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Directionality and lexical selection in professional translators: Evidence from verbal fluency and translation tasks

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Abstract: Lexical selection is a key process in any language-based communicative event, but in translation it occurs in the semantic network activated by two languages. The question asked in this article is how the direction in which translation proceeds affects the process and outcome of lexical selection by experienced bidirectional translators. The prediction from the available empirical evidence that lexical selection when translating into the translator's L2 (learned language) is more cognitively demanding than when working into L1 (native language) is tested in an experimental study with translators who regularly translate into their L1 (Polish) and L2 (English). The participants performed verbal fluency tasks and translated two texts (a product description text and a film review) into their L1 and L2 (four texts in total). The entire process was recorded by key-logging, eye-tracking and screen capture programs. The results confirm that lexical selection is more demanding and less successful in L1→L2 translation, thus confirming the L2 cognitive disadvantage. Equipping translation students with effective error-preventing strategies and encouraging collaboration between translators and proofreaders could optimise lexical selection in L1→L2 translation.

Keywords: Directionality, verbal fluency, lexical selection, bidirectional translators, expertise, key-logging, eye-tracking, screen capture.

1. Introduction

Lexical selection or lexical choice is about choosing words which we consider the best fit for the meaning we want to share with our interlocutors. The ability to access, select and produce (articulate or write) words is a part of vocabulary retrieval and of general verbal ability. Lexical selection is essential in any language-based communicative event including translation. In simple terms, it is a process of mapping meaning, or concepts onto words. In everyday language use, people are "subject to selection pressure from within language alternatives (e.g., *cup* vs. *mug*)" and have to resolve semantic competition (Friesen et al., 2016, p. 1). When monolingual speakers face lexical choices and alternative words are activated in their mental lexicon, the selection process is more demanding. Psycholinguistic research, which taps into how language is processed by the human mind, has demonstrated that participants in controlled experiments when faced with alternative words take longer to name pictures (Schriefers et al., 1990) and fixate more on semantic competitors in visual world

paradigm studies compared to trials with no semantic competitors (Huettig & Altmann, 2005).

The cognitive cost of processing semantic competition is much higher for bilingual speakers. Gollan et al. (2005) showed that bilingual speakers take longer to name pictures than monolinguals, although both groups do not differ in simple nonverbal semantic classification tasks. This is explained by spreading activation across the language-independent conceptual store which activates words in both languages (Collins & Loftus, 1975). Bilinguals have more options to consider and language control mechanisms are needed to select the word in the language chosen for communication (Green & Abutalebi, 2013).

In translation, language control and efficient lexical selection are of key importance both for the fluency of the process and the effect of the translated text on its readers. When reading a source text (ST) for translation, activation is spreading across the semantic network (Schaeffer et al., 2016), and theoretically all the translator needs to do is choose the target language words and structures to compose a new target text. Jakobsen and Jensen (2008) demonstrated that translators' reading patterns show more processing effort when they read for translation than when they read for comprehension (see also Macizo & Bajo, 2006). Yet, selecting words from the target language is often the most painstaking aspect of the translation process and it is still unclear how translators deal with unequal proficiency in their working languages. This article investigates to what extent the process of lexical selection is modulated by directionality in experienced bidirectional translators, that is translators who frequently translate into their L1 and L2. Section 2 focuses on translation directionality, section 3 explains the complexity of semantic activation networks, and sections 4-6 discuss a study which measures the effect of translation direction on the process of lexical selection in professional bidirectional translators.

2. Directionality matters

There is a common consensus that translating single words and sentences into L2 is cognitively more demanding than translating into L1. Muñoz et al. (2019, p. 8) review neurocognitive and behavioural studies (e.g., Fabbro & Paradis, 1995; Klein et al.,1995) and show that L2 translation of isolated words recruits additional subcortical mechanisms responsible for executive and linguistic functions in comparison with L1 translation. Further evidence that translating isolated words into L2 is more demanding than translating into L1 comes from psycholinguistic reaction time studies which repeatedly reported that participants take longer to translate in the L2 direction, and the level of accuracy is much lower than in the opposite direction (Kroll & Tokowicz, 2001, p. 54). Chmiel (2018) investigated bidirectional interpreters using semantic priming in a single word recognition task and reported that despite their bilingual expertise, they showed the effect of L1 dominance. If translating single words and sentences into L2 is cognitively more demanding and error-prone than translating into L1, can this finding be extrapolated to full text translation?

Directionality-related problems with lexical choices have been reported by participants in some studies. Buchweitz and Alves (2006, p. 254) analysed the retrospective protocols of 10 students who translated into L2 and into L1 and revealed that in the revision phase, the participants were mostly concerned with lexical choices. Ferreira et al. (2018, p. 112) analysed the retrospective protocols of 8 professional translators working into L1 (Spanish) and L2 (English) and stated that the larger difficulty with L1→L2 translation was ascribed to lexical decisions.

