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Exploring Learning Context Effects and Grapho(-Phonic)-Phonological Priming in Trilinguals

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Abstract: A growing body of research on bilingual word recognition suggests that lexical access is language non-selective in nature. This claim aligns with the Dynamic Systems Theory (DST) approach to (multilingual) language acquisition, according to which complex systems involve a large number of elements that interact. In language learners, these interactions lead to the creation and dissolution of patterns as the tasks and environments around them change. In this study, we extend the scope from previous research on word recognition to include the role immersion plays on the transfer of grapho(-phonic)-phonological patterns among (Brazilian Portuguese–French–English) trilinguals. Two groups of participants—one group living in their L1 environment and the other in an L2 setting—were presented with a primed lexical decision task. Besides revealing a high impact of L2 immersion on the processing of grapho(-phonic)-phonological related primes, our results provide further support for the notion of language non-selective access to the lexicon, which seems to generalize to trilingual word recognition. Implications for the DST view of multiple language acquisition are briefly discussed.

Keywords: grapho(-phonic)-phonological priming; multilingualism; non-selective lexical access; immersion

1. Introduction

Priming can be described as the activation, by means of a stimulus, (of parts) of a given representation or association in memory just before an ensuing action or task is carried out. In the context of language use, priming has been defined as “the phenomenon in which prior exposure to language somehow influences subsequent language processing, which may occur in the form of recognition or production” (McDonough and Trofimovich 2008, p. 1).

Different types of stimuli (primes), such as words, images, or sounds, can be employed in any given priming task in order to trigger an effect on the participants’ processing of the same or a related stimulus (target). The logic behind such a task is that the target will be more readily accessible (and thus participants will respond faster) if it shares some characteristics with the prime (Busnello 2007; Dijkstra et al. 2000; Tokowicz 2000). In the literature, the facilitative effect that a prime can have on a related target is referred to as “positive priming” (Stadler and Hogan 1996). Positive priming commonly occurs in studies on lexical access in which participants are asked to decide whether a target is a word or not when the prime and the target share similar orthographic, phonetic/phonological, and/or semantic traits. However, primes can also lead to a slowing in performance, that is, to “negative

priming". This can occur, for example, when participants are instructed to ignore the prime and focus on the target. Ignored primes are inhibited, causing targets that share similarities with them to be harder to access, compared to those that are rather different from their primes (Stadler and Hogan 1996).

Psycholinguistic and Second Language (L2) Acquisition (SLA) research on lexical access often employ priming as a tool to explore how words are interconnected and processed. According to Van Wijnendale and Brysbaert (2002), until 1990, the general view, which is known as selective lexical access, was that bilinguals had separate lexicons—one per language they spoke—and that each lexicon was activated separately. However, more recently, support for this view appears to be dwindling, as a growing number of studies provide evidence that bilinguals keep both languages simultaneously activated (De Groot et al. 2000; Dijkstra et al. 2000; among others) and cannot suppress access to one of them, even when performing a task that would require them to do so (Van Wijnendale and Brysbaert 2002). In the case of trilinguals, this accumulating evidence comes mainly from studies on visual word recognition (Lemhöfer et al. 2004; Szubko-Sitarek 2011; Van Hell and Dijkstra 2002) and it suggests that, rather than being independent, the lexicons of each known language interact and may be activated in parallel. Therefore, bi/multilingual lexical access would be language non-selective.¹ Bearing this in mind, in the present paper, we argue that the study of lexical access should be undertaken from a dynamic approach, as will be explained, all the more so when dealing with multilinguals.

In the two following sections, we address multilingualism from a Dynamic Systems Theory (DST) standpoint, within which we then evaluate a selection of studies investigating priming effects on (grapho-phonico-phonological) processing in trilinguals.

2. A Dynamic Systems Approach to Multilingual Acquisition

The main premise underlying the dynamic systems perspective on multilingual acquisition is that language and the cognitive system are interconnected systems and as such, they process patterns in an interrelated and indissociable manner (Elman 1995). In this view, language learning derives from the observation of linguistic regularities in the input to which learners are exposed. They need to select whatever aspects of language are relevant, establish new connections, and strengthen existing ones. The higher the exposure to input, the stronger those connections will become. In alignment with this, Elman (1995) suggested that language is to be understood as a non-representational, malleable system that is highly influenced by the environment.

Despite being initially developed as a branch in mathematics and physics, DST is a far-reaching theoretical paradigm whose applications extend to a wide range of disciplines. According to De Bot et al. (2007, 2012), the number of studies that apply DST to SLA is scarce², and more traditional paradigms tend to adhere to a rather linear view, i.e., they see language acquisition as “essentially modular and incremental and assume stable representations as building blocks” (De Bot et al. 2012, p. 188). Moreover, L2 learners are often “predicted to go through highly similar stages in acquiring the L2” (De Bot et al. 2007, p. 7). In contrast, dynamic systems have been roughly defined as sets of changing states that vary as a function of time and space according to a given rule, which itself evolves in time and space (Van Gelder and Port 1995). Within these sets, some state spaces are favored and, according to Kelso (1995), constitute a subset space within the possible states a system can occupy, and toward which that system evolves over time. These subsets, called attractors, are by definition temporary, non-fixed, and not necessarily predictable (De Bot et al. 2007). Let us consider an

¹ We elaborate on this assumption and explain how findings from studies on word recognition support the language non-selective view of bilingual lexical access in Section 3. A more detailed discussion of (non-)selectivity can also be found in Pu et al. (2019).

