1990. Where are the effects of frequency in visual word recognition tasks? Right where we said they were. Comment on Monsell, Doyle, and Haggard (1989). *Journal of Experimental Psychology: General*. US: American Psychological Association 119(2). 231–237. https://doi.org/10.1037/0096-3445.119.2.231.

Bhatia, Tej K. & William C. Ritchie (eds.). 2014. *The Handbook of Bilingualism and Multilingualism*. 2nd edn. Malden, MA; Oxford; Cichester: Wiley Blackwell.

Bloomfield, Leonard. 1935. *Language*. London and Aylesbury: Compton Printing LTD.

Davis, Chris, Rosa Sánchez-Casas, José E. García-Albea, Marc Guasch, Margarita Molero & Pilar Ferré. 2010. Masked translation priming: Varying language experience and word type with Spanish–English bilinguals. *Bilingualism: Language and Cognition* 13(2). 137–155. https://doi.org/10.1017/S1366728909990393.

Duyck, Wouter. 2005. Translation and Associative Priming With Cross-Lingual Pseudohomophones: Evidence for Nonselective Phonological Activation in Bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. US: American Psychological Association 31(6). 1340–1359. https://doi.org/10.1037/0278-7393.31.6.1340.

Duyck, Wouter, Timothy Desmet, Lieven P. C. Verbeke & Marc Brysbaert. 2004. WordGen: A tool for word selection and nonword generation in Dutch, English, German, and French. *Behavior Research Methods, Instruments, & Computers* 36(3). 488–499. https://doi.org/10.3758/BF03195595.

Francis, Wendy S. 1999. Cognitive integration of language and memory in bilinguals: Semantic representation. *Psychological Bulletin*. US: American Psychological Association 125(2). 193–222. https://doi.org/10.1037/0033-2909.125.2.193.

Gollan, Tamar H., Kenneth I. Forster & Ram Frost. 1997. Translation priming with different scripts: Masked priming with cognates and noncognates in Hebrew–English bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. US: American Psychological Association 23(5). 1122–1139. https://doi.org/10.1037/0278-7393.23.5.1122.

Grosjean, FrançLois. 1992. Another View of Bilingualism. In Richard Jackson Harris (ed.), *Advances in Psychology* (Cognitive Processing in Bilinguals), vol. 83, 51–62. North-Holland. https://doi.org/10.1016/S0166-4115(08)61487-9. http://www.sciencedirect.com/science/article/pii/S0166411508614879 (25 August, 2020).

Hell, Janet G. van & Ton Dijkstra. 2002. Foreign language knowledge can influence native language performance in exclusively native contexts. *Psychonomic Bulletin & Review* 9(4). 780–789. https://doi.org/10.3758/BF03196335.

Jiang, Nan. 1999. Testing processing explanations for the asymmetry in masked cross-language priming. *Bilingualism: Language and Cognition*. Cambridge University Press 2(1). 59–75. https://doi.org/10.1017/S1366728999000152.

Jiang, Nan & Kenneth I. Forster. 2001. Cross-Language Priming Asymmetries in Lexical Decision and Episodic Recognition. *Journal of Memory and Language* 44(1). 32–51. https://doi.org/10.1006/jmla.2000.2737.

Keatley, Catharine W., John A. Spinks & Beatrice De Gelder. 1994. Asymmetrical cross-language priming effects. *Memory & Cognition* 22(1). 70–84. https://doi.org/10.3758/BF03202763.

Kroll, J. F. & E. Stewart. 1994. Category Interference in Translation and Picture Naming: Evidence for Asymmetric Connections Between Bilingual Memory Representations. *Journal of Memory and Language* 33(2). 149–174. https://doi.org/10.1006/jmla.1994.1008.

Lee, Yoonhyoung, Euna Jang & Wonil Choi. 2018. L2-L1 Translation Priming Effects in a Lexical Decision Task: Evidence From Low Proficient Korean-English Bilinguals. *Frontiers in Psychology*. Frontiers 9. https://doi.org/10.3389/fpsyg.2018.00267. https://www.frontiersin.org/articles/10.3389/fpsyg.2018.00267/full (13 June, 2020).