Interestingly, similar findings are reported in L2 writing research. Manchón et al. (2007) present a comprehensive review of research on lexical retrieval in L2 writing and underscore the central role of vocabulary in text composing processes at the stage of planning, formulation and revision. They refer to Porte (1997) who reported that L2 writers were mostly concerned with vocabulary usage during their revision stage. Stevenson et al. (2006) showed that their participants revised their L2 compositions with more focus on vocabulary than their L1 compositions to filter out undesired words. A more profound understanding of the effect directionality has on the process of lexical selection requires more insight into the nature of semantic activation networks.

3. Semantic activation networks in the translating mind

Undoubtedly, "the scope and strength of the two bilingual vocabularies is a critical factor" (Diamond & Shreve, 2017, p. 490) for translators and it can be expected that through practice the two vocabularies become not only richer but also more closely knit than for non-translating bilinguals (Paradis, 2009). Halverson (2017, p. 14) talks about *connectivity* understood as "the nature and strength of links between elements in a bilingual's two languages" which is the effect of the frequent co-occurrence of a translation pair and will lead to the so-called default translation – fast and effortless solutions. On the other hand, the high activation of the translator's working languages creates perfect conditions for cross-linguistic interference effects at the conceptual and lexical level (Toury's law of interference, 1995, p. 275). Even though translation is always situated, and context narrows down the most desirable lexical choices, there are many sources of difficulty which require conflict resolution.

The first source of difficulty is that the lexical resources in the translator's two languages are uneven because they reflect different language experience and culturally unique mental representations. Martín de León (2017, p. 115) suggests that mental representations "may be differently organised by source and target groups, and that translators must identify these differences to create mappings or to make explicit the incongruences between the knowledge structures evoked by source and target texts." For example, Cifuentes-Férez (2009) tested Slobin's (2004) observations concerning manner-of-motion verbs in English and Spanish, and reported that English has far more motion verbs which include fine-grained information about the manner of motion than Spanish. In effect, the fine-grained information about the manner of motion is frequently lost when translating from English into Spanish. Cifuentes-Férez and Rojo (2015, p. 293) confirmed that around 50 percent of manner-of-motion information was either lost or modified in the Spanish target texts. Yet, in their think aloud protocols, the translators did not verbalise any concerns about disregarding the information about the manner of motion. Cifuentes-Férez and Rojo (2015, p. 278), conclude that "thinking-for-translating might colour translators' construals and expressions of motion events in the target language that are different from what is expressed in the source text." The authors refer to Slobin (1996), who noted that when translating from Spanish into English translators tended to add descriptions of the manner of motion (Cifuentes-Férez & Rojo, 2015, p. 277). It is not clear to what extent translators are aware of what is explicitly available and what is implicit in the two lexicons of their working languages.

The second area of difficulty in lexical selection when translating lies in the implicit process of semantic priming, which means that when we see a word, activation spreads across the semantic network and words with similar meanings become activated (McNamara, 2005). Even if the translator fairly

quickly selects a potentially good translation equivalent, research shows that semantic competitors will be also activated in the target language and might need to be considered. Most words come in cohorts of near synonyms which, although sharing similar prototypical meaning, differ in terms of shades and nuances including connotations, implications or attitudes (Edmonds & Hirst, 2002, p. 105), for example, *error, mistake, blunder, slip, lapse, boner,* or *faux pas* (p. 106).

Langacker (1987, p. 385) noted that some elements of the network are more prominent (salient) than others because they are more frequently used, their activation patterns become entrenched and are therefore more likely to be selected for production (Langacker, 2008, p. 226). However, what is more salient in the source language may not overlap with what is more salient in the target language, and the translator may have a different awareness of the salience in their L2, the usually weaker language.

Halverson (2003), building on Langacker's model of semantic structure, formulated the *gravitational pull hypothesis* which explains that translators' choices have cognitive underpinnings. As she explains, salience can be "metaphorically understood as a true form of cognitive gravity, i.e. a cognitive force that makes it difficult for the translator to escape from the cognitive pull of highly salient representational elements in the source language" (Halverson, 2017, p. 14). On the other hand, some lexical (and grammatical) choices can be steered by salience in the target language which Halverson metaphorically terms *magnetism*. Both forces might play an important part in how the activation spreads across the semantic network and the elements more salient in the ST might be selected, which may not be contextually the most appropriate for the TT (see also Levý, 2008).

The need for conflict resolution in translation is especially pressing when one ST word activates many potential target language words (one-to-many). Kroll and Tokowicz (2001, p. 61) demonstrate that participants take longer to translate concrete and abstract words which have more than one translation equivalent than words with only one translation equivalent. Schaeffer et al. (2016) showed that when translators read words in the ST which had multiple translation equivalents (*word translation entropy*), their eye movements reflected more effortful cognitive processing, which they ascribed to the co-activation of both lexicons. However, translators need to remember that only some meanings (or senses) of a ST word may overlap with those activated by a target language word. Finkbeiner et al. (2004, p. 8) give an example of the word 'black' in English and Japanese (*kuroi*) to show that translation equivalents in two languages usually share some senses but not all. Most often L2 users know many meanings of their L1 words but they might be aware only of some meanings evoked by the L2 translation equivalents. Therefore, a stronger semantic priming effect is typically found in the L1→L2 direction.