² Regarding the application of DST to language acquisition, two works are especially worth of mention here. The first one is the article by Larsen-Freeman (1997), due to its pioneering status. The second one is the book by Herdina and Jessner (2002), in which the authors provide researchers with a model—the Dynamic Model of Multilingualism—that goes beyond bilingualism in an effort to allow for predictions about the development of multilingual systems. For overviews of DST within the field of SLA, the reader is referred to De Bot et al. (2007, 2012).

example of how, in the field of linguistics, phonetic/phonological knowledge can act as an attractor. Albano (2012) explained that the trajectories specified for /e/ and /i/ and their variations can be defined by the degree of constriction of the vocal tract. Accordingly, and despite some potential overlap or dispersion, the degree of openness required for the production of /e/ is larger than that for /i/. Therefore, Albano argued that the targets for /e/ and /i/ need to be understood as natural attractors with regard to the state spaces specified for these vowels' dimension(s) of openness.

Zimmer and Alves (2012) also view language as a dynamic system under the influence of attractors. They claim that at the onset of L2 learning, the L1's dynamic system is equipped with attractors typical of that language, which exert an influence on the L2 system. The attractors typical of the L2 are clearly biased toward the L1 articulatory state spaces, which results in a noticeable accent. As L2 proficiency increases, L2 speakers' production is expected to become more attuned to the L2 system, especially if they have been immersed in an L2 context. In such cases, their L1 speech production is expected to start evolving toward the L2 gestural constellation.

Given that the acquisition of any linguistic pattern in the L1, L2, or L_n (L3 or beyond) for that matter, evolves and changes over time, as dynamic systems do, it is reasonable to generally describe linguistic systems as complex and dynamic. They too can be affected by many factors that play a decisive role in the development of an interlanguage. In fact, the various structures that form each linguistic sub-system (whether phonetic, phonological, semantic, morphological, syntactic, etc.) are interdependent, and a change in any one of them can lead to changes in the others. According to Larsen-Freeman (1997), among the factors that can influence the development of an L2, we find: the source language, the target language, the amount and type of L2 input/L2 interaction/feedback received, the learning context, the learner's age, motivation, cognitive style, etc. These authors suggest that "no one of these by itself is a determining factor, the interaction of them, however, has a very profound effect" (Larsen-Freeman 1997, p. 151).

3. Grapho(-Phonic)-Phonological Priming and Multilingualism

As stated earlier, a significant body of bilingual research supports the language non-selective view, namely that, when exposed to words from one of their languages, bilinguals co-activate word candidates from both of their languages. Studies aiming to explore the nature of bi/multilingual lexical access have mainly employed two types of stimuli: cognates (i.e., words that share the same or similar meaning and spelling, and are often pronounced similarly across languages, such as the word *animal*, a triple cognate in English, French, and Portuguese; see studies by Barcelos 2016; Lemhöfer et al. 2004; Szubko-Sitarek 2011, among others) and interlingual homographs (i.e., words with identical form but different meanings across languages, such as the word *late*, which means to be behind schedule in English and can also be the third person singular of the verb to bark in the present tense in Portuguese; see studies by De Groot et al. 2000; Dijkstra et al. 1999; Tokowicz 2000, among others). The rationale behind this is that if bi/multilingual lexical access operates non-selectively, upon seeing these types of items, readings in the different languages would become activated. In contrast, words that exist exclusively in one of the languages (or single-language words) would activate their readings in that language only. Accordingly, cognates and interlingual homographs should trigger different response times than single-language words when bi/multilinguals are faced with a lexical decision task, for example. Whereas investigations involving cognates have consistently shown facilitative effects (i.e., faster responses), results from studies employing interlingual homographs are more varied. Similar to cognates, interlingual homographs have at times been recognized faster than single-language words (see experiment 3 in Dijkstra et al. 1998). Nonetheless, other studies have failed to reveal any statistically significant differences in response times relative to one-language controls (see experiment 1 in Dijkstra et al. 1998, as well as experiment 1 in De Groot et al. 2000), or have even found inhibitory effects (i.e., slower responses; see experiment 2 in Dijkstra et al. 1998). The differences in processing between these two types of items are discussed in more detail in the following paragraphs.

