

Meaning and words in the conference interpreter's mind

Effects of interpreter training and experience in a semantic priming study

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The aim of the study was to examine how interpreter training and experience influence word recognition and cross-linguistic connections in the bilingual mental lexicon. Sixty-eight professional interpreters, interpreter trainees (tested at the beginning and end of their training) and bilingual controls were asked to complete a semantic priming study. Priming is a psycholinguistic research method used to examine connections between words and languages in the mind. Data analysis conducted by means of linear mixed models revealed that advanced trainees recognised words faster than beginners, but were not outperformed by professionals. A priming effect was found only in the L1-L2 direction, suggesting similar asymmetries between languages irrespective of the interpreting experience. It is the first study to adopt a priming paradigm and a longitudinal design to examine the interpreters' mental lexicon. The study shows that word recognition is faster due to interpreter training, but is not modulated further by interpreting experience.

Keywords: priming, interpreter training, interpreting experience, mental lexicon, word recognition

1. Introduction

Psycholinguists have frequently examined the structure of languages in the bilingual mind to answer important questions about how the two languages of a bilingual co-exist and co-activate each other. Semantic priming, or facilitation in processing of words following previous exposure to semantically related words, is a frequently applied method of psycholinguistic research. The facilitation effect (measured as response to a primed target) reflects the phenomenon of spreading

activation (McNamara 2005). Words in the mental lexicon are connected in a network and the stronger the associations and meaning similarities between the words, the stronger the connections and the more conspicuous the activation (Altarriba and Basnight-Brown 2007). This method is also very useful to study the structure of languages in the interpreting mind, i.e., how the two languages are represented and co-exist in the mind. Simultaneous interpreters are a special case of bilinguals (Chmiel 2010; Elmer 2012; Hervais-Adelman et al. 2015) since they use their two working languages in a specific way: by concurrently activating comprehension in the source language and production in the target language. It seems likely that interpreting experience should boost lexical processing as “any translation act will become reflected in a memory trace that connects the two terms of the translation; the more often the same two terms (words or longer phrases) co-occur in a translation act, the stronger the memory connection between them will be” (de Groot & Christoffels 2006, 198). In fact, neurolinguistic studies do suggest that in the interpreter’s mind “semantic representations of L1 and L2 words are physiologically more richly interconnected, this leading in turn to a wider co-activation of lexical-semantic neighbourhoods” (Elmer et al. 2010, 153). The aim of this study is to examine word recognition and cross-linguistic connections in a L1-L2 and L2-L1 semantic priming study with a lexical decision task performed by four groups of participants differing in interpreting experience: bilingual controls with no experience, interpreting trainees tested at the beginning of their programme, the same trainees re-tested at the end of their two-year programme and professional interpreters. By looking at group differences in response times and priming effects, we can disentangle the effect of interpreter training and experience and see how these two modulate interlingual connections in the mental lexicon.

2. Priming

If a bilingual sees a word in one language (the prime) and then a word in another language (the target), the reaction to the target will be typically faster if it is semantically related to the prime (McNamara 2005). That is, the bilingual will react faster to the word *DESZCZ* [‘rain’] if it is preceded by a related prime *umbrella*, rather than by an unrelated prime *chair*. Such priming effect is explained by activation of words and concepts spreading in the mind. If a word is presented, its meaning is activated and this activation spreads automatically to semantically related words. Cross-linguistic priming studies (reviewed below) show that this effect operates across languages. Thus, they are especially suited to examine the organisation of meanings and forms of words in the bilingual’s mental lexicon.

A number of studies have used this paradigm with a lexical decision task, where following the presentation of a prime, the participant decides if the target is a word or not. For instance, Schwanenflugel & Rey (1986) and Chen & Ng (1989) found no difference in facilitation following within- and between-language primes. De Groot & Nas (1991) used masked and unmasked semantic priming for cognates and noncognates. In a masked priming experiment, the prime is presented briefly and followed by a mask consisting of hashtags so that the participants cannot consciously recall seeing it. De Groot & Nas (1991) found that the priming effects were present in all conditions but disappeared for masked cross-linguistic priming for non-cognates. This suggests shared conceptual representations for cognate translations and separate representations for noncognate translations. While de Groot & Nas (1991) manipulated the cognate status of their stimuli, Jin (1990) manipulated concreteness and found greater priming effects for concrete rather than abstract word-pairs. The findings of both of these studies show varying strengths of connections in the mental lexicon and a varying power of ensuing spreading activation.

The pattern of results of cross-linguistic semantic priming studies is similar when it comes to language advantage. In general, responses are faster in the L2-L1 direction as opposed to the L1-L2 direction (Jin 1990; de Groot & Nas 1991; Perea et al. 2008), which shows a general L1 advantage in lexical access. An opposite asymmetry is usually found in the priming effect. The effect is larger in the L1-L2 direction as compared to smaller (Jin 1990) or insignificant (Keatley et al. 1994) priming in the L2-L1 direction. The L1-L2 advantage—i.e., stronger priming of L2 words by L1 words—is explained by the fact that L1 is richer in semantic representations and more semantic information is accessed in L1 as opposed to L2 (Basnight-Brown & Altarriba 2007). The only study that found significant L2-L1 priming effect and no L1-L2 effect was the one by Basnight-Brown & Altarriba (2007). However, the authors reanalysed language histories of their participants and found that they were more dominant in their L2. Thus, the results were consistent with previous studies in which the dominant language influenced the non-dominant more than vice versa.

These studies show that activation differs depending on the strengths of connections in the mental lexicon. The findings might be accommodated by those bilingual lexicon models that assume quantitative, rather than qualitative, differences in cross-linguistic connections, such as the Distributed Representation Model—DRM (van Hell & de Groot 1998) and the Sense Model (Finkbeiner et al. 2004). According to the DRM, lexical representations of words are linked to semantic or conceptual features. The more meaning is shared by two words, the greater the overlap between their conceptual features. This is also true across languages, thus translation equivalents from two different languages would share the

same or similar conceptual features (van Hell & de Groot 1998). Abstract words typically share fewer features than concrete words, and noncognates would have smaller overlaps than cognates. This might explain why, according to the DRM, the priming effect is greater for concrete rather than abstract words and for cognates rather than noncognates.