Although there is a clear understanding of asymmetry in how semantic networks are activated in L1 and L2, the answer to the question of how the direction of translation affects the process of lexical selection in professional bidirectional translators is far from clear. To address this gap, we report on an experimental study in which we test the verbal fluency of experienced translators and explore their process of lexical selection when translating into L1 and L2.

4. The study

The study presented here is a part of a large-scale research project designed to

test the effects of directionality in the translation process and the end product – the EDiT project (Whyatt 2018, 2019).[1]

4.1. Research questions

Five research questions referring to the impact of directionality on the speed and accuracy of lexical selection were formulated:

1) Do experienced bidirectional translators have lower verbal fluency in their L2 than in their L1?
2) Are the unsuccessful lexical choices more frequent in L1→L2 than in L2→L1 translation?
3) Do translators need more support from external resources (e.g., online dictionaries) in L1→L2 than in L2→L1 translation?
4) Do translators change their lexical decisions more often in L1→L2 than in L2→L1 translation?
5) Are the unsuccessful lexical choices in L1→L2 translation made automatically or do they follow more effortful decision-making?

The research questions respond to the assumptions discussed in sections 2 and 3 about the effect of language dominance on lexical selection in terms of speed and accuracy – slower and less successful in the L2 direction. The questions are operationalised in the following way: To answer RQ1 and establish which language is dominant, verbal fluency (VF) is measured by the number of words and speed of typing them when performing a series of standard VF tasks (described in detail in section 4.2). To answer RQ2-5, the translation process and the target texts are analysed. For RQ2, lexical choices are considered unsuccessful if they were corrected by experienced proofreaders in all four experimental texts. To answer RQ3, all instances of dictionary use (typing a word in the Internet browser) are calculated and taken as evidence for problems with lexical selection when translating the four texts. Answering RQ4 and RQ5 required a very laborious manual analysis of the entire translation process, therefore we decided to focus on the product description texts as this type calls for more terminological accuracy than a more creative text type – a film review. To answer RQ4, we count all instances when translators delete a partially or completely typed word and replace it with a different word during drafting and end revision. To answer RQ5, we focus on the translation of product description texts only into L2 (the translator's weaker language) as this direction is more likely to result in less accurate lexical choices, as discussed in section 2. The manner in which the unsuccessful selection proceeded is classified as automatic (fast) or effortful (preceded by a pause longer than 5 seconds assumed to reflect conscious problem solving).[2]

4.2. Participants and materials

Thirty professional bidirectional translators with at least three years of experience in translation participated in the study. The participants worked in experimental conditions and translated 2 texts into their L1 (Polish) and 2 texts

[1] EDiT stands for Effects of Directionality in the Translation process and product. The EDiT project (2016-2019) combines TPR methodology with product assessment to investigate how directionality affects professional translators' performance.

[2] We are aware that the length of pauses classified as indicative of conscious problem solving varies in TPR studies (see Kumpulainen, 2015). Although the choice of a 5 second pause might seem arbitrary (Jakobsen, 2016), such pauses have been considered in other studies as unlikely to represent minor distractions or slow typing (Buchweitz & Alves, 2006, p. 249).

of comparable level of complexity into their L2 (English). The texts were about 162 words long and represented two text types: a product description text (of a mop cleaning set and a ceiling fan) and a film review (of *Afterimage* by Andrzej Wajda and *Silence* by Martin Scorsese). They also performed verbal fluency tasks (VF) – three letter fluency tasks and three category fluency tasks in their L1 and L2. [3]

Verbal fluency tasks are an objective measure of verbal ability (vocabulary size) and executive control ability. The participants are asked to generate as many meaningful words as they can within 1 minute. There are two types of cues used to elicit words – a letter and a category cue. For example, participants may be asked to produce words beginning with the letter 's' or belonging to the category 'fruit' (Luo et al., 2010). The more words produced mean the higher verbal ability score and better verbal fluency performance. Luo et al. (2010) compared the verbal fluency scores of monolingual English speakers with two groups of bilingual speakers and found that monolinguals outperformed the bilingual speakers in terms of the number of correct responses and the timing of the first response. Shao et al. (2014, p. 2) refer to neuroimaging evidence pointing out that "verbal ability may be more strongly reflected in category than in letter fluency scores, and that, conversely, executive control ability may be more strongly reflected in letter fluency scores." VF tasks are usually performed orally but since our participants are written translators, we asked them to type the words.