According to Van Hell and Dijkstra (2002), the facilitative effect is particularly salient in the case of cognates. Fontes et al. (2010) added that when cognates have an identical lexical form (such as *piano* in English, French, and Portuguese) it is possible that they also share a single lexical representation across languages. If, in addition, their meanings coincide, the facilitative effect could be enhanced, given that the convergence of form and meaning should prevent the triggering of any conflicts in terms of processing. Lemhöfer et al. (2004) used cognates as a tool to investigate whether their L1-Dutch/L2-English/L3-German trilingual participants co-activated all three languages during a lexical decision task in their L3. The task included three different types of stimuli depending on whether German words shared cognates (1) with none of the other two languages (control words), (2) only with Dutch (double cognates), or (3) with both Dutch and English (triple cognates). Participants recognized triplets faster than doublets, and doublets faster than control words, whereas a group of German monolinguals reacted equally to all stimuli types. Their finding was replicated by Szubko-Sitarek (2011) when she tested a group of L1-Polish/L2-English/L3-German speakers using a very similar task. In a less obvious manner, Barcelos (2016) claimed to have found partial support for the facilitative cognate effect in a study conducted with 26 L1-Brazilian Portuguese/L2-English/L3-French speakers. They completed a lexical decision task that consisted of deciding whether a given string of letters was a French word or not. They were presented with: (1) double cognates (in either the L1 and the L3 or in the L2 and the L3), (2) triple cognates (in the L1, L2, and L3), (3) French control words, and (4) pseudowords that appeared to be French. Against the author's prediction, reaction times (RTs) for cognates were not significantly lower than they were for control words. Moreover, unlike Lemhöfer et al. (2004), Barcelos did not find an enhancing effect for triple cognates. Nonetheless, cognates were recognized more accurately than control words. The percentage of accurate responses (i.e., the accurate identification of a letter string as being a French word) turned out to be significantly higher for cognates than for non-cognates, which was interpreted by the author as partial evidence in favor of the non-selective language view. Barcelos believed that the lack of significantly faster RTs for cognates could be explained by factors such as the proficiency in French not being high enough to cause an effect (see Van Hell and Dijkstra 2002) or low exposure to French.

Going beyond cognates, Dijkstra et al. (1999) investigated bilingual word recognition by manipulating form and meaning overlap to different extents. Their results revealed that, due to a lack of semantic congruence and despite a high overlap in form, homographs cause an inhibitory rather than facilitative effect on lexical access. In De Groot et al.'s (2000) opinion, there is a model that can account for such inhibition: the Interactive Activation Model (IAM) by McClelland and Rumelhart (1981), according to which lexical recognition results from the competition among form-similar words. Additional evidence for the inhibitory effects of interlingual homographs comes from Tokowicz (2000). Her participants took longer to translate words with different meanings than words that overlapped semantically. It seems likely that the translation performance was slowed down due to multiple meanings being activated and competing during task completion. Despite this evidence, a lot of ambiguity remains regarding interlingual homographs (recall the conflicting results reported by De Groot et al. 2000; Dijkstra et al. 1998). In Dijkstra et al.'s (2000) opinion, the presence of facilitative or inhibitory effects caused by homographs while completing primed lexical decision tasks depends largely on the type of task and its specific demands, such as the frequency of the items presented or the instructions given to informants, among other factors.

Besides cognates and homographs, other types of lexical stimuli such as interlingual and intralingual neighbors, or words "differing by a single letter from the target" (Dijkstra 2005, p. 187), can be used to create priming tasks. Similarly to the inhibitory effects described for homographs, Bijeljac-Babic et al. (1997) found that the more proficient their participants were in their L2 (English), the greater the inhibition they experienced during target recognition. Only for their highly proficient bilinguals, L1 French words (such as "AMONT") triggered slower RTs when preceded by L2 English neighbors (such as "AMONG") than when preceded by L2 English unrelated primes (such as "DRIVE"). This type of item seems to be less commonly used in studies on multilingual lexical activation to

date. Some exceptions are the studies by Blank and Zimmer (2008) and Duarte (2018). In order to investigate the activation of interlingual neighbors during a read-aloud task, Blank and Zimmer (2008) conducted a case study with a native speaker of Brazilian Portuguese who was more proficient in his L2 French than in his L3 English. With the aim of assessing how his grapho(-phonic)-phonological knowledge in French affected his reading time in English, the authors used a task previously employed by Jared and Kroll (2001). It contained 20 French filler words and 60 English words, some of which displayed either word bodies that could not occur in French (as in BUMP) or word bodies that are pronounced differently in French (as in BAIT versus LAIT). It was found that, when read after French words, English words with French-like word bodies were strongly impacted by French grapho(-phonic)-phonological knowledge. Moreover, the opposite was also true: RTs increased when reading French words with English-like word bodies after having read English words. Conversely, RTs were not significantly higher for dissimilar words, which further attests to the interfering effect of a mismatch in meaning for words with similar forms. In a study related to ours, Duarte (2018)³ explored how grapho(-phonic)-phonological similarities across L1, L2, and L3 words affected responses in a lexical decision task performed by L1-Brazilian Portuguese/L2-English/L3-French speakers living in Brazil. The 18 participants were presented with prime and target dyads that either shared part of their word bodies (i.e., were grapho(-phonic)-phonologically related) in two of the learners' languages or not (i.e., were grapho(-phonic)-phonologically unrelated). Overall, words in the related condition triggered significantly longer RTs than those in the unrelated condition.