McNamara, Timothy P. & Jon B. Holbrook. 2003. Semantic Memory and Priming. In *Handbook of Psychology*, 445–474. American Cancer Society. https://doi.org/10.1002/0471264385.wei0416. https://onlinelibrary.wiley.com/doi/abs/10.1002/0471264385.wei0416 (21 August, 2020).

Nakayama, Mariko, Keisuke Ida & Stephen J. Lupker. 2016. Cross-script L2-L1 noncognate translation priming in lexical decision depends on L2 proficiency: Evidence from Japanese–English bilinguals*. *Bilingualism: Language and Cognition*. Cambridge University Press 19(5). 1001–1022. https://doi.org/10.1017/S1366728915000462.

Podesva, Robert J. & Devyani Sharma. 2013. *Research methods in linguistics*. Cambridge University Press. https://ci.nii.ac.jp/ncid/BB14737963 (3 September, 2020).

Schoonbaert, Sofie, Wouter Duyck, Marc Brysbaert & Robert J. Hartsuiker. 2009. Semantic and translation priming from a first language to a second and back: Making sense of the findings. *Memory & Cognition* 37(5). 569–586. https://doi.org/10.3758/MC.37.5.569.

Stoet, Gijsbert. 2010. PsyToolkit: A software package for programming psychological experiments using Linux. *Behavior Research Methods* 42(4). 1096–1104. https://doi.org/10.3758/BRM.42.4.1096.

Stoet, Gijsbert. 2017. PsyToolkit: A Novel Web-Based Method for Running Online Questionnaires and Reaction-Time Experiments. *Teaching of Psychology*. SAGE Publications Inc 44(1). 24–31. https://doi.org/10.1177/0098628316677643.

Voga, Madeleine & Jonathan Grainger. 2007. Cognate status and cross-script translation priming. *Memory & Cognition* 35(5). 938–952. https://doi.org/10.3758/BF03193467.

Appendix

Table 1: Complete List of Stimuli

German Targets	**Primes**	**English Targets**	**Primes**
Blick	look	paint	Farbe
Reihe	row	space	Weltall
Kampf	fight	stage	Bühne
Punkt	point	trade	Handel
Krieg	war	blood	Blut
Macht	power	waste	Abfall
Liebe	love	smile	Lächeln
Sache	thing	sleep	Schlaf
Tisch	table	reply	Antwort
Kreis	circle	woman	Frau
Staat	cattle	south	Summe
Leben	lobe	dress	Kanal
Essen	fire	sense	Sucht
Bauer	smith	earth	Efeu
Grund	treat	doubt	Zunge
Brief	ladder	watch	Traum
Woche	mine	labor	Abscheu
Kunst	sun	value	Wurst
Spiel	fame	issue	Puste
Recht	lye	dance	Tod
Thema	-	chair	-
Junge	-	image	-
Abend	-	train	-
Sorge	-	cross	-
Kraft	-	human	-
Stadt	-	sound	-
Boden	-	visit	-
Opfer	-	smell	-
Angst	-	offer	-
Wesen	-	voice	-
Waufe	book	fluof	Gebirge
Heuem	race	gyass	Kerbe
Ketzt	tube	pault	Stirn

Legam	car	somma	Bast
Besge	chimney	cargy	Bengel
Hohin	berry	worsk	Haus
Rukel	word	tacry	Anfahrt
Zenft	pride	snile	Luft
Urupp	fork	bixed	Lösung
Aerle	fly	valme	Apfel
Amben	-	monor	-
Hemne	-	dirvy	-
Losal	-	shern	-
Toger	-	maich	-
Aucen	-	gessy	-
Pudee	-	graio	-
Lotue	-	spige	-
Pauen	-	guiet	-
Buzen	-	japer	-
Staro	-	snoon	-