4.3. Methods and procedure

All of the participants worked in Translog II (Jakobsen, 2011; Carl, 2012) and performed the verbal fluency tasks in their L1 before they translated two texts into their L2. After a short break, they performed the verbal fluency task in their L2 and translated comparable texts into their L1. It was our intention that the verbal fluency task was carried out first and in the language in which the participants later on read the ST for translation. The directions were counterbalanced and the order of texts was randomised to minimise task order effects. The participants came for individual sessions which lasted up to 120 minutes, they received a translation brief, had access to an Internet browser and were remunerated for their work. Their task performance was recorded by the key-logging program (Translog II), an eye-tracker (EyeLink 1000 Plus) and a screen-capture program (Morae). The target texts, which they produced, were later corrected by experienced proofreaders (two for each translation direction) who are native speakers of the target language. When inserting their corrections, the proofreaders were asked to use the 'track changes' function in Microsoft Word. The corrections by the proofreader were classified as either minor –1 penalty point (only slightly affecting the meaning construal) or major –5 penalty points (gravely distorting the meaning construal). In this paper we focus on the corrections to vocabulary (for more details see Whyatt, 2019).

4.4. Data trimming and analysis

Out of 30 data sets, 26 were suitable for analysis (4 sets were discarded due to being incomplete or of poor quality). In the verbal fluency task, one participant produced words in English (L2) when performing a verbal fluency task in Polish (L1). The key-logging data from 25 participants were analysed to obtain results for the verbal fluency tasks. A two-way repeated measures analysis of variance (ANOVA) with planned comparisons was performed to test whether the

[3] For a detailed description of the experimental procedures, participants and materials see the project website at: http://wa.amu.edu.pl/EDiT/index.html

differences in the verbal fluency scores obtained for the letter-cued and category-cued tasks were statistically significant (RQ1). The analysis of the corrections classified as 'vocabulary' (RQ2) and the use of external resources (RQ3) was performed on 26 data sets, that is 52 texts translated into L1 and 52 texts translated into L2. The statistical analysis used linear mixed-effects models (LMM) with translation direction and text type as fixed factors and the translators and proofreaders as random factors. The analysis of the process data for RQ4 and RQ5 is based only on the product description texts. This decision was motivated by two factors. The decision was made to focus on product description texts because being a more technical type they require more standardised vocabulary than the more creative texts, i.e. film reviews. The second reason was pragmatic – because of the laborious manual data extraction needed to see how the online changes in the lexical selection occurred in real time, the idea of analysing all of the experimental texts was abandoned.[4]

To answer RQ4, all the instances when the participants deleted an already typed or partially typed word were counted and compared for both directions of translation. We had to make decisions when the change was not to be classified as lexical – we excluded grammatically motivated changes (grammatical transformations, morpho-syntactic modifications), stylistic adjustments, typos and unclear single letters typed and deleted which could not be assumed as being potential lexical alternatives. For example, in the following section of the key-logging file, in which black arrows show deleted letters, the word 'a few' was replaced by 'several': [push•a••few◄◄◄◄◄several•times] and was classified as a change in lexical selection. Similarly, a change in lexical selection was counted in the following sentence: [The•process•takes•place••• pracita◄◄◄◄◄◄◄almost•effortlessly] – the translator most likely abandoned the idea to use the word 'practically' and went for 'almost effortlessly'. However, in the following excerpt from the key-logging file: [The•process•requires•practicell◄◄◄ally•no•as◄◄s◄force•], the two letters typed (underlined) could not be counted as a change in lexical selection and were not included in the analysis. Also grammatically motivated transformations were excluded, for example the following excerpt shows a deletion in the key-logging file: [uses•an•in•tegrated•◄◄◄◄◄◄◄◄◄◄◄◄◄◄◄•system•integrated•in•the•na◄◄handle] – the initially planned 'integrated system' was deleted and reformulated as 'system integrated in'. Such changes were not counted.

For RQ5 all the corrections to vocabulary made by the proofreaders in the L1→L2 translations were entered in an excel sheet and aligned with the process data from respective key-logging files. The length of the pause before the translator typed the word which was later corrected by at least one proofreader (and therefore judged as unsuccessful) was measured – if the same word was corrected by both proofreaders, it was counted only once. If the pause was shorter than 5 seconds, the lexical selection was classified as automatic; if the pause was longer than 5 seconds, the lexical selection was classified as non-automatic.

To illustrate how the classification of pauses indicating automatic and non-automatic lexical selection was done, let us look at two examples. In the following sentence, 'Simply place it in a special chamber, release the rod and press several times', the underlined word 'rod' was corrected and replaced by 'lever' by a proofreader. The key-logging record shows how the sentence was

[4] Noting online changes required the use of the replay function in Translog and watching video recordings from the eye-tracker (EyeLink 1000 Plus) and the screen capture software (Morae) when confirmation was needed.

typed: [Simply•place•it•in•a•special•chamber,•••release•the••••**handle**•and• press•several•times[•20.296][▼][▲][▼][▲]•rod••[▼][▲]•••••]. The word 'rod' (underlined) was in fact the translator's second choice – first the word 'handle' (in bold) was selected very quickly/automatically (4 dots before it was typed show that it took 4 seconds – one dot is one second). The word 'rod' was chosen after over 20 seconds (time in square brackets) and therefore the lexical selection was classified as effortful/non-automatic. In another sentence, 'Its robust design withstands up to 150 kg,…' the word 'withstands' was corrected by a proofreader and replaced by 'can take'. The key-logging record: [It•◄s•robust•design••••withstands•••up•to•150•kg] shows that the unsuccessful choice of the word was fairly fast – 4 seconds and therefore classified as automatic.