A similar mechanism was posited to operate in the Sense Model (Finkbeiner et al. 2004), the difference being that conceptual features are organised into bundles representing various senses of a word. This leads to representational asymmetries between words. Because of greater L1 command, the number of senses (or conceptual features in the DRM) activated for an L1 word will be higher than the number of senses activated for an L2 word and this mechanism explains smaller or non-existent priming effects in L2-L1 direction. The L2 prime simply preactivates too few senses (or too few conceptual features due to smaller overlaps, according to the DRM) of the L1 semantic representation to facilitate the recognition of the L1 word. L1 leads to greater priming effects than L2 also because, in general, L1 words are reacted to faster than L2 words. This is due to the fact that L1 representations are stronger and tend to be activated more frequently than L2 representations (Dijkstra & van Heuven 2002).

The semantic representation system can be described as fluid since interlingual connections become stronger with higher L2 proficiency and greater exposure to specific words (Altarriba & Basnight-Brown 2009; Cop et al. 2015). Simultaneous interpreting offers concurrent exposure to words in L1 and L2. Thus, the priming effect may be posited to occur in interpreting on a regular basis and it might be one of the factors facilitating interpreting, i.e., exposure to source language words may facilitate and speed up access to the target language words. Setton (2003) subscribes to the connectionist view of the mental lexicon and claims that connections and paths between words and concepts are dynamic and shaped by individual experience. The selective weighting of connections (Setton 2003) begins with interpreter training and continues as a function of one's interpreting experience. Setton (2003) claims that these connections are first shaped during training when trainees acquire new terminology domains. They are then refined in the course of the professional career with episodes of extreme activation before and during assignments. It seems that effects of training and experience should be separately visible in the changing structure of the mental lexicon and the present study aims at revealing such modulation. Since there are no priming studies focusing on interpreter training and experience effects, the following section is a review of other studies that shed more light on differences between bilinguals, interpreter trainees and professional interpreters in lexical access and comprehension.

3. Effects of training and experience in lexical access and comprehension

To date, many studies comparing simultaneous interpreting performed by professional interpreters and trainees have found the effect of experience manifested in better accuracy (Setton & Motta 2007; Díaz et al. 2015), more efficient syntactic restructuring (Riccardi 1998), improved comprehension of the source text (Sunari 1995; 1996), better use of background knowledge (De Feo 1993) and more efficient selection of information to be processed (Liu et al. 2004). Studies examining the effect of training—especially in the within-subject longitudinal design—are less frequent but they do reveal improved interpreting skills (Bartłomiejczyk 2010; Hervais-Adelman et al. 2015) and verbal fluency (Chmiel 2007). It is interesting to see if, and to what extent, this advantage is also present in lower-level processes, such as lexical access and comprehension.

Studies focusing on comprehension processes in interpreting used such methods as self-paced reading, an error detection task, a lexical decision task, and semantic decision and categorisation tasks. Bajo et al. (2000) examined professionals, trainees and controls on a self-paced sentence reading task and found interpreter advantage in comprehension and reading times over controls and no group difference between professionals and trainees. Error detection studies show that experienced interpreters outperform trainees when it comes to identifying semantic errors (Fabbro et al. 1991; Yudes et al. 2012). Interestingly, the study by Yudes et al. (2012) found no difference between interpreters, trainees and controls in detecting lexical errors (i.e., misspellings). Thus, comprehension did not differ on the single word level but did differ when the processing of larger units was involved. Yudes et al. (2012) concluded that interpreting experience increased the efficiency of comprehension strategies.

In a lexical decision task, participants are asked to decide whether a string of letters is a word or not. In the study by Bajo et al. (2000), interpreters outperformed trainees and controls in a lexical decision task only when recognising non-words, and not words. In a semantic categorisation task, interpreters categorised typical exemplars (words typically associated with a given category, e.g., *apples* as a type of fruit) equally fast and non-typical exemplars—less frequently associated with a given category, e.g., *figs* as a type of fruit—faster than the other groups. Bajo et al. (2000) concluded that the interpreters might have more efficient access to semantic information, especially when it comes to less typical associations. To examine the effect of training, Bajo et al. (2000) re-tested the trainees (a small group of eight) and the controls on the same tasks after the end of their studies, almost one year later. They found no improvements in the control group and some improvements in the group of interpreter trainees—statistically insignificant in the lexical decision task, and statistically significant in the semantic categorisation

task. The effects shown in the study by Bajo et al. (2000) suggest that interpreter training and experience does improve access to conceptual information needed in comprehension.

Finally, Elmer et al. (2010) tested professional interpreters and bilingual controls on a semantic decision task. The participants were to determine if the auditorily presented pairs of nouns—either both in L1, both in L2, one in L1 and the other in L2 in both orders—were semantically congruent. They found no group differences in error rates and response times but they did find differences in EEG data, suggesting “a training-related altered sensitivity to lexical-semantic processing within and across L1 and L2, probably relying on stronger connections within and between the lexicons” (Elmer et al. 2010, 153).

Taken together, these studies seem to suggest that the interpreting practice does not modulate basic processing in comprehension (activation of lexical representations of words and pertaining to typical exemplars in a semantic category), but does influence higher-level processing (activation of conceptual representations of words and pertaining to non-typical exemplars in a category). The connections between lexical and conceptual representations might strengthen where there is greater potential for improvement, i.e., where performance is not at ceiling.

The studies reviewed above focused on comprehension in interpreting. However, the discussion of how interpreting experience modulates lexical processing and comprehension could also be enriched by findings from studies involving translators. García et al. (2014) claim explicitly that strictly linguistic effects of translation experience may be independent of the modality, i.e., they would be similar in the case of interpreting and translation. This is juxtaposed with executive functions that might be more prone to change due to time constraints experienced by interpreters. Let us now review some lexical processing studies involving translators performing tasks that focused on comprehension.

