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Exploring the Role of L2 Experience-Related Factors in Cross-Language Lexical Priming

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1. Introduction

Research on multilingual lexical organization is coming to a consensus, led by a growing body of studies (e.g., De Groot, Delmaar & Lupker, 2000; Dijkstra, Grainger & Van Heuven, 1999; Kroll & Stewart, 1994; Van Heuven, Schriefers, Dijkstra & Hagoort, 2008), whereby the multilingual lexicon is seen as a unitary system and cross-linguistic competition occurs during lexical access. This increasing agreement on the basic structure of the multilingual lexicon is leading researchers towards a more thorough exploration of the nature of the relationships established between words from different languages.

In order to study cross-linguistic lexical interaction, researchers have commonly employed the masked translation priming paradigm (Forster & Davis, 1984). The aim is to observe whether an unconsciously processed first language (L1) translation equivalent prime facilitates the activation of its target second language (L2) counterpart. Two measures are taken to ensure that prime processing remains unconscious. First, prime presentation is very brief, usually between 40 and 75 ms. Second, a forward mask (e.g. #####), typically presented for 500 ms, is shown before the prime to mask (hide) it. To measure facilitation, response latencies to target words from critical trials (in, for example, a lexical decision task), where the primes are translation equivalents (e.g., *mouse* as a prime of its Spanish translation *ratón*), are compared to response times (RT) in control trials, where the primes are unrelated words (e.g., *arrow*). Significantly shorter average response times for the critical as compared to the control condition indicate a priming effect.

Research on lexical access with cognate words has largely shown cross-linguistic priming effects, suggesting a close association between lexical representations from different languages (e.g., Dijkstra et al., 1999; Lemhöfer, Dijkstra & Michel, 2004). During the past two decades, however, non-cognate status has also been investigated in priming research. This growing interest can be attributed to the fact that non-cognate translation equivalents (e.g., *mouse* and *ratón*), unencumbered by any orthographic or phonological similarities to primed

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targets, still have semantic ties, leading to the assumption that any potential priming effects observed for such words can be ascribed to their convergence at the conceptual level (Xia & Andrews, 2015:295).

The present paper addresses the aforementioned directionality asymmetry in non-native masked translation priming by testing late unbalanced bilinguals with a lexical decision task with non-cognate translation equivalents. As we will see, the results replicate this priming asymmetry, also showing an interaction between prime frequency and resulting priming effects. Moreover, there were no correlational effects between L2 experience related factors and response times as some models would have expected.

2. The Priming Asymmetry

Most of the masked translation priming literature has employed lexical decision tasks (henceforth LDT) (but also semantic categorization tasks, e.g., Grainger & Frenck-Mestre, 1998; Finkbeiner, Forster, Nicol & Nakamura, 2004; Wang & Forster, 2010; Xia and Andrews, 2015). In LDTs, participants judge whether the strings of letters presented on a screen are real words or nonce words. Importantly, when using this task under masked translation priming conditions, the literature recurrently reports a directional priming asymmetry. L1 primes elicit robust priming effects (i.e. responses to L2 targets are faster when they are preceded by related L1 primes than by control, unrelated L1 words). However, in the opposite translation direction (L2 primes-L1 targets), priming effects, if observed at all (see Gollan, Forster & Frost, 1997; Grainger & Frenck-Mestre, 1998, for null effects), are significantly smaller than those elicited by the L1 primes (e.g., Basnight-Brown & Altarriba, 2007; Schoonbaert, Duyck, Brysbaert & Hartsuiker, 2009). Notably, the priming asymmetry has only been observed when testing late, unbalanced bilinguals (e.g., Duñabeitia, Dimitropoulou, Uribe-Etxebarria, Laka & Carreiras, 2010; Duñabeitia, Perea & Carreiras, 2010); when more balanced bilinguals are tested, the asymmetry effect is attenuated, L2 primes being equally able to activate their L1 target counterparts.