The significance of the results for RQ4 and RQ5 was established with the Wilcoxon matched-pairs signed-rank test.

5. Results

5.1. Translators have lower verbal fluency in their L2 than in their L1

The results obtained on the verbal fluency tasks in the participants' L1 and L2 showed no statistically significant main effect of language (F (1, 24) = 2.48, p = 0.128, η^2 = 0.09), and a significant main effect of the cue (F (1, 24) = 16.50, p < 0.001, η^2 = 0.41), namely the significant differences in performance (the number of words) appeared only on the VF task cued by category. Additionally, a statistically significant interaction effect was observed between the cue and language (F (1, 24) = 12.40, p = 0.002, η^2 = 0.34), as shown in Figure 1. In response to three category cues the participants generated more words in their L1 (M = 43.80, sd = 10.44) than in their L2 (M = 38.76, sd = 7.42) and the difference was statistically significant (t = 3.06, df = 24, p = 0.005). For total user keyboard events per minute (TUE/min), the main effect of language turned out to be statistically significant (F(1, 24) = 30.38, p < 0.001, η^2 = 0.56), and the main effect of the cue not significant (F(1, 24) = 0.26, p = 0.618, η^2 = 0.01). Also, the interaction effect between the cue and language was found to be significant (F(1, 24) = 24.79, p < 0.001, η^2 = 0.51). The words cued by category were typed significantly faster in terms of total user keyboard events per minute (t = 6.60, df = 24, p < 0.001) in L1 (M = 152.96, sd = 25.74) than in L2 (M = 120.52, sd = 18.07). Following Shao et al. (2014, p. 2), it can be concluded that the translators who participated in this study have larger vocabularies in L1 and are faster in accessing L1 words than L2 words – better verbal fluency.

Yet, in the letter fluency task (three letter cues) they produced almost an equal number of words in both languages (M = 48.28, sd = 12.29 for L1 and M = 49.36, sd = 12.12 for L2; t = -0.77, df = 24, p = 0.446) and there was no statistically significant difference in the speed with which the words were typed (M = 142.92, sd = 32.36 for L1 and M = 136.50, sd = 28.59 for L2; t = 1.69, df = 24, p = 0.104). This confirms that being professional translators, they have very high executive control ability (Shao et al., 2014, p. 2), which they use to switch efficiently between languages in the process of translation but, as confirmed by the response to the category-cued task, their access to L2 vocabulary might be more effortful and less effective (less acceptable). The results reported in sections 5.2 to 5.5 will test if this is indeed the case.

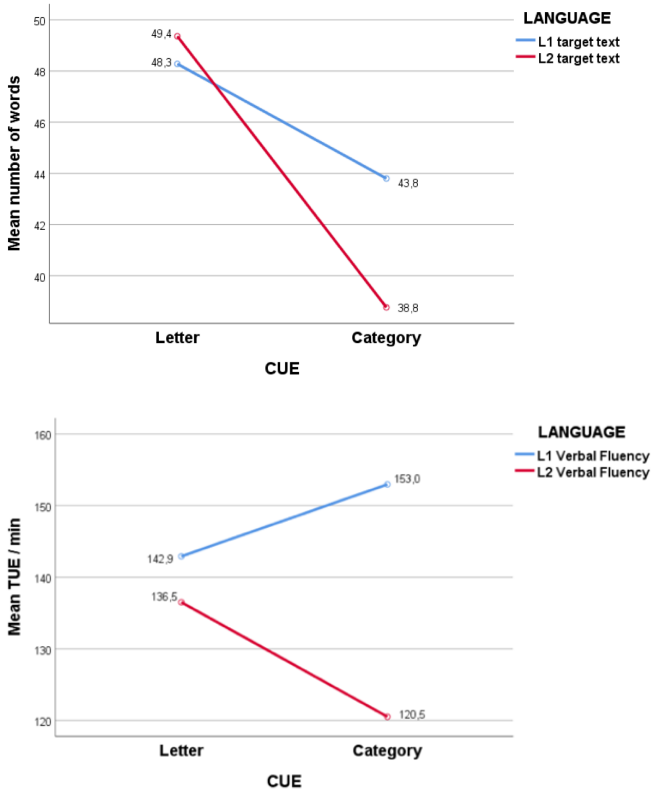

Figure 1. The mean number of words and mean number of total user keyboard events per minute (TUE/min) in verbal fluency tasks performed in translators' L1 and L2 in response to letter cues and category cues

5.2. Less acceptable lexical selection in L1→L2 translation of product description texts

Figure 2 shows that out of all the penalty points granted for misused vocabulary by the four proofreaders (two for each direction of translation), more penalty points were given to the lexical choices the translators made when translating into L2 (English) than into L1 (Polish).