Results from cognate studies on the one hand, and those from research on interlingual homographs and (phonological) neighbors on the other, seem to go in opposite directions. More precisely, cognates seem to speed up multilingual lexical access, whereas homographs and neighbors appear to delay it. Therefore, a shared meaning seems to be a decisive criterion for a facilitative effect on lexical access to occur. Nevertheless, what they have in common is that experiments involving these types of items show that they are processed differently (whether faster or slower) than single-language control words. Taken together, the results are consistent with the notion that it is hard to suppress the activation of one language, even when this leads to a disadvantage.

4. This Study

The main aim of this study was to explore the role of immersion on how grapho(-phonic)-phonological patterns may get transferred in trilinguals. To that end, we compared two groups of participants: one living in an L1 context, and the other immersed in an L2 setting where authentic exposure to the L3 is also common. It is predicted that a higher level of exposure to, and a more frequent use of, the two non-native languages in natural contexts will lead to stronger and more activated L2/L3 attractors, hindering lexical access in tasks involving interlingual neighbors (Dijkstra et al. 2000, McClelland and Rumelhardt 1981; MacWhinney 2002; Zimmer and Alves 2012).

4.1. Methodology

4.1.1. Participants

The participants in this study were 20 adult native speakers of Brazilian Portuguese (BP), with an advanced knowledge of French (FR) as an L2, and intermediate proficiency in English (EN), their L3. According to the context of use of their non-native languages, they were assigned to one of two groups. While participants in Group 1 ($n = 10$; mean age = 35; seven females and three males) lived in Pelotas, Brazil, and used their L2/L3 merely in academic contexts, those in Group 2 ($n = 10$; mean age = 31.1; six females

³ This study employs an adapted, slightly shorter version of the instrument we describe in Section 4.1.2, where the reader can find examples of the stimuli used. It also follows the same procedure and has been conducted with participants that are comparable to our Group 1 (see Section 4.1.1), except that they differ in which of the non-native languages, French and English, is the L2 and which the L3.

and four males) had lived in Montreal, Canada, for a minimum of two years (the range of time spent in Montreal was from two to four years; mean: 2.8), where they spoke both the L2 and the L3 in immersion.

In order to assess their L2/L3 proficiency, participants were administered two standardized proficiency tests: DALF (*Diplôme approfondi de langue française* – Diploma in Advanced French Language) C1 for French and the TOEIC (Test of English for International Communication) Listening and Reading Test for English. DALF test takers are examined for reading, writing, listening, and speaking, and are expected to score 50 out of 100 to obtain a passing mark. Due to time restrictions, our participants only completed the reading and listening sections. To be considered for participation, they had to score 70 points or higher. TOEIC test takers are assigned to different proficiency levels depending on their score (from 10 to 990 points). For example, a score between 405 and 780 corresponds to Elementary Proficiency (405–600) and Elementary Proficiency Plus (605–780). All of our participants in Brazil and five of our participants in Canada fell within the Elementary Proficiency range, whereas the rest of the Canadian group attained the Elementary Proficiency Plus level.

Candidates were excluded if they did not meet all of the following criteria: they (i) were native speakers of BP, (ii) right-handed, (iii) spoke French at an advanced level (i.e., obtained a score of 70 points or higher), (iv) English at an intermediate level (i.e., obtained a score between 405 and 780 points), and (v) had no knowledge of additional languages. Out of the 28 candidates that made it to the testing phase, two participants in Montreal and six participants in Pelotas were not included in the final groups due to proficiency issues. All the participants gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the Universidade Católica de Pelotas (Project 2011/75).

As part of their testing session, participants completed a language background questionnaire, which allowed for the collection of biographical data and information on their language acquisition history and current use. Among other questions, they were asked to provide an estimated percentage of daily use of their three languages across a variety of activities and contexts. A detailed summary can be found in Table 1. Unsurprisingly, participants in Group 1 used BP over 85% of the time across the board, whereas French was the most commonly used language for Group 2.

Table 1. Frequency of use per language and group. BP: Brazilian Portuguese, FR: French, EN: English.

Context	Group	Language		
		L1 (BP)	L2 (FR)	L3 (EN)
Home	1 (Br) ¹	93%	5%	2%
	2 (Cn) ²	26%	42%	32%
Interaction with relatives	1 (Br)	89%	8%	3%
	2 (Cn)	75%	23%	2%
Work/university	1 (Br)	94%	4%	2%
	2 (Cn)	10%	65%	25%
Interaction with friends	1 (Br)	89%	8%	3%
	2 (Cn)	27%	56%	17%
Holidays	1 (Br)	88%	10%	2%
	2 (Cn)	35%	39%	26%
Social/other events	1 (Br)	87%	11%	2%
	2 (Cn)	15%	60%	25%

¹ Br = participants living in Brazil; ² Cn = participants living in Canada (please note that this also applies to Tables 3–5).