3. Models of bilingual lexical processing

We consider three models frequently used in this literature. The Revised Hierarchical Model (RHM; Kroll & Stewart, 1994; Kroll, Van Hell, Tokowizc & Green, 2010) states that words from different languages are separately represented at the lexical level, but share a common access to the conceptual store. Yet, these links to semantic information differ qualitatively for L1 and L2—potentially L3/ L*n*—representations, especially at low levels of proficiency. Well-established lexical-semantic mappings permit L1 representations to have a straightforward access to the concepts, guaranteed by fully-developed L1 lexicons by the time an L2 is (generally) learned. Access to semantic information for L2 representations is not so clear-cut since these have to rely on their L1 translation equivalents to access the relevant concepts (at least until stronger lexical-conceptual links are built in the L2 at more advanced proficiencies).

The RHM has not explicitly addressed the priming asymmetry. However, following Xia and Andrews' (2015) suggestion that priming occurs due to semantic mediation would permit the model to accommodate the asymmetrical effect. Thus, L1-L2 priming is observed because L1 primes can directly activate the shared conceptual nodes, which then stimulate the L2 lexical representations. However, L2-L1 priming is less reliable because L2 primes cannot sufficiently stimulate those conceptual representations.

The main prediction of the RHM is that L2-L1 priming effects would be more robust as the L2 learners' proficiency increases. In other words, as the connections between L2 lexical representations and concepts become more entrenched, there is less need of L1-mediated conceptual retrieval, which would allow L2 primes to semantically activate L1 targets. Although the studies showing no asymmetries in priming effects for simultaneous bilinguals (e.g., Basnight-Brown & Altarriba, 2007; Duñabeitia, Dimitropoulou et al., 2010; Duñabeitia, Perea et al. 2010) are, in principle, proof that the model might be on the right track, the empirical evidence for the role of L2 proficiency in modulating priming effects remains inconclusive (e.g., Dimitropoulou, Duñabeitia, & Carreiras, 2011; Nakayama, Ida, & Lupker, 2016).

The Bilingual Interactive Activation + model (BIA+; Dijkstra & Van Heuven, 1998, 2002) claims that the resting activation levels of the L2 words could explain the difficulty of observing L2-L1 priming effects under the already discussed conditions. The assumption is that, for a word to become recognised, its resting activation level must reach a certain threshold (Jiang, 2015). With L2 words having lower levels of resting activation, which is assumed to be a natural consequence of L1 and L2 amount of use in late bilinguals, L2 representations do not have enough time to be processed and stimulate their L1 target counterparts in masked priming experiments. The BIA+ model, like the RHM, suggests that factors that might act as a proxy for subjective frequency of use, such as L2 proficiency, L2 word frequency, time of immersion, and so on, can potentially alter these resting levels of activation. As discussed above, this would directly affect the likelihood of observing L2-L1 priming effects.

The Sense Model (SM, Finkbeiner et al., 2004) was conceived to give an answer to the priming asymmetry and its task-dependency, whereby the asymmetry is only observed in LDTs, contrary to the comparable priming effects obtained for both translation directions in semantic categorization tasks (SCT) (see Xia & Andrews, 2015, for further discussion). Thus, the model is a bespoke solution that originates from the results found in SCTs[1] and extrapolates to account for the asymmetry in LDTs.

Essentially, the SM claims that a representational asymmetry in the senses (meanings) known for L1 and L2 words causes the divergence in priming effects

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[1] But see Xia and Andrews, 2015, for discussion on why the priming symmetry in SCTs might be task-dependent and not an outcome of tapping into the semantic level.

in LDTs. The many senses known of an L1 prime are able to activate the few senses known of an L2 translation equivalent, but not the other way around. The prediction, thus, is that in LDTs, the higher the ratio of known to unknown senses between L2 primes and L1 targets, the larger the size of L2-L1 priming effects will be.