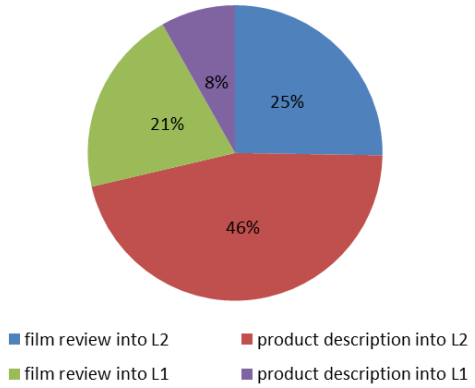

Figure 2. Proportion of the sum of penalty points from both proofreaders for corrections to vocabulary per text

The linear mixed-effects model (LMM) showed that directionality did not have a statistically significant effect on the number of penalty points scored for

unacceptable vocabulary items, but the effect of the text type proved to be significant. More vocabulary items were corrected in the product description texts ($M = 3.06$) than in the film reviews ($M = 2.58$), with $b = 2.35$, $SE = 0.40$, $t = 5.89$, $p < 0.001$. The interaction effect of translation direction and text type reached statistical significance ($b = -3.73$, SE = 0.56, $t = -6.62$, $p < 0.001$). See Table 1.

Table 1. Inferential statistics (LMM) for the effect of translation direction and text type on the acceptability of lexical selection

Fixed effects					
Effect	*b*	*SE*	*df*	*t*	*p*
Intercept	2.85	0.62	2.71	4.56	0.025
Direction	-0.54	0.86	2.50	-0.62	0.586
Text Type	2.35	0.40	177	5.89	< 0.001
Direction* Text Type	-3.73	0.56	177	-6.62	< 0.001
Random effects					
Effect		*Variance*	*SE*	*Z*	*p*
Intercept [Participant]		0.40	0.27	1.52	0.129
Intercept [Proofreader]		0.59	0.67	0.88	0.378
Residual		4.13	0.44	9.41	< 0.001

Post-hoc tests (Bonferroni correction) showed that vocabulary needed to be corrected significantly more often in the product description texts ($p < 0.05$) in L1→L2 ($M = 5.19$) than in L2→L1 translations of the same text type ($M = 0.92$). There were significantly fewer ($p < 0.001$) vocabulary errors in the L1→L2 translations of the film reviews ($M = 2.85$) than of the product description texts in the same direction ($M = 5.19$). But when translating the film reviews, the participants' lexical choices were corrected significantly more often ($p < 0.01$) in L2→L1 ($M = 2.31$) than in the product description texts in the same direction ($M = 0.92$).

5.3. More external support needed in L1→L2 translation

The LMM analysis presented in Table 2 showed that translators turned for support to online resources significantly more ($b = -5.54$, $SE = 1.29$, $t = -4.30$, $p < 0.001$) when translating into their L2 ($M = 11.75$) than into their L1 ($M = 8.71$). Additionally, the effect of text type reached statistical significance ($b = -3.58$, SE = 1.29, $t = -2.78$, $p < 0.01$) – the participants typed a significantly higher number of words in the Internet browser when translating the product description texts ($M = 10.77$) than the film reviews ($M = 9.69$).

Table 2. Inferential statistics (LMM) for the effect of translation direction and text type on the number of entries in the Internet browser

Fixed effects					
Effect	*b*	*SE*	*df*	*t*	*p*
Intercept	13.54	1.29	59.55	10.51	< 0.001
Direction	-5.54	1.29	78	-4.30	< 0.001
Text Type	-3.58	1.29	78	-2.78	0.007
Direction* Text Type	5.00	1.82	78	2.74	0.008
Random effects					
Effect		*Variance*	*SE*	*Z*	*p*
Intercept [Participant]		21.51	7.51	2.86	0.004
Residual		21.61	3.46	6.25	< 0.001

There was also a significant interaction effect of directionality and text type pointing to the more frequent inability to select words when translating into L2 without the help of dictionaries and other online resources (for more details on information searching see Whyatt et al., 2021, pp. 162-163).

5.4. More online changes in L2→L1 translation direction

RQ 4 asked whether the translators change their mind when selecting a word more often when translating into their L1 or L2. The results show that when drafting the target text, the participants made significantly more changes in L2→L1 translations than in the L1→L2 direction. Figure 3 shows the differences in the number of online changes to initially selected vocabulary for each participant.