4.1.2. Instruments

For this experiment, a grapho(-phonic)-phonological primed task was designed. It contained 108 word pairs: in 54 of them, primes and targets were orthographically, phonetically, and phonologically related, while the other 54 consisted of completely unrelated prime–target dyads. They were further

subdivided into nine language pairings, which resulted in 18 different combinations, as shown in Table 2. Each sub-condition involved six word pairs: three sets of monosyllabic words and three sets of disyllabic words. All of them were high-frequency words, as per the corpora from which they were taken (*Ceten-Folha* for Portuguese, *Lexique* for French, and Brown for English). All the words used are provided in Appendix A.

Table 2. Summary of language pairings and conditions devised for the grapho(-phonic)-phonologically primed task.

Language Pairings	Conditions			
	Related Priming		Unrelated Priming	
	Example	# of Items	Example	# of Items
bp-BP	seu-CEU	6	arte-ILHA	6
en-EN	two-TOO	6	lake-DRESS	6
fr-FR	barque-BARBE	6	cas-FEU	6
bp-EN	meu-MAIL	6	por-SUN	6
en-BP	soul-SOL	6	gun-VEZ	6
bp-FR	santo-SANTÉ	6	renda-CADEAU	6
fr-BP	depuis-DESPOIS	6	façon-PROVA	6
fr-EN	avoir-AVOID	6	soir-FAKE	6
en-FR	lack-LAC	6	desk-POCHE	6
TOTAL		54		54

4.1.3. Procedure and Data Analysis

A laptop running E-prime software was used for stimuli presentation and data collection. For each trial, participants were presented with a prime and a target, and asked to determine which language the target belonged to by pressing the assigned computer key. Primes were presented in lower case letters for 250 ms, followed by a blank screen for 250 ms, and then the screen displayed the target, in capital letters, which remained on the screen until a response was provided.

Participants were instructed to ignore the prime and focus on the target. To ensure they understood the procedure, they completed a six-item practice round before the actual test. They needed to score 100% in the practice round for the actual task to start. This task allowed for the collection of latencies and accuracy of recognition for all the items tested. During coding, practice items and trials with an incorrect response, accounting for 12% of the data, were removed. The mean and standard deviation (SD) were calculated for all the correct answers within each condition. For the comparison of performance across groups, final data was submitted to a non-parametric statistical test, Mann–Whitney, and *p* was set at 0.05.

5. Results

A first comparison of interest is between conditions involving related versus unrelated primes and targets. Although the contrast is larger for Group 2, which is the group living in Canada, (unrelated priming: 1393.43 ms, related priming: 1722.32 ms) than for Group 1, which is the group living in Brazil, (unrelated priming: 1145.37, related priming: 1215.74), both differences turned out to be significant ($Z = -6.391, p < 0.001$ in the case of Group 2, and $Z = -2.961, p < 0.005$ in the case of Group 1). A summary of these within-group comparisons is presented in Table 3.

Table 3. Results from the comparison of reaction times (RTs) regarding the processing of grapho(-phonic)-phonologically related and unrelated primed items by both groups.

Groups	Conditions	Mean	SD	Z	p
1 (Br)	Unrelated priming	1145.37	474.93	-2.961	0.003 *
	Related priming	1215.74	485.28		
2 (Cn)	Unrelated priming	1393.43	981.25	6.391	0.000 *
	Related priming	1722.32	1107.76		

Asterisks (*) indicate statistical significance. This also applies to Tables 4 and 5.

Of special importance for this study was whether the disparity in RTs between groups would also be significant. As per the groups' mean RTs provided in Table 3, trilinguals who used their L2 and L3 merely in academic contexts took an average of 507 ms less than trilinguals in an immersion setting to process related lexical items (primed; see grey-shaded cells in Table 3). A Mann–Whitney test returned a significant difference ($Z = -8.756, p < 0.001$) between groups regarding time, as reported in Table 4⁴.

Table 4. Results for the comparison of RTs regarding the processing of grapho(-phonic)-phonologically related primed items by both groups.

Groups	Mean	SD	Z	p
1 (Br)	1215.74	485.28	−8.756	0.000 *
2 (Cn)	1722.32	1107.76		

These values are also reported in Table 3 (grey-shaded cells). Asterisks (*) indicate statistical significance.

To further assess the potential effect of immersion on our data, we ran a Mann–Whitney test comparing the performance between both groups in the different primed combinations across all the language pairings detailed in Table 2. We start by reporting results from within-language comparisons.

5.1. Within-Language Comparisons

The RTs elicited via the primed single-language combinations resulted in substantially longer means for the trilinguals in L2/L3 immersion than for those trilinguals who live in Brazil. It was the French–French primed combination that elicited the largest difference in means and standard deviations between both groups: 1863 ms (SD = 1087 ms) in the case of the group immersed in a French environment and 1193 ms (SD = 391 ms) in the case of group that uses French merely in an academic context. This difference turned out to be significant ($Z = -4.181, p < 0.01$). Likewise, with regard to the Portuguese–Portuguese related prime–target dyads, the trilinguals in L2/L3 immersion were significantly slower (mean: 1455 ms, SD = 729 ms) than trilinguals in their L1 environment (mean = 1132, SD = 374 ms), as revealed by the Mann–Whitney test ($Z = -2.553, p = 0.011$). The descriptive statistics along with the statistical significance as determined by the Mann–Whitney test for these and all other comparisons to follow are provided in Table 5, at the end of this section.