García et al. (2014) studied word reading and word translation tasks performed by groups differing in translation experience: beginner translation trainees, advanced translation trainees and professional translators. They found that beginner trainees were significantly slower in general than translators and advanced trainees, while the latter two groups did not differ. They also found no general language asymmetry and some modulation of language asymmetry by a combination of word-specific factors, such as concreteness and cognate status. García et al. (2014) explained their results by claiming that relative strengths of interlingual links involved in lexical processing might be modulated by early training and reach a ceiling, i.e., become strengthened to the maximum as a result of translation training. According to García et al. (2014, 10) “during the first months of formal translation education prospective translators establish and analyse interlinguistic associations more frequently and intensely than they did

before enrolment.” They further speculate that new interlinguistic associations are reinforced by beginner trainees due to their focus on similarities and differences between translation equivalents. The study has shown that translation experience might in fact be responsible for certain reconfiguration of connections in the mental lexicon.

Ibáñez et al. (2010) asked professional translators and a control group of matched bilinguals to perform self-paced reading of sentences with critical cognate or control words in a language switching paradigm. They were asked either to read and then repeat, or simply to read the sentences. In general, reading in L1 was faster than in L2, regardless of the translation experience. When reading for repetition, translators were found to simultaneously activate both languages, since they manifested a cognate facilitation effect. As a result, they also showed no switching costs, contrary to bilinguals, who read more slowly when switching from L2 to L1. Group and language asymmetry effects disappeared in the reading-only task, suggesting that both translation experience and task demands can modulate lexical processing.

The studies on translators and interpreters bring a similar pattern of results: groups of controls, trainees and professionals differ on more elaborate tasks and not on basic tasks. The findings are more complex when directionality of processing is considered as a variable. While García et al. (2014) found no general directionality effect, Ibáñez et al. (2010) reported an L1 comprehension advantage for both professionals and controls. Since the present study includes two directions (L1-L2 and L2-L1), below is a brief overview of directionality effects found in interpreting studies.

When it comes to directionality in interpreting, most studies show that performance is more efficient and better in L2-L1 direction as opposed to L1-L2 direction (Gran & Fabbro 1988; Chang 2005; Donovan 2005; Mead 2005). Only two studies to date have shown L1-L2 directionality advantage (Tommola & Helevä 1998; Kurz & Färber 2003). In a single word translation study by Christofels et al. (2006), the directionality effect was manifested only by bilinguals and not by interpreters and language teachers. Such language symmetry was posited to result from proficient language use typical in interpreting and language teaching. A similar pattern of results was discovered by De Bot (2000): L2-L1 advantage was found in intermediate and advanced bilinguals performing word translation, but not in proficient bilinguals. Chmiel (2016) investigated to what extent the directionality of interpreting practice modulates directionality effects in a word translation task. Chmiel examined both unidirectional interpreters (working only in the L2-L1 direction) and bidirectional interpreters (working equally often in the L2-L1 and L1-L2 direction). Contrary to her assumptions, it was bidirectional and not unidirectional interpreters who showed the L2-L1 advantage. Chmiel (2016)

explained her results by claiming that other factors (such as language use, exposure and immersion) might have more bearing on the structure of cross-linguistic links in the mental lexicon than the predominant interpreting direction.

Taken together, the majority of directionality studies show L2-L1 advantage and some modulation by factors such as language proficiency and interpreting experience. Thus, the cross-linguistic mappings in the mental lexicon may undergo reorganisation due to interpreting practice. While the majority of these studies revealed directionality effects in production, the following study will examine these effects in comprehension.

4. The present study

In the present study, four groups of unbalanced bilinguals with varying simultaneous interpreting experience were asked to perform a lexical decision task in a cross-linguistic semantic priming study to evaluate to what extent simultaneous interpreting modulates conceptual and lexical connections in a bilingual mind. This is, to the best of my knowledge, the first study applying a semantic priming paradigm to study interpreting populations. The aim was to see if the amount of interpreter training and interpreting experience modulates word recognition in general (manifested by response times) and the priming effect, that is, the difference in recognition times between semantically primed and neutrally primed words. Previous neurolinguistically-oriented studies (Elmer et al. 2010; García 2013) seem to suggest that the strength of semantic and lexical links between translation equivalents might depend on translation and interpreting experience. In line with the study by Bajo et al. (2000), faster word recognition was expected by advanced trainees as compared to beginner trainees, as well as by professionals and trainees as compared to controls. Since all groups were unbalanced bilinguals, a general L1 comprehension advantage was expected for all groups. It was also predicted that participants with more exposure to interpreting (advanced trainees and professionals) would manifest semantic priming in both directions while bilingual controls and beginner trainees would manifest semantic priming only in the usual L1-L2 direction.

Semantic priming is said to reflect an automatic process since the priming effect has been discovered for the time between the appearance of a prime and a target (or *stimulus-onset-asynchrony*, henceforth SOA) of 200 ms or shorter (McNamara 2005; McDonough & Trofimovich 2008). If longer prime-target intervals are applied, semantic priming may also reflect controlled or strategic processing. According to McNamara (2005:74), “any delay between processing of the prime and processing of the target will allow some progress to be made in gen-

eration of the semantic set for a word prime, setting the stage for facilitation.” With longer SOA, participants are believed to apply various strategies (Perea & Rosa 2002). Expectancy generation is one of such strategies, and it is crucial for the present study. This mechanism involves the mental construction of a list of words related to the prime before the appearance of the target (McNamara 2005; Altarriba & Basnight-Brown 2007; Basnight-Brown & Altarriba 2007; Heyman et al. 2015). When applied in a cross-linguistic priming task, such as the one in the present study, a long SOA “may allow participants to translate the prime into the alternate language” (Basnight-Brown & Altarriba 2007, 5) and response times reaching 1000 ms may be an indication of that translation mechanism.

Since the present study focuses on the differences between groups more and less experienced in interpreting I decided to use a SOA of 750 ms. As mentioned earlier, effects found with a longer SOA may reflect strategic processing involving expectancy mechanism. Such mechanism is frequently employed by interpreters to anticipate the meaning of the incoming speech. Thus, it was expected that any group differences in word recognition and priming effects would be especially salient with such a long SOA.

4.1 Participants

There were four groups of participants: 20 interpreting trainees tested before a two-year graduate programme in conference interpreting, the same 20 trainees re-tested after their two-year training, 24 professional conference interpreters and 24 non-interpreting bilingual controls.