4. Relevant background literature

L2 proficiency (this factor being the most relevant predictor in two of the theoretical models) has only been directly addressed in two studies, with mixed results: whereas Dimitropoulou et al. (2011) find no significant differences in the response times of three groups that differ in L2 proficiency, Nakayama et al. (2016) conclude that this factor plays a significant role in the emergence of L2-L1 priming effects across proficiency groups.

Word frequency is another factor that might be responsible for the elusiveness of L2-L1 priming. To have a standard measure of what low and high frequency means, we turn to Van Heuven, Mandera, Keuleers and Brysbaert (2014) and their logarithmic Zipf scale. In this scale, word frequencies between 1 and 3 are considered low, whereas those between 4 to 7 are considered high (see Van Heuven et al., 2014, for further discussion). Once the reported prime frequencies of current studies are log transformed, we observe that even in those experiments where frequency was directly addressed, the value remained above what is considered moderate. Only in Lijewska, Ziegler and Olko (2018) did the value remain relatively low (3.6). In this study, the authors found significant L2-L1 priming; however, the participants had two potential advantages over those in previous research: (i) they were same-script language bilinguals (Polish-English), and (ii) the experiment's presentation included a backward mask of 150 ms after the 50 ms prime presentation, thus, the task had a stimulus onset asynchrony (SOA) of 200 ms.

5. The present study

The priming asymmetry was directly addressed by testing 29 L1 Spanish-L2 English late bilinguals (most of them unbalanced) in an L2 dominant environment, who took part in an LDT in both translation directions. The study used low-to-moderate frequency stimuli, as in Lijewska et al. (2018). Crucially, and contrary to their experimental setup, our SOA was of only 60 ms (no backward mask was presented). These are the hypotheses:

1. L1-L2 priming will be observed, as typical in the literature.
2. The use of a short SOA and low-to-moderate frequency words will reduce the likeliness of observing L2-L1 priming effects if the BIA+ model is on the right track.
3. Following the predictions of the RHM and the BIA+ model, we expect a correlation between L2 proficiency and L2-L1 priming effects, such that they will be larger for the more proficient subjects.

Moreover, following the BIA+ model's predictions, we investigated understudied factors that could relate to the subjective frequency of use of an L2 (time of immersion, language dominance, and the age of acquisition of the L2).

6. Method
6.1. Participants

Twenty-nine L1 Spanish late L2 English learners were recruited from the Spanish speaking community in York and Leeds (United Kingdom), see Table 1.

Table 1. Participants' characteristics (mean values and standard deviation).

Age	29 (4.5)
Self-reported English proficiency	5.6 (0.5)
Oxford Quick Placement Test's scores	50 (5.1)
Language Dominance	12 (6.6)
Age of acquisition	9 (2.9)
Years living in the UK	3 (2.64)

All participants took the Oxford Quick Placement Test (OQPT; Oxford University Press, University of Cambridge, & Association of Language Testers in Europe, 2001). The test consists of 60 multiple choice questions and examines English grammar and vocabulary knowledge. The participants' mean score was 50 (*SD* = 5.08), corresponding to a lower-advanced proficiency. However, the group was not entirely homogenous with regard to L2 proficiency: eight participants scored within the upper-advanced proficiency range, 11 lower-advanced, and 10 upper-intermediate. This permitted treating the factor as a continuous variable in the analysis. They started learning English at an average age of 9 (*SD* = 2.9), although seven participants reported having started before the age of 7, which has been argued to be a cut-off point for qualitative differences in how non-native languages are acquired (see chapters in Granena & Long, 2013 for discussion and Rothman, 2008 for counter argumentation). Again, this factor was controlled in the data analysis. At the time of the experiment, the participants had studied English for an average of 12 years (*SD* = 2.9) and had been living in the UK for the last 3 years on average (*SD* = 2.64).