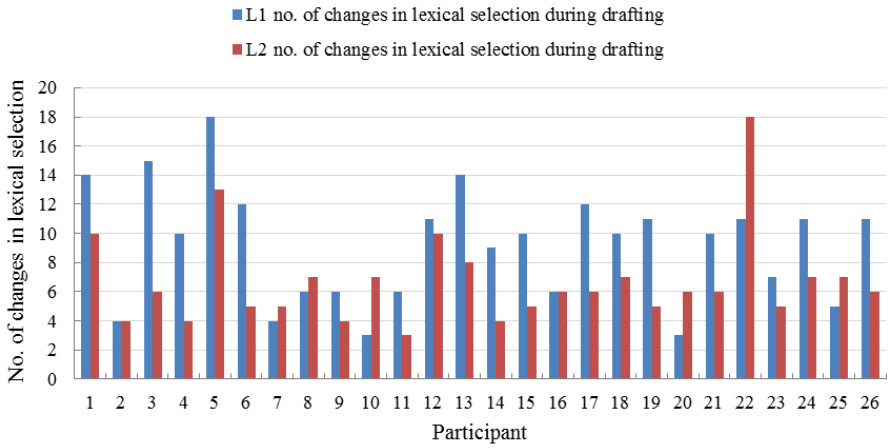

Figure 3. Number of changes in lexical choices during drafting in the L2→L1 (L1) and L1→L2 (L2) translation for the 26 participants

Despite the individual differences between the participants' tendencies to make changes when selecting words, the Wilcoxon matched-pairs signed-rank test showed that significantly more changes were made in the L2→L1 direction ($Z = -2.84$, $p < 0.01$; $Me_{L2→L1} = 10$, $Me_{L1→L2} = 6$). During end revision, however, the participants did not differ significantly in terms of the number of changes introduced when they worked in the L1→L2 direction vs. the L2→L1 direction ($Z = -0.133$, $p = 0.894$; $Me_{L1→L2} = 1$, $Me_{L2→L1} = 1$).

5.5. The majority of unsuccessful lexical choices in L1→L2 are automatic

In raw numbers, 223 words selected by the translators in the L1→L2 direction were corrected by the proofreaders and replaced with what was in their estimation a more suitable word. Out of the 223 unsuccessful lexical choices as many as 148 were classified as automatic and 75 as non-automatic. Figure 4 shows that the majority of unsuccessful lexical choices when translating into L2 were made fairly quickly (in less than 5 seconds).

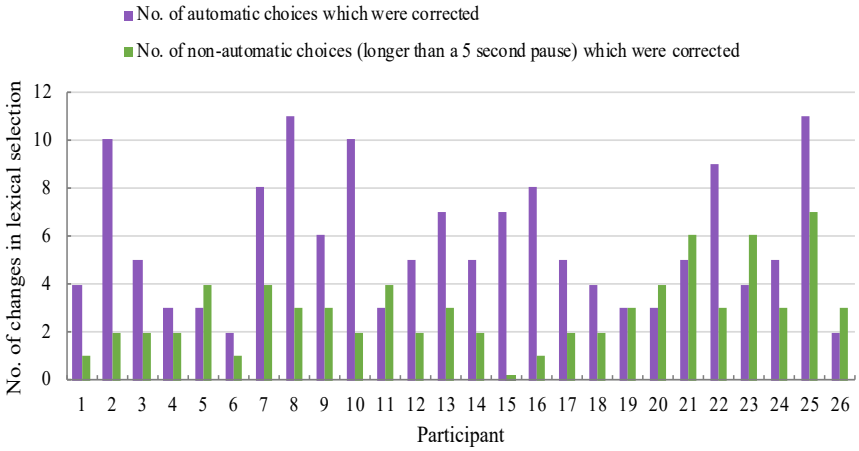

Figure 4. Number of automatic and non-automatic choices of vocabulary in the L1→L2 translations which led to unsuccessful solutions for the 26 participants

The Wilcoxon matched-pairs signed-rank test (Z = -3.61, $p < 0.001$; $Me_{automatic} = 5$, $Me_{non\text{-}automatic} = 3$) showed that significantly more corrections were made by the proofreaders to words which were selected by the translators fairly quickly (in less than 5 seconds) than to words for which they took more time to select. The results point to the need to exercise more caution when selecting vocabulary from the translator's weaker language (L2).

6. Discussion

The results obtained in the study reported here can be explained by the present insights from bilingualism research, psycholinguistic and neurolinguistic studies (García, 2013; Kroll & Tokowicz, 2001; Muñoz et al., 2019). What has been referred to as the L2 cognitive disadvantage (more effortful L2 processing) has been confirmed in experimental conditions involving professional bidirectional translators who participated in the EDiT project. Although, as reported in Whyatt (2019), there was no statistically significant effect of directionality on the time taken to translate the experimental texts, a close investigation of lexical selection in verbal fluency and translation tasks shows that L1→L2 translation is the more taxing, i.e. cognitively demanding direction.