Our last within-language comparison focuses on English targets and their related English primes. The higher RT mean and standard deviation were associated with the trilinguals in Canada (mean = 1518 ms, SD = 1071 ms), whereas the trilinguals in Brazil were on average almost 200 ms faster (mean = 1313 ms, SD = 503 ms). However, this time, the Mann–Whitney test failed to uncover a significant difference ($Z = -703, p = \text{n.s.}$). As we will argue in the Discussion section, proficiency could provide a plausible explanation as to why, out of the three within-language combinations, only the English–English one did not yield a significant difference between groups.

5.2. Between-Language Comparisons

We now turn to the between-language comparisons. Regarding the primed Portuguese–French language pairing, the participants who use their L2 in academic contexts (mean = 1308 ms, SD = 703 ms) clearly outperformed and were more consistent than their counterparts in Canada (mean = 2186 ms, SD = 1591 ms), as evidenced by a much lower RT mean and a tighter standard deviation. Unsurprisingly, the difference between the two groups was found to be significant ($Z = -3.417, p = 0.01$). The French–Portuguese condition yielded a mean RT that was about 600 ms higher for the trilinguals in Canada (mean = 1738 ms, SD = 1024 ms) than for those in Brazil (mean = 1129 ms, SD = 377 ms),

⁴ Please note that this comparison has been reported elsewhere (Blank and Llama 2016). The main contribution of this article lies in the data and analysis reported in Table 5 (Section 5.2), and the additional discussion they entail (Sections 5.1 and 5.2).

which was a difference that was also significant ($Z = -4.152, p < 0.01$). It seems to be the case that when testing the two languages in which participants are more proficient, the languages' order of presentation does not matter. That is, both French and Portuguese caused a significant increase in RTs for the group in immersion, regardless of whether these languages were the language of the prime or of the target.

As for the primed Portuguese–English condition, the mean RT for the trilinguals in immersion was 1400 ms ($SD = 755$ ms), versus 1230 ms ($SD = 585$ ms) for the trilinguals who use English in an academic context. Although the trilinguals in Canada took longer to complete the decision task, the difference between the groups failed to reach significance ($Z = -1.128, p = n.s.$). For the English–Portuguese combination, the trilingual group in immersion produced the highest RT mean, 1588 ms ($SD = 1167$ ms), and the group in Brazil produced the lowest: 1088 ms ($SD = 312$ ms). The Mann–Whitney test revealed a significant difference for this comparison ($Z = -3.181, p = 0.001$), in contrast with the previous combination, where Portuguese was the prime and English was the target (and no significant difference was found). This could indicate that the order of language presentation can be crucial when a strong language is paired with a weak language.

When considering the combination of the two non-native languages, more precisely the French–English condition, we observe a mean RT of 1827 ms ($SD = 857$ ms) for our trilinguals in immersion and of 1307 ms ($SD = 537$ ms) for those in Brazil. The difference between both groups was once again significant ($Z = -4.015, p < 0.01$). We now focus on the primed English–French combination. As has been the trend so far, the trilinguals in Canada produced a higher RT mean (1920 ms, $SD = 1251$ ms) than did their counterparts in Brazil (mean: 1238 ms, $SD = 418$ ms), and the difference was significant ($Z = -3.139, p = 0.002$). It appears that for combinations involving two non-native languages, there is a significant effect of the pre-activation of one over the other. This seems true regardless of whether the prime is in the strongest language or not.

Table 5. Results for the comparison of combinations containing related primes.

Language Pairings (with Priming)	Groups	Mean (SD)	Z	p
BP–BP	1 (Br)	1132 (374)	−2.553	0.011 *
	2 (Cn)	1455 (729)		
FR–FR	1 (Br)	1193 (391)	−4.181	0.000 *
	2 (Cn)	1863 (1087)		
EN–EN	1 (Br)	1313 (503)	−0.703	0.482
	2 (Cn)	1518 (1071)		
BP–FR	1 (Br)	1308 (703)	−3.417	0.001 *
	2 (Cn)	2186 (1591)		
BP–EN	1 (Br)	1230 (585)	−1.128	0.259
	2 (Cn)	1400 (755)		
FR–BP	1 (Br)	1129 (377)	−4.152	0.000 *
	2 (Cn)	1738 (1024)		
FR–EN	1 (Br)	1307 (537)	−4.015	0.000 *
	2 (Cn)	1827 (857)		
EN–BP	1 (Br)	1088 (312)	−3.181	0.001 *
	2 (Cn)	1588 (1167)		
EN–FR	1 (Br)	1238 (418)	−3.139	0.002 *
	2 (Cn)	1920 (1251)		

Asterisks (*) indicate statistical significance.