A version of the Dominance Scale questionnaire (Dunn & Tree, 2009) was employed to assess the bilinguals' language use and dominance. The scale ranges from -25 to 25 where scores above 5 reflect L1 dominance, whereas those below -5 would reflect an L2 privilege. Although the main goal of this study was to test unbalanced bilinguals, seven of our subjects scored below 5, making them, in theory, unable to be considered dominant in Spanish. However, they were kept in the study in order to test the relevance of this factor.

6.1.2. Materials

Sixty-four pairs of Spanish-English non-cognate translation equivalents were used in the experiment (see Table 2 for sample stimuli and Table 3 for the characteristics of the stimuli). The Spanish words had a mean frequency of 3.7 (*SD* = 0.47) on the Zipf scale, whereas the frequency of the English pairs was 3.9 (*SD* = 0.38). The word frequencies for the Spanish stimuli were extracted from SUBTLEX-ESP (Cuetos, Glez-Nosti, Barbón & Brysbaert, 2011), and those for the English words from SUBTLEX-UK (Van Heuven et al., 2014). Only concrete nouns were used in order to avoid the concreteness effect (e.g., Finkbeiner et al., 2004; Schoonbaert et al., 2009), whereby abstract words lag in response time compared to concrete words.

Table 2. Sample stimuli.

L1-L2			
Translation prime	**Control prime**	**Word target**	**Nonword target**
bosque 'forest'	*leche* ‘milk’	FOREST	SMOUNT
L2-L1			
Translation prime	**Control prime**	**Word target**	**Nonword target**
corn	pencil	*MAÍZ* ‘corn’	VATO

Table 3. Stimuli’s characteristics.

	Spanish	**English**
Frequency	3.6 (0.5)	3.9 (0.4)
Length	5.9 (1.3)	5.4 (1.2)

To elicit “no” responses in the task, 64 nonce words were created in both languages. Spanish ones were created by replacing one letter from real words while respecting the phonotactics of the language. The English nonce words were created using the ARC Nonword Database (Rastle, Harrington & Coltheart, 2002), all of them phonologically and orthographically plausible in English.

In critical trials, the targets were preceded by a translation equivalent prime (as opposed to semantically unrelated primes in baseline or control trials). The primes for nonce words were matched in length with the translation equivalent primes, but their mean frequency was slightly higher: 4.1 (*SD* = 0.45). We opted for using the translation equivalents both as related primes in one list and as control primes in the other. This less-straightforward approach was chosen because finding Spanish-English translation equivalents that had approximately the same length and frequency, are non-cognates, and are known by the participants significantly reduces the pool of available words, and is likely to compromise comparability across the set with regard to other stimuli characteristics. Four stimulus lists (two in each language) of 64 word and 64 nonce word targets were generated. In one of the lists, half of the target words were preceded by their translation equivalents and the other half by control primes. In the other list, the order was inverted, so that across both lists all words were preceded by their translation equivalents and control primes. Each list began with sixteen practice items.

6.1.3. English word translation task

To ensure that the responses to the English items were not arbitrary, the participants completed a task involving a translation of these words into Spanish. Only those answers that were identical to the translation pairs in the stimuli were considered correct. Items with less than a 50% rate of correct answers were excluded from the analysis. In total, five pairs were removed. For the remaining items, the correct answer was given 88% of the time. Admittedly, a 50% rate of correct responses is a low cut-off; however, most of the time, the (incorrect) responses were synonyms of the expected translations. Moreover, some participants stated that they were incapable of recalling the required translation during the completion of the task. We assumed that their inability of remembering the word on that specific moment does not necessarily entail a lack of sensitivity to those English primes during the experimental task.

6.1.4 Procedure

The experiment was programmed using PsychoPy v1.8 software (Peirce, 2007). Each trial began with a 500 ms forward mask (#####), followed by a 60 ms prime (in lowercase letters), which was immediately followed by an uppercase target that remained on screen until the participant's response. The stimuli were presented on a white screen in 44 point black Arial font. The subjects were asked to judge whether the targets were real words or not by pressing a YES or NO button as quickly and as accurately as possible. Subjects were not informed about the presence of the primes, and they were asked about their awareness of them during the post-experimental debriefing.