Translators, despite their professional expertise, which makes them highly proficient in their working languages, still showed asymmetrical verbal fluency with significantly higher scores in L1 in the VF category-cued tasks than in their L2. Verbal fluency scores are a well-established indicator of the size of the vocabulary and the speed of connections between items in the semantic activation network. The results reported here are in line with the study on bidirectional conference interpreters by Chmiel (2018, p. 36) who concluded that "no evidence was found that interpreting experience alters their bilingual language profile and language dominance and asymmetry".

The evidence presented to answer research questions 2 to 5 shows that the statistically significant difference in verbal fluency in L1 and L2 has a bearing on the manner of lexical selection in the translation process, and, to a certain extent, on the acceptability of the final choices by the proofreaders. However, since more unsuccessful instances of lexical selection occurred in the product description texts translated into L2 than in the film reviews translated into L2, the type of text and its complexity might also play a role (Whyatt, 2019). It should also be mentioned that the vast majority of corrections to vocabulary

were classified as minor mistakes. For example, the word *rod* was replaced by *lever* in the phrase *unlock the rod*, the word *pleasant* was replaced by *enjoyable* in the sentence *cleaning can be a pleasant task*, or the word *structure* was replaced by *construction* in the phrase *durable structure*. All these unsuccessfully selected words were replaced by the proofreaders with words with very similar prototypical meaning but contextually more appropriate than the words selected by the translators. Following Halverson (2017), these examples might be the effect of the *gravitational pull* towards more salient items in the source language and a failure to recognise that they are not equally salient in the target (L2) language. A more detailed qualitative analysis of the unsuccessful lexical choices is worth pursuing as it would help to diagnose the root of the infelicitous decisions made by the participants in the study.

Lower verbal ability in L2 was reflected in more frequent use of external resources when translating into L2, whereas the translators' internal mental lexicon was more often sufficient when selecting words in the L2→L1 translation. However, looking up words in an online dictionary still requires the decision of which word to select and does not guarantee that a solution which is selected will be in fact contextually appropriate.

Although access to L1 vocabulary seems faster, the selection process is not devoid of difficulty – in a way, being spoilt for choice makes making a choice more time consuming. When typing the translations of the product description texts, the translators did change their mind more often when working into their L1 – they erased, either a completely or partially typed word, and replaced it with a word which they, most likely, considered more effective in its meaning making potential. Such online changes to the initially selected words were less frequent when translating into their L2 – most likely because fewer semantic competitors are activated in the weaker language (McNamara, 2005). On the other hand, words selected during drafting, irrespective of the translation direction, were rarely changed at the end revision stage and there was no statistically significant difference between the number of changes made in both directions. This lack of difference at the stage of end revision is different from the results reported by Buchweitz and Alves (2006) and Manchón et al. (2007) who showed that the concern for the appropriateness of lexical choices in L2 resulted in more changes when revising texts in the L2 direction. However, it needs to be remembered that the participants in the two studies were either translation students or L2 writing students. In the study reported here, the participants were experienced professional bidirectional translators who, most likely because of their expertise, rarely change their decisions concerning lexical choices at the end revision stage.

Finally, despite the fact that selecting words when translating into L2 seems more demanding, it is overall less successful, and directionality does matter in this respect (Kroll & Tokowicz, 2001). A more detailed look at the process of selecting words which were judged as unacceptable showed a very revealing observation that in most cases translators made wrong choices without much delay. This might suggest that the lexical decisions were fairly automatic and possibly activated by the semantic priming of entrenched connections which nevertheless did not result in optimum solutions when the target language was the translator's L2 (Langacker, 2008; Halverson, 2017). As put by Muñoz and Rojo (2018, p. 72), "translators need to be aware that words are only partial clues that they must interpret in combination with their own knowledge (culture) and needs, and their assumptions about what the author of the original wants and knows, and what the audiences of both texts also want and know". This approach requires strategic recipient-oriented decision making which will cancel the effect of cross-language priming to prevent undesired solutions (Shreve, 2009). The practical implications of the results reported in this article

might include a set of error-preventing strategies for lexical selection depending on translation direction (Wu & Liao, 2018).

7. Conclusion

The study presented in this article is not without limitations, which include one language pair and selected text types. Still, it seems justifiable to claim that directionality affects lexical selection even in professional bidirectional translators who are used to translating in both directions. Understanding the difficulty and uncertainty behind selecting words when translating into one's weaker language (usually L2) can contribute to raising awareness of the strong impact of language dominance on verbal fluency and its role in translators' decision-making processes. More focus on how translators use their bilingual resources and how the implicit priming mechanisms operate could become a part of translator training programs and lead to outlining effective error-preventing strategies. The findings are also relevant for foreign language didactics – if some aspects of lexical selection are problematic even for experienced bidirectional translators, they might require more attention in the context of foreign language teaching. Another indirect implication of the study presented here is that cooperation between translators and proofreaders is tantamount to ensuring good quality translation irrespective of directionality.

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