The group of trainees included 14 females and 6 males. Their mean age was 22 years ($SD = .88$) before training and 24 years ($SD = 1.1$) after training. Their A language (L1) was Polish, their B language (L2) was English and 13 of them had a C language (L3, German or French). None of them reported any significant interpreting experience. The two-year programme included over 500 contact hours focusing on the practical training in interpreting (including liaison, consecutive and simultaneous interpreting). This group was tested twice: in the first and the last month of their programme, so the interval was 21 months. The trainees' B language proficiency was at least on the C1 level—according to the Common European Framework of Reference for Languages, or CEFR (North 2014)—following the entry requirements to the master's programme.

The group of conference interpreters included professional interpreters working for the European Commission and the European Parliament: 17 of them worked for the EU institutions full-time and 7 were freelancers. This group included 11 females and 13 males. Their mean age was 38 years ($SD = 5.49$) and their mean self-reported professional experience in conference interpreting was

10 years ($SD=5.28$). They all had Polish as their A language, English as their B language and most of them had also one or two C languages (Czech, French, German, Greek, Italian, Spanish or Swedish).

The control group included students of the master's programme in English. Polish was their mother tongue. They came from the same university as the interpreting trainees and their L2 proficiency was at a similar level (at least C1 according to CEFR). Their mean age was 24 ($SD=2.0$). They could be classified as non-interpreting bilinguals since none of them had any significant training or professional experience in interpreting.

4.2 Materials

The materials included 80 targets (50 words and 30 non-words) in English and in Polish. All words were matched for frequency and length based on the SUBTLEX-uk (Van Heuven et al. 2014) and SUBTLEX-pl (Mandera et al. 2015) database. The average frequency of the targets was 4.6 for English and 4.2 for Polish on the Zipf scale, which is a standardised word frequency measure (Van Heuven et al. 2014). The Zipf scale ranges from 1 to 7 and the Zipf value of 4 corresponds to the frequency of 10 per 1 million words. Words with Zipf scores between 4 and 7 are considered frequent. Thus, the experimental items used in this study rank in the lower range of frequent words. Association norms for the experimental prime-target pairs were collected from 100 participants coming from the same population as the control group. The participants were asked to rate association strengths on a 7-point Likert scale. Targets from pairs with scores below 2.5 were treated as neutrally primed and targets from pairs with scores above 5.5 were treated as semantically primed. Non-words were created by adding, deleting or changing 1–3 letters in an existing word in a given language. Each target word appeared in two conditions—preceded by a related semantic prime in the other language (e.g., *welna* [‘wool’]—SHEEP) and preceded by an unrelated prime in the other language (e.g., *krzesło* [‘chair’]—SHEEP). Two sets of stimuli were created with randomised conditions. If a target was preceded by a related prime in set A, the same target was preceded by an unrelated prime in set B. Thus, each set included 25 targets preceded by related primes, 25 targets preceded by unrelated primes and 30 non-words preceded by primes. Sets were randomised across participants and each set was presented to half of the participants in each group.

4.3 Procedure

The experiment was designed and run on E-Prime 2 (Schneider et al. 2002) on a laptop computer. Reaction times were measured with the Serial Response Box.

Participants were examined in a quiet room (bilinguals in a university laboratory and interpreters in a quiet office in the building of either the European Parliament or the Directorate-General for Interpretation in Brussels). Before the experiment they completed a pre-questionnaire including questions about their age, known languages and experience in interpreting. They were given oral instructions and completed a practice block in either Polish-English direction or English-Polish direction. Instructions were given in the language of the target words. After the practice block, the participants completed the trial block and the direction was reversed, so that they then could complete both the practice block and the trial block in the other direction. The procedure within a trial involved the following elements: first the participants looked at a fixation mark for 1000 ms. This was followed by a prime that appeared on the screen for 250 ms and a blank screen visible for 500 ms. The participants then saw the target which disappeared when they made a decision (by pressing 1 for words and 0 for non-words) or after 4000 ms, whichever came first.

4.4 Data analysis

Incorrect responses and responses to nonwords were removed from the analysed data (nonwords are included in the experiment only to make the participants differentiate between words and nonwords and they do not provide any information about lexical processing). Response times below 200 ms and above 1500 ms were considered outliers in line with Schoonbaert et al. (2009) and Carreiras et al. (1997) and removed from the analysis (1% of the data). The data were analysed by means of fitting a linear mixed effects model with the lme4 package (Bates 2007) in R software (R Development Core Team 2013). This method was chosen over the traditional ANOVA since it allows for better handling of unbalanced data. It also combines ANOVA's separate F1 and F2 analyses to capture individual differences between participants and experimental items (Barr et al. 2013; Bates et al. 2015). The response times were log-transformed to achieve the normal distribution of data. Thus, coefficients from the model are based on log-transformed values. However, for convenience, means and effects are presented in ms.

4.5 Results

No single model could be fitted to analyse all data since group was a within-subject variable when comparing beginner and advanced trainees and a between-group variable when comparing advanced trainees to professional interpreters and controls. Thus, separate models were fitted for the effect of training (comparing trainees before and after training) and the effect of experience (comparing

advanced trainees and professionals to controls). For all models, Satterthwaite approximations were used to establish p values and sliding contrasts were set to estimate parameters for main effects and interactions.

4.5.1 *Effect of training*

Two linear models were fitted to analyse priming in the L1-L2 direction and L2-L1 direction. Both models included group (beginners vs. advanced trainees) and prime type (related vs. unrelated) plus their interactions as fixed factors and items and participants as random intercepts. They also included both prime and target frequency and length as fixed factors. The analysis of priming in the L2-L1 direction revealed the main effect of group ($b = .05$, $t = 3.37$, $p < .001$) with quicker reactions of advanced trainees ($M = 574$ ms, $SD = 179$) than beginner trainees ($M = 603$ ms, $SD = 174$). No priming effect was found ($b = .006$, $t = .37$, $p > .05$) and no interactions were revealed. The analysis of data for the L1-L2 direction revealed a reliable effect of group ($b = .03$, $t = 2.13$, $p < .05$). Again, advanced trainees ($M = 624$ ms, $SD = 170$) were faster than beginners ($M = 667$ ms, $SD = 178$). There was a marginally significant priming effect ($b = .03$, $t = 1.79$, $p = .07$). Semantically primed targets ($M = 638$ ms, $SD = 175$) were reacted to 11 ms faster than neutrally primed targets ($M = 649$ ms, $SD = 175$). No group by prime type interaction was revealed, which means that the priming effect did not differ for both groups.