6.2. Results

Correct responses to experimental trials with latencies above 1500 ms were replaced by this cut-off value (1.1% of the data). Nine data points were excluded due to glitches in the presentation. Table 4 provides a summary of error rates, mean response times, and priming effects (calculated as the difference between mean RTs to control and critical trials) for correct responses to word targets.

Table 4. Mean RTs (ms), error rates (%), and priming effects in the LDT.

	Related		Unrelated		
	RT	**Error Rate**	**RT**	**Error Rate**	**Priming**
L1 to L2	711	3.6	749	5.7	38*
L2 to L1	731	1.9	748	3	17

Note: * = $p < 0.05$

The RTs of the correct responses were log-transformed to normalize their distribution prior to data analysis, which was conducted employing linear mixed effects models (Baayen, 2008; Baayen, Davidson & Bates, 2008) in R (version 3.3.1) (R Core Team, 2016) with the lme4 package (Bates, Maechler, Bolker & Walker, 2015).

The following factors were considered as potential predictors of response time: Prime Type, Target Language, Prime Length, Prime Frequency, Target Length, Target Frequency, (L2) Proficiency, Time (duration) of Immersion (ToI), Age of Acquisition (AoA), Language Dominance, and Order (i.e. trial number). Awareness of the prime was included as a post-hoc factor, because, unexpectedly given the prime duration, 11 participants reported having seen some characters prior to target onset in at least one trial. Notably, this only happened when the primes were in Spanish, and no subject saw more than two (most of them reporting only one observation). We decided to keep these participants so the effect of awareness of the prime could be explored during data analysis. We carried out independent analyses for each translation direction.

6.2.1. Spanish to English (L1-L2)

A likelihood ratio test was performed to select the model of best fit (as described in Cunnings, 2012, and Link & Cunnings, 2015), which for this direction contained Prime Type, Target Frequency and (trial) Order as fixed effects, as well as random intercepts for Subject and Item and a by-item random slope for Prime Type. Effects with absolute t-values above 2 (or below -2) were considered significant ($p < .05$) (see Baayen, 2008; Gelman & Hill, 2007).

With regard to the accuracy results, Awareness (of the prime) ($\beta < -0.01$, $SE < 0.01$, $t = -2.23$) and AoA ($\beta < -0.01$, $SE < 0.01$, $t = 2.03$) came out as significant predictors. The significant effect of AoA reflected that those participants who started learning English at an older age were significantly less accurate on their responses. The significant effect of Awareness indicated that those subjects who reported seeing some of the primes were significantly more accurate on their responses.

As for RTs, Prime Type ($\beta = -0.02$, $SE < 0.01$, $t = -5.1$), Target Frequency ($\beta = -0.04$, $SE = 0.01$, $t = - 3.01$), and Order ($\beta < 0.01$, $SE < 0.01$, $t = -6.31$), were revealed as significant predictors. The effect of Prime Type reflected overall faster response latencies for targets preceded by L2 Spanish translation equivalents as compared to those preceded by control primes (i.e., a masked translation priming effect).

6.2.2. English to Spanish (L2-L1)

In the analysis of the accuracy results, only Order ($\beta < 0.01$, $SE < 0.001$, $t = 2.16$) came out as a significant predictor, indicating that the participants' accuracy decreased as the number of trials increased.

The analysis of the RTs revealed that the model of best fit had Order and the interactions of Prime Type with Prime and Target Frequency as fixed effects, and random intercepts for Subject and Item.

A significant interaction between Prime Type and Prime Frequency (β = - 0.06, *SE* = 0.02, *t* = - 3.01) (see Figure 4) revealed that related English primes with higher frequencies yielded faster responses, whereas, for the control primes, the response times barely varied. Consequently, priming effects were observed with more frequent primes, while, for those of lower frequencies, the priming effect was negative. Note from Figure 4 that the priming effect with the most frequent primes was of approximately 70 ms, which is numerically larger than the (significant) effect observed in the L1-L2 direction.