6. Discussion

The present study sought to explore how immersion in an L2, and to a lesser extent in an L3, context may impact the transfer of grapho(-phonic)-phonological patterns across the L1, L2, and L3. Recall from the earlier discussion that speakers who use their L2 and L3 immersed in non-native contexts are expected to experience a delay during the processing of interlingual neighbors due to a more balanced competition for activation among all the known languages.

Zimmer and Alves (2012), with the view of dynamic attractors at play during L2 acquisition, predict that proficient L2 speakers who have used their L2 in immersion have incorporated into their L2 system the attractors that are typical of this language. By virtue of more frequent exposure to one's non-native languages, their prediction was extended to our study's trilinguals in a trilingual context in the following manner: attractors from more than two languages may exert balanced forces, which requires an increase in effort (higher RTs) for the grapho(-phonic)-phonological patterns of the intended language to be finally chosen. The results reported in Table 4, where we compare mean RTs regarding the processing of grapho(-phonic)-phonologically primed items by both groups, indicate that expectation was met. Moreover, the substantial delay observed may suggest that a lack of complete overlap between form, meaning, and phonetic/phonological activation, even within a single linguistic system, becomes more burdensome for those multilinguals who actually use more than one language on a daily basis.

Our data seem to have brought to light some trends in the processing of related prime-target dyads by these two groups of trilinguals. Although, in all nine combinations we tested, the trilinguals in L2/L3 immersion consistently obtained the highest RT means and standard deviations, only seven of those differences were significant, while in two cases, the difference between both groups failed to reach significance. Those two cases were the English–English (a within-language dyad) and the Portuguese–English (a between-language dyad) combinations. Interestingly, both cases involve English, which was the least proficient language for all the participants.

Regarding within-language comparisons, French and BP were the strongest languages for both groups, whereas English was the weakest and least used language for all the participants alike. It may be the case that a certain level of proficiency needs to be attained for a given language to experience lexical competition among its own items. In other words, participants' lower level of proficiency in English could have minimized competition between English primes and English targets. Perhaps this could be interpreted as the representations in English not being as strong and well established as those in the two dominant languages, if viewed from a DS approach.

Moreover, and regarding between-language comparisons, it seems that the level of English proficiency was not high enough for this L3 to compete with the L1 when the prime was presented in Portuguese and the target in English. Nonetheless, it is surprising to see that English primes seemed to hinder access to Portuguese targets. In fact, Van Hell and Dijkstra (2002) stated that "a certain level of weaker language proficiency is required before any weaker language effects become noticeable in L1 processing" (p. 787). Therefore, it was counterintuitive and somewhat unexpected to see the weakest language interfere on access to the strongest one rather than the other way around. Of note, a previous study by Aparicio and Lavaur (2014) on the effects of language dominance during word recognition in trilinguals has shown that it is more costly to switch to the L3 from the L1, and to a lesser extent from the L2, than to switch to the L1 from the L2/L3. However, it has to be acknowledged that they used a different task, their stimuli differed from ours in that their primes, and targets did not overlap orthographically. More importantly, all of their participants lived in an L1 setting, rather than being immersed. Admittedly, the differences between Aparicio and Lavaur's study and this investigation render any comparison of their results to ours inadequate at best. In our particular case, our findings could indicate that pre-activation in a non-native language could have a stronger impact on the processing of a target in the L1 rather than the opposite scenario, at least in an immersion situation. Although Portuguese is, without a doubt, the strongest language for all participants, those

trilinguals who live in Canada make limited use of it. Infrequent or reduced language use could help explain this result.

The coupling of an advanced level of L2 proficiency with immersion, as is the case of French for Group 2, may result in the reinforcement of French activation patterns. This seems to have further hindered the lexical decision process for the participants living in Canada. It would seem that immersion in an L2 setting could intensify competition between lexical forms displaying some level of mismatch between their written form and their phonetic/phonological activation in the two strongest languages.

Results from the French–English and English–French combinations suggest that the strongest non-native language in the prime position can cause the transfer of its more activated patterns to the weakest non-native language. Moreover, in the immersion context, the activation of French could be enhanced, thus further hindering the activation of the grapho(-phonic)-phonological correspondence with English. It has to be highlighted that although they live in a bilingual city, our Brazilian participants in Montreal need not be as immersed in English as they are in French. This became evident on their self reports of English use, which are summarized in Table 1. Additionally, we observe that being immersed in an L2/L3 context does slow down one’s performance in the two non-native languages.

7. Conclusions

Our results both contribute to the literature on priming and provide further support for the notion that lexical access is non-selective in bi/multilingual⁵ speakers, as we are about to argue. Many studies on lexical priming focus on cognates, and thus on words that display total or partial overlap between their written form, phonetic–phonological activation, and meaning. As discussed earlier, a common finding is that cognates facilitate access to the target (leading to faster response) when the task requires participants to identify whether the target is a word or not. In such cases, non-selective language activation is expected for bilinguals and multilinguals alike. However, the experimental task at hand had an added difficulty: participants were asked to identify the language in which the target word was written. In this case, negative priming (i.e., slower response) was expected instead, because cross-linguistic similarities could interfere with the recognition of a word as belonging to a particular language.