In order to look for general direction asymmetries, a linear model was first fitted with group (beginners vs. advanced trainees), prime type (related vs. unrelated) and direction (L2-L1 and L1-L2) plus their interactions as fixed factors and items and participants as random intercepts, as well as both prime and target frequency and length as fixed factors. The analysis revealed the main effect of group ($b = .004$, $t = 3.807$, $p < .001$), where advanced trainees ($M = 596$ ms, $SD = 177$) responded faster than beginner trainees ($M = 630$ ms, $SD = 179$). It also revealed the main effect of direction ($b = .012$, $t = 5.19$, $p < .001$), with reactions faster in the L2-L1 direction ($M = 587$ ms, $SD = 177$) than in the L1-L2 direction ($M = 643$ ms, $SD = 175$). There was also a marginally significant effect of prime type ($b = .002$, $t = 1.78$, $p = .07$): semantically primed targets ($M = 605$ ms, $SD = 179$) were recognised 12 ms faster than neutrally primed targets ($M = 617$ ms, $SD = 177$).

4.5.2 *Effect of experience*

In order to analyse the effect of experience, two linear models were fitted for two directions (L1-L2 and L2-L1) with group (controls, advanced trainees, professional interpreters) and prime type (related vs. unrelated) plus their interactions as fixed factors and items and participants as random intercepts. Additionally, both prime and target frequency and length were controlled for in the model by entering them as covariates. In the L2-L1 condition, numerical differences show

that both advanced trainees ($M=574$ ms, $SD=179$) and professionals ($M=582$ ms, $SD=145$) performed faster than controls ($M=6418$ ms, $SD=178$). However, none of the group comparisons turned out statistically significant and there was no priming effect. In the L1-L2 direction, advanced trainees ($M=624$ ms, $SD=170$) were marginally faster than controls ($M=676$ ms, $SD=177$) ($b=-.07$, $t=-1.75$, $p=.08$). No other group comparisons turned out to be reliable. A marginally significant priming effect was found ($b=.06$, $t=.189$, $p=.05$). Semantically primed targets ($M=639$ ms, $SD=165$) were recognised 14 ms faster than neutrally primed targets ($M=653$ ms, $SD=165$). Again, no prime type by group interactions were revealed, suggesting a similar behaviour of all groups.

Finally, in order to compare both directions a linear model was fitted with direction, group and prime type and their interactions as fixed factors. Other characteristics of the model were similar. The analysis revealed the main effect of direction ($b=.011$, $t=6.6$, $p<.001$), with L1 words recognised faster ($M=593$ ms, $SD=168$) than L2 words ($M=646$ ms, $SD=165$), and an interaction between prime type and direction ($b=.003$, $t=2.1$, $p<.05$) stemming from the priming effect in the L1-L2 direction and the lack of effect in the L2-L1 direction.

4.6 Discussion

The aim of the study was to examine how interpreter training and experience influence word recognition latencies and the representation of words in the mental lexicon. It was predicted that words would be recognised faster by participants with interpreting experience, words in L1 would be recognised faster than words in L2 and that semantic priming effects would be symmetrical for professional interpreters and advanced trainees due to stronger interlingual connections in their mental lexicons.

A consistent effect of training was found in both directions as at the end of interpreter training the trainees recognised words faster than at the beginning. This result confirms the theoretical conjecture by Setton (2003) and adds to a few studies that have found the training effect in such comprehension tasks as semantic categorisation (Bajo et al. 2000) and word reading (García et al. 2014). However, it contradicts the findings from a longitudinal study on trainees by Bajo et al. (2000), who found no training effect in a lexical decision task. This discrepancy may be explained by the fact that Bajo et al. (2000) used a slightly different lexical decision task in their study—it did not involve priming. As regards the effect of experience, no group differences were found when comparing advanced trainees, professional interpreters and controls. This is in line with Bajo et al. (2000), who found no difference between similar groups in word recognition, Yudes et al. (2012), who found no effect as regards single word processing, and Elmer et al.

(2010), who found differences between interpreters and controls performing a semantic decision task only in the EEG data and not in behavioural data. This suggests that single word processing might develop due to interpreter training but there is no evidence showing that it undergoes major modifications as a result of interpreting experience. However, the experimental items used in the study were frequent words (4.2 and 4.6 on the 7 point Zipf scale). The results might have been different if the study had involved less frequent words or words that are typically found in interpreting contexts.¹

The study revealed a significant direction effect: L1 words (L2-L1 direction) were recognised faster than L2 words (L1-L2 direction). This was an expected result, corroborating findings from many studies that show an L1 comprehension advantage (Donovan 2005; Mead 2005; Perea et al. 2008; Ibáñez et al. 2010). It seems that, despite a unique use of two languages involved in interpreting, the interpreters' bilingual language profile might not undergo major changes, at least as regards the processing of frequent stimuli. The participants in this study were unbalanced late bilinguals and this asymmetry remained unaltered by interpreting experience or training.

Asymmetrical priming in beginner trainees and controls was expected in line with the priming literature on bilinguals (Keatley et al. 1994, Basnight-Brown & Altarriba 2007). This prediction was confirmed and the priming effect for these participants was found only in the L1-L2 direction. More experienced participants (advanced trainees and professional interpreters), had been expected to display a priming effect also in the L2-L1 direction, since it was predicted that interpreter training and experience would modulate the lexical and conceptual connections, thus making it easy for activation to spread also from L2 words to L1 words. This was not the case: no L2-L1 priming effect was revealed and no group by prime type interactions were found. Priming was not modulated neither by interpreter training or by interpreting experience. Thus, it might have occurred similarly in all participant groups.

These results can be explained in various ways. First, group differences might not be visible in behavioural data, as shown by Elmer et al. (2010), and might require the application of neurocognitive research methods in order to be discovered. Another explanation might be related to the study design. Keatley et al. (1994) found priming effects in short SOA conditions (200 ms and 250 ms) and not in the long SOA condition (2000 ms). The potential time sensitivity of the effect might have influenced the results of the present study, which employed a long SOA. A similar study with a shorter SOA might be in order to verify this assumption. Finally, interpreting experience and interpreter training might not

1. I thank an anonymous reviewer for this suggestion.

modulate the connections between words in the mental lexicon to an extent visible in a priming study, at least in the case of more frequent words, such as the ones used in this study.