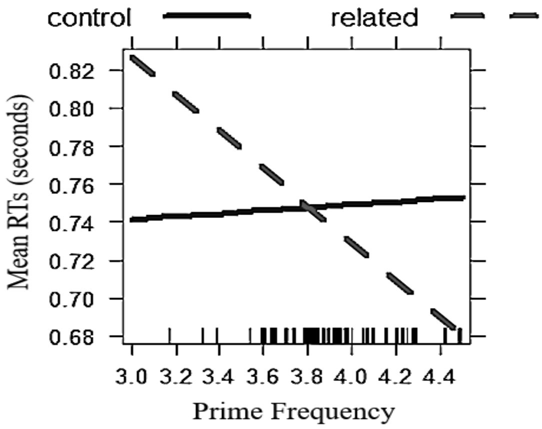

Figure 4. Prime Type and Prime Frequency interaction.

Prime Type and Target Frequency also interacted significantly (β = 0.05, *SE* = 0.01, *t* = 4.42) indicating that, for control primes, larger target frequencies yielded faster RTs. By contrast, high-frequency related targets elicited slower RTs. This meant that priming effects were observed for lower frequencies, whereas, for those targets with higher frequencies, the priming effect was negative.

Importantly, no predictor related to the participants' English background came out as significant in any translation direction. Moreover, sporadic awareness of the prime—where applicable—had no noticeable effects on the results of the RT analyses.

6.2.3 Joint analysis

A comparison of priming effects between translation directions revealed a significant interaction between Prime Type and Target Language (β = 0.03, *SE* = 0.01, *t* = 4.01). The participants responded faster to related primes than to control primes overall, and this effect was larger in the L1-L2 direction (Figure 5). This interaction constitutes direct evidence of a priming asymmetry.

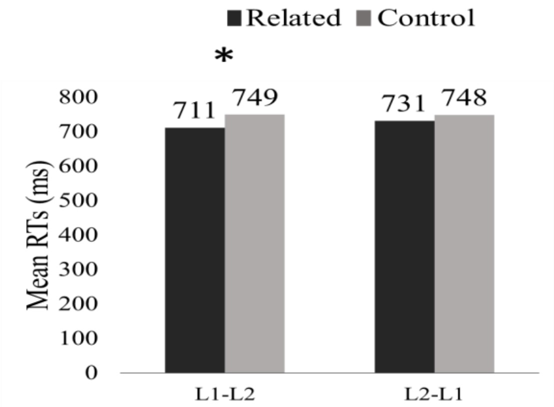

Figure 5. Mean RTs for related and control primes in both translation directions.

At this point, it is reasonable to ask whether the observed asymmetry was due to a (significant) difference in the size of the priming effects in both translation directions or, given the lack of Prime Type effects for the English primes, the asymmetry is explained by a complete absence of L2-L1 priming. Crucially, the presence of the significant interactions in the L2-L1 dataset sheds some light on this question. Especially in the case of Prime Frequency and its interaction with Prime Type, the results suggest that L2-L1 priming is, in fact, obtainable yet modulated by prime frequency.

Furthermore, the aforementioned interactions point to an interpretation of the priming asymmetry as a matter of quantitative differences in the way L1 and L2 words are processed. As the BIA+ model proposes, priming should be obtained in both translation directions when similar resting activation levels for L1 and L2 words are expected. Given those conditions, which might be attained when exposure to and use of an L2 are considerably frequent—and comparable to those expected in an L1—, the priming asymmetry should vanish.