The L1 advantage and the priming effects revealed by the present study are easily accommodated by the bilingual mental lexicon models as they converge with data from regular bilinguals. Thus, the L1 advantage can be explained by the fact that L1 representations, either in the form of conceptual features posited by the Distributed Representation Model (van Hell & de Groot 1998) or in the form of senses as stipulated in the Sense Model (Finkbeiner et al. 2004), are stronger than L2 features and become activated faster. It seems that the interpreting experience and training do not lead to stronger L2 representations. The asymmetric priming effect can be explained by the fact that L1 primes activate more conceptual features or senses than L2 primes and thus enable stronger spreading activation to primed words in the other language. Again, the specific simultaneous processing of two languages in the course of interpreter training and experience might not alter these patterns of activation in the case of high frequency words.

4.7 Limitations

The present study was not free of limitations. First, it employed a task involving the recognition of written words while comprehension in interpreting is usually from an auditory channel. This may have been a potential weakness for the ecological validity of the study. Another limitation may have been that the SOA used in the present study was longer than in most priming studies. This was deliberate, so as to capture strategic processing and expectancy generation. However, neurolinguistic research has shown that facilitatory priming effects might be fading by the end of a long SOA (Rossell et al. 2003). This might partially explain only marginally significant priming effects in L1-L2 and no reliable priming in the other direction. More studies are needed with manipulated SOAs to shed more light on expectancy generation and priming effects in interpreters. Also, the study by Elmer et al. (2010) has shown that typically behavioural data collected in a regular priming study might not show underlying differences, revealed only by neurolinguistic methods. Thus, a combination of both psycholinguistic and neurolinguistic research paradigms can prove beneficial in discovering how interpreting experience and training modulates linguistic processing. Finally, the experimental items were high frequency words and any changes in the processing may be too subtle in the case of such words. It would be interesting to manipulate target frequency in the study to see if more salient differences can be found. In fact, the frequency could be manipulated according to the objective frequency

based on language corpora, subjective frequency ratings collected from the participants and interpretation-specific frequencies based on interpreting corpora.

5. Conclusions

The aim of this study was to examine how interpreter training and interpreting experience influence the representation of words in the bilingual mental lexicon through the analysis of word recognition and priming effects in a lexical decision task. To the best of my knowledge, it was the first study adopting a longitudinal design to examine word recognition and priming in interpreting trainees. The findings show that interpreter training modulates word recognition latencies and that neither interpreter training nor interpreting experience modulate priming effects. This study involved a basic task of single word recognition. Although it was sufficient to reveal the effect of training, the interpreter's advantage (if it exists) might be related to higher-order, more complex linguistic processing and would thus not be visible in a more basic word processing task, such as the one employed here. The study revealed an expected L1 comprehension advantage across all participants. Although interpreters are language specialists, no evidence was found that interpreting experience alters their bilingual language profile and language dominance and asymmetry. The asymmetry was visible in that the priming effect was found only in the expected L1-L2 direction. Again, the representation of words in the bilingual lexicon (to the extent identifiable through priming) remained unchanged as a result of interpreter training and experience. It seems that the specific simultaneous processing of two languages in the interpreting profession is not a strong factor in shaping the bilingual profile. Other factors, such as the initial bilingual symmetry or dominance, immersion, and daily language use might be more important in this case. The priming paradigm can be useful in studying interlingual connections in the interpreter's mental lexicon. However, interpreting involves a lot of top-down processing and more studies are needed to find out how the makeup of the mental lexicon affects the speed and ease of continuous speech-in-context processing typical of simultaneous interpreting.²

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References

- Altarriba, Jeanette, and Dana M. Basnight-Brown. 2007. "Methodological Considerations in Performing Semantic- and Translation-Priming Experiments across Languages." *Behavior Research Methods* 39 (1):1–18. doi: 10.3758/BF03192839
- Altarriba, Jeanette, and Dana M. Basnight-Brown. 2009. "An Overview of Semantic Processing in Bilinguals: Methods and Findings." In *The Bilingual Mental Lexicon: Interdisciplinary Approaches*. Edited by A. Pavlenko, 79–99. Bristol: Multilingual Matters.
- Bajo Molina, M^a. Teresa, Francisca Padilla Adamuz, and Presentacion Padilla Benítez. 2000. "Comprehension Processes in Simultaneous Interpreting." In *Translation in Context*. Edited by A. Chesterman, N. Gallardo, and Y. Gambier, 127–142. Amsterdam: John Benjamins. doi: 10.1075/btl.39.15baj
- Barr, Dale J., Roger Levy, Christoph Scheepers, and Harry J. Tily. 2013. "Random Effects Structure for Confirmatory Hypothesis Testing: Keep It Maximal." *Journal of Memory and Language* 68 (3): 255–278. doi: 10.1016/j.jml.2012.11.001
- Bartłomiejczyk, Magdalena. 2010. "Effects of Short Intensive Practice on Interpreter Trainees' Performance." In *Why Translation Studies Matters*. Edited by D. Gile, G. Hansen, and N. Pokorn, 183–194. Amsterdam: John Benjamins. doi: 10.1075/btl.88.16bar
- Basnight-Brown, Dana M., and Jeanette Altarriba. 2007. "Differences in semantic and Translation Priming across Languages: The Role of Language Direction and Language Dominance." *Memory & Cognition* 35 (5): 953–965. doi: 10.3758/BF03193468
- Bates, Douglas. 2007. *Linear Mixed Model Implementation in lme4*. Manuscript, University of Wisconsin-Madison.
- Bates, Douglas, Reinhold Kliegl, Shravan Vasishth, and Harald Baayen. 2015. "Parsimonious Mixed Models." *arXiv preprint arXiv:1506.04967*.
- Carreiras Valiña, Manuel F., Manuel Perea Lara, and Jonathan Grainger. 1997. "Effects of Orthographic Neighborhood in Visual Word Recognition: Cross-Task Comparisons." *Journal of Experimental Psychology-Learning Memory and Cognition* 23 (4): 857–871. doi: 10.1037/0278-7393.23.4.857
- Chang, Chia-chien. 2005. "Directionality in Chinese/English Simultaneous Interpreting: Impact on Performance and Strategy Use." PhD Dissertation, University of Texas at Austin.
- Chen, Hsuan-Chih, and Man-Lai Ng. 1989. "Semantic Facilitation and Translation Priming Effects in Chinese-English Bilinguals." *Memory & Cognition* 17 (4): 454–462. doi: 10.3758/BF03202618
- Chmiel, Agnieszka. 2007. "Focusing on Sense or Developing Interlingual Lexical Links? Verbal Fluency Development in Interpreting Trainees." In *Translationsqualität [Translation Quality]*. Edited by P. A. Schmitt and H. E. Jüngst, 66–78. Frankfurt am Main: Peter Lang.
- Chmiel, Agnieszka. 2010. "Interpreting Studies and Psycholinguistics: A Possible Synergy Effect." In *Why Translation Studies Matters*. Edited by D. Gile, G. Hansen, and N. Pokorn, 223–236. Amsterdam: John Benjamins. doi: 10.1075/btl.88.19sch
- Chmiel, Agnieszka. 2016. "Directionality and Context Effects in Word Translation Tasks Performed by Conference Interpreters." *Poznan Studies in Contemporary Linguistics* 52 (2): 269–295.