7. Discussion

The present study aimed to investigate the asymmetry found in masked translation priming LDTs, whereby L1-L2 priming effects are typically significantly larger than those in the L2-L1 direction. The study tested Spanish-English later, unbalanced bilinguals living in an L2-dominant environment. The results show a priming asymmetry, but, crucially, in the L2-L1 direction, the priming effects are modulated by Prime and Target Frequency. The interaction between Prime Type and Prime Frequency reveal that the more frequent L2 primes effectively activate their L1 target counterparts. The Prime Type and

Target Frequency interaction, on the other hand, reflect that priming effects were larger when the Spanish targets are less frequent. At the moment, we do not have an explanation for this finding and we are cautious in interpreting it, thus, until we have more data to explore tentative thinking we will not discuss it further.

Unexpectedly—recall that the RHM and (to some extent) the BIA+ model predicted that L2 proficiency would be a significant modulator of L2-L1 priming effects—, despite examining participants with a relatively broad range in their English proficiency, this factor was not significant: L2-L1 priming was not larger for the more proficient subjects. This result adds to the scarce literature on the specific role of this predictor on masked translation priming effects (see also Dimitropoulou et al., 2011; Nakayama et al., 2016).

Importantly for the BIA+ model's predictions, in this study, we controlled for other factors that might be considered a proxy to assess subjective frequency of L2 use (i.e., time of immersion and language dominance) yet they did not significantly influence response times. However, caution should be exercised in interpreting these results, since a reliable method to measure the—certainly complex—idiosyncrasies of what is meant by language use/dominance is yet to be established (see Silva-Corvalán & Treffers-Daller, 2015). For instance seven participants in our study were considered balanced bilinguals according to the criteria set by the Bilingual Dominance Scale; however, the English proficiency of five of them was below upper-advanced. Which criteria is then more reflective of how active a language is in someone's brain? In light of such simple evidence, it does not seem unreasonable to think that the answers to the empirical questions we researchers make can—more often than desired—be misguided if we rely on measures that do not reveal what we really aim to capture. Thus, it might very well be the case that our seemingly irreconcilable results — on theoretical grounds— of a significant interaction between Prime Type and Prime Frequency together with the lack of effects of L2 proficiency and language dominance might only signal an inefficiency in the way the latter factors were quantified.

8. Theoretical implications

In this study, we aimed to test the predictions of three theoretical models, namely the RHM, the BIA+ model and the SM. Under the assumption that priming occurs due to semantic activation, the RHM predicted that a higher L2 proficiency would strengthen the connections between the L2 lexical representations and the conceptual store, allowing for the observation of L2-L1 priming. However, our results contradicted this prediction: L2 proficiency was not a significant predictor for priming effects in any translation direction.

The asymmetry observed in our results was, in principle, expected under the SM's argumentation; however, the model does not provide a means to understand the significant effect of Prime Frequency for the English primes. Such an outcome demands a processing-based explanation, instead of one that relies solely on semantics.

Finally, our data can be easily accommodated by the BIA+ model, under which the asymmetry is accounted for by non-sufficient time for the (slower) processing of the L2 primes to take place under masked translation priming conditions. The effect found for frequency nicely matches this explanation, as those L2 primes with higher frequencies would have higher resting activation levels. This would speed up processing, allowing them to reach a threshold of activation even under extremely short presentations. Those primes would then be able to sufficiently stimulate their translation equivalent targets, a boost that would then be reflected in shorter response times in critical trials as compared to control ones. It should be noted, however, that the null effects of L2 experience-related factors (AoA, proficiency, ToI) do not sit well with the predictions of the BIA+ model, which should expect the overall resting activation levels of L2 words to increase as a function of these measures.

9. Conclusion

The present study explored the (masked) translation priming asymmetry. The results of testing unbalanced Spanish-English bilinguals living in an L2-dominant environment in an LDT suggested that the priming asymmetry might disappear when highly proficient bilinguals and high-frequency primes are employed. In light of these findings, the priming asymmetry might be understood as a matter of quantitative differences in the way L1 and L2 words are processed, rather than as a fundamental (qualitative) difference between native and non-native lexical processing. In this respect, the BIA+ model would best be able to accommodate these results, with prime frequency as a key factor in the raising of the resting activation levels of L2 words, at least for those bilinguals living in an L2 environment.

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