- Christoffels, Ingrid, Annette M. B. de Groot, and Judith Kroll. 2006. "Memory and Language Skills in Simultaneous Interpreters: The Role of Expertise and Language Proficiency." *Journal of Memory and Language* 54 (3): 324–345. doi:10.1016/j.jml.2005.12.004
- Cop, Uschi, Emmanuel Keuleers, Denis Drieghe, and Wouter Duyck. 2015. "Frequency Effects in Monolingual and Bilingual Natural Reading." *Psychonomic Bulletin & Review* 22 (5): 1216–1234. doi:10.3758/s13423-015-0819-2
- De Bot, Kees. 2000. "Simultaneous Interpreting as Language Production." In *Language Processing and Simultaneous Interpreting: Interdisciplinary Perspectives*. Edited by B. Englund Dimitrova and K. Hyltenstam, 65–88. Amsterdam: John Benjamins. doi:10.1075/btl.40.06bot
- De Feo, N. 1993. *Strategie di riformulazione sintetica nell'interpretazione simultanea dall'inglese in italiano: un contributo sperimentale* [Syntactic reformulation strategies in English-Italian simultaneous interpreting]. Graduation Thesis, SSLM, University of Trieste.
- de Groot, Annette M. B., and Ingrid K. Christoffels. 2006. "Language Control in Bilinguals: Monolingual Tasks and Simultaneous Interpreting." *Bilingualism: Language and Cognition* 9 (2): 189–201. doi:10.1017/S1366728906002537
- de Groot, Annette M. B., and Gerard L. J. Nas. 1991. "Lexical Representation of Cognates and Noncognates in Compound Bilinguals." *Journal of Memory and Language* 30 (1): 90–123. doi:10.1016/0749-596X(91)90012-9
- Díaz Galaz, Stephanie, Presentacion Padilla Benítez, and M^a. Teresa Bajo Molina. 2015. "The Role of Advance Preparation in Simultaneous Interpreting: A Comparison of Professional Interpreters and Interpreting Students." *Interpreting* 17 (1): 1–25. doi:10.1075/intp.17.1.01dia
- Dijkstra, Ton, and Walter J. B. van Heuven. 2002. "Modeling Bilingual Word Recognition: Past, Present and Future." *Bilingualism: Language and Cognition* 5 (3): 219–224. doi:10.1017/S1366728902283017
- Donovan, Clare. 2005. "Teaching Simultaneous Interpretation into B: A Challenge for Responsible Interpreter Training." *Communication and Cognition. Monographies* 38 (1–2): 147–166.
- Elmer, Stefan. 2012. "The Investigation of Simultaneous Interpreters as an Alternative Approach to Address the Signature of Multilingual Speech Processing." *Zeitschrift für Neuropsychologie* 23 (2): 105–116. doi:10.1024/1016-264X/a000068
- Elmer, Stefan, Martin Meyer, and Lutz Jancke. 2010. "Simultaneous Interpreters as a Model for Neuronal Adaptation in the Domain of Language Processing." *Brain Research* 1317: 147–156. doi:10.1016/j.brainres.2009.12.052
- Fabbro, Franco, Bruno Gran, and Laura Gran. 1991. "Hemispheric Specialization for Semantic and Syntactic Components of Language in Simultaneous Interpreters." *Brain and Language* 41 (1): 1–42. doi:10.1016/0093-934X(91)90108-D
- Finkbeiner, Matthew, Kenneth Forster, Janet Nicol, and Kumiko Nakamura. 2004. "The Role of Polysemy in Masked Semantic and Translation Priming." *Journal of Memory and Language* 51 (1): 1–22. doi:10.1016/j.jml.2004.01.004
- García, Adolfo M., Agustín J. Ibáñez Barassi, David Huepe Artiaga, Alexander L. Houck, Maëva Michon, Carlos Gelormini Lezama, Sumeer Chadha, and Álvaro Rivera Rei. 2014. "Word Reading and Translation in Bilinguals: The Impact of Formal and Informal Translation Expertise." *Frontiers in Psychology* 5: 1302.

- García, Adolfo M. 2013. "Brain Activity during Translation: A Review of the Neuroimaging Evidence as a Testing Ground for Clinically-Based Hypotheses." *Journal of Neurolinguistics* 26 (3): 370–383. doi:10.1016/j.jneuroling.2012.12.002
- Gran, Laura, and Franco Fabbro. 1988. "The Role of Neuroscience in the Teaching of Interpretation." *The Interpreters' Newsletter* 1: 23–41.
- Hervais-Adelman, Alexis, Barbara Moser-Mercer, and Narly Golestani. 2015. "Brain Functional Plasticity Associated with the Emergence of Expertise in Extreme Language Control." *Neuroimage* 114: 264–274. doi:10.1016/j.neuroimage.2015.03.072
- Heyman, Tom, Bram Van Rensbergen, Gert Storms, Keith A. Hutchison, and Simon De Deyne. 2015. "The Influence of Working Memory Load on Semantic Priming." *Journal of Experimental Psychology: Learning, Memory and Cognition* 41 (3): 911–920.
- Ibáñez Barassi, Agustín J., Pedro Macizo Soria, and M^a. Teresa Bajo Molina. 2010. "Language Access and Language Selection in Professional Translators." *Acta Psychologica* 135 (2): 257–266. doi:10.1016/j.actpsy.2010.07.009
- Jin, Young-Sun. 1990. "Effects of Concreteness on Cross-Language Priming in Lexical Decisions." *Perceptual and Motor Skills* 70 (3): 1139–1154. doi:10.2466/PMS.70.3.1139-1154
- Keatley, Catharine W., John A. Spinks, and Beatrice De Gelder. 1994. "Asymmetrical Cross-Language Priming Effects." *Memory & Cognition* 22 (1): 70–84. doi:10.3758/BF03202763
- Kurz, Ingrid, and Birgit Färber. 2003. "Anticipation in German-English Simultaneous Interpreting." *Forum* 1 (2): 123–150.
- Liu, Minhua, Diane L. Schallert, and Patrick J. Carroll. 2004. "Working Memory and Expertise in Simultaneous Interpreting." *Interpreting* 6 (1): 19–42. doi:10.1075/intp.6.1.04liu
- Mandera, Paweł, Emmanuel Keuleers, Zofia Wodniecka, and Marc Brysbaert. 2015. "Subtlex-pl: Subtitle-Based Word Frequency Estimates for Polish." *Behavior Research Methods* 47 (2): 471–483. doi:10.3758/s13428-014-0489-4
- McDonough, Kim, and Pavel Trofimovich. 2009. *Using Priming Methods in Second Language Research*. London: Routledge.
- McNamara, Timothy P. 2005. *Semantic Priming: Perspectives from Memory and Word Recognition*. New York: Psychology Press. doi:10.4324/9780203338001
- Mead, Peter. 2005. "Directionality and Fluency: An Experimental Study of Pausing in Consecutive Interpretation into English and Italian." *Communication and Cognition. Monographs* 38 (1–2): 127–146.
- North, Brian. 2014. "Putting the Common European Framework of Reference to Good Use." *Language Teaching* 47 (2): 228–249. doi:10.1017/S0261444811000206
- Perea Lara, Manuel, Jon A. Duñabeitia Landaburu, and Manuel F. Carreiras Valiña. 2008. "Masked Associative/Semantic Priming Effects across Languages with Highly Proficient Bilinguals." *Journal of Memory and Language* 58 (4): 916–930. doi:10.1016/j.jml.2008.01.003
- Perea Lara, Manuel, and Eva M^a. Rosa Martínez. 2002. "The Effects of Associative and Semantic Priming in The Lexical Decision Task." *Psychological Research* 66 (3): 180–194. doi:10.1007/s00426-002-0086-5
- R: *A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna.
- Riccardi, Alessandra. 1998. "Interpreting Strategies and Creativity." In *Translators' Strategies and Creativity*. Edited by A. Beylard-Ozeroff, J. Králová, and B. Moser-Mercer, 171–180. Amsterdam: John Benjamins. doi:10.1075/btl.27.24ric

- Rossell, Susan L., Cathy J. Price, and A. Christina Nobre. 2003. "The Anatomy and Time Course of Semantic Priming Investigated by fMRI and ERPs." *Neuropsychologia* 41 (5): 550–564. doi:10.1016/S0028-3932(02)00181-1
- Schneider, Walte, Amy Eschman, and Anthony Zuccolotto. 2002. *E-Prime User's Guide*. Pittsburgh: Psychology Software Tools.
- Schoonbaert, Sofie, Wouter Duyck, Marc Brysbaert, and 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): 569–86. doi:10.3758/MC.37.5.569
- Schwanenflugel, Paula J., and Mario Rey. 1986. "Interlingual Semantic Facilitation: Evidence for a Common Representational System in the Bilingual Lexicon." *Journal of Memory and Language* 25 (5): 605–618. doi:10.1016/0749-596X(86)90014-8
- Setton, Robin. 2003. "Words and Sense. Revisiting Lexical Processes in Interpreting." *FORUM. International Journal of Interpretation and Translation* 1 (1): 139–168.
- Setton, Robin, and Manuela Motta. 2007. "Syntacrobatics: Quality and Reformulation in Simultaneous-with-Text." *Interpreting* 9 (2): 199–230. doi:10.1075/intp.9.2.04set
- Sunnari, Marianna. 1995. "Processing Strategies in Simultaneous Interpreting: 'Saying It All' vs. Synthesis." In *Topics in Interpreting Research*. Edited by J. Tommola, 109–119. Turku: University of Turku, Centre for Translation and Interpreting.
- Sunnari, Marianna. 1996. "Comparison of Expert and Novice Performance in Simultaneous Interpreting." In *Proceedings of the XIV World Congress of FIT*, 993–1000. Melbourne: Institute of Interpreters and Translators.
- Tommola, Jorma, and Marketta Helevä. 1998. "Language Direction and Source Text Complexity: Effects on Trainee Performance in Simultaneous Interpreting." In *Unity in Diversity. Current Trends in Translation Studies*. Edited by L. Bowker, M. Cronin, D. Kenny, and J. Pearson, 177–186. Manchester: St. Jerome.
- van Hell, Janet G., and Annette M. B. de Groot. 1998. "Conceptual Representation in Bilingual Memory: Effects of Concreteness and Cognate Status in Word Association." *Bilingualism: Language and Cognition* 1 (3): 193–211. doi:10.1017/S1366728998000352
- van Heuven, Walter J. B., Paweł Mandera, Emmanuel Keuleers, and Marc Brysbaert. 2014. "SUBTLEX-UK: A New and Improved Word Frequency Database for British English." *The Quarterly Journal of Experimental Psychology* 67 (6): 1176–1190. doi:10.1080/17470218.2013.850521
- Yudes Gómez, Carolina, Pedro Macizo Soria, Luis Morales Márquez, and M^a. Teresa Bajo Molina. 2012. "Comprehension and Error Monitoring in Simultaneous Interpreters." *Applied Psycholinguistics* 34 (05): 1039–1057. doi:10.1017/S0142716412000112

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