That is why our results complement those from cognate studies, since our work taps into lexical access from a different angle. Moreover, we argue that this change in perspective justifies our finding of negative priming without undermining the support to the non-selective lexical access hypothesis. Let us recall that we consider parallel access to all the languages of the trilingual (mostly triggered by the frequency of exposure to the languages involved) to be responsible for the slowing in performance (Aparicio and Lavaur 2014). This parallel access allows for one language to exert an influence on another and for the attractors created for each of the languages to compete.

According to MacWhinney (2002), who also supports the idea of parallel access to all the languages of a multilingual, it is the linguistic cues found in the input that guide the learning of a new language. These cues, which interact among themselves, can at times promote and at other times hinder the understanding of how the new system works. The multilinguals immersed in an L2/L3 context encounter in their input linguistic cues from more than one language simultaneously. This appears to cause the simultaneous activation of grapho(-phonic)-phonological patterns from several languages, and therefore greater competition between the known letter-sound associations.

⁵ For some potential counter evidence to the co-activation of multiple languages in multilinguals, the reader is referred to Tytus (2018). After conducting a study with L1-German/L2-English/L3-French speakers who were asked to complete a picture-naming task (in their L1) and a Stroop interference task, the author concluded that “the simultaneous co-activation of multiple languages may be task specific” (p. 15), since findings from the picture-naming task involving triple and double cognates as well as control words did not seem to lend support to lexical non-selectivity.

What best seems to account for our immersed participants' difficulties when trying to make a decision on lexical items that displayed graphemic and phonetic/phonological similarities is the dynamic perspective together with the non-selective lexical access hypothesis. As per Van Gelder and Port's (1995) description, dynamic systems are understood as systems whose states change over time. In this respect, the differences between our groups regarding these priming data reveal clear changes in the linguistic system of our trilinguals in Canada, which point to a higher degree of interconnection between the known languages. In addition, within a dynamic system, we find that some states are preferred over others (Van Gelder and Port 1995). Therefore, it is to be expected that the preferred, or more stable, grapho(-phonic)-phonological patterns become more activated than dispreferred or less stable ones. This would explain why the trilingual group in Canada experienced more influence across languages, as evidenced by participants taking longer than their counterparts to process the items that followed related primes. Given our findings, we argue that certain contexts of exposure favor the development of stronger attractors. A more authentic and frequent L2 and L3 input in immersion led to stronger L2 and L3 attractors, and to a more balanced competition among the three languages in the case of our trilinguals in Group 2.

In sum, it appears that using one's languages in an immersion context is a factor that causes negative priming in the type of combinations we have analyzed; it is a factor that hinders or slows down the access to the targets we presented. It is worth noting that although the comparison between groups regarding two combinations failed to reach significance, we still observed higher RT means for Group 2 than for Group 1. In a larger sample, it is possible that such differences become significant, which warrants further investigation. For now, and to the best of our knowledge, this paper's main contribution is its comparison of lexical processing by a group of trilinguals who have learnt and use their non-native languages in a formal (academic) environment to a group of trilinguals who use their two non-native languages in an immersion context.

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Appendix A

Full list of stimuli per language and condition

English

Related priming condition: again, against, any, arrest, avoid, basic, basis, come, county, fairly, farther, father, fine, home, hour, lack, lady, loose, mail, many, market, mass, mess, mouse, our, party, permit, ready, right, so, soul, the, too, travel, two, write. Mean log frequency: 2.36 (SD: 0.74).

Unrelated priming condition: ago, apple, baby, ball, bank, baseball, beach, building, chair, cold, corner, cousin, desk, doctor, dress, fake, fashion, garden, gold, gun, hair, head, housing, key, kitchen, lake, less, letter, machine, money, office, paper, rain, river, stone, sun. Mean log frequency: 2.08 (SD: 0.31).

French

Related priming condition: arrêt, avoir, barbe, barque, bas, bateau, brume, brune, casser, chevaux, cheveux, comme, corps, depuis, enfant, enfin, homme, lac, lait, manie, marre, mes, messe, mousse, outil, parmi, partie, pourtant, santé, sein, sens, thé, travail, vent, verre, vin. Mean log frequency: 2.99 (SD: 0.61).

Unrelated priming condition: abbé, bague, bain, beaucoup, bête, bistrot, boîte, cadeau, cas, chaise, château, chemise, coeur, danse, doigt, éclat, façon, famille, feu, genoux, gens, geste, glace, hiver, honte, lunette, miroir, paquet, poche, poitrine, rêve, soir, soirée, tout, visage, voiture. Mean log frequency: 2.91 (SD: 0.73).

Portuguese

Related priming condition: ano, bar, batom, cara, caro, casa, casar, caso, cem, céu, conta, cor, depois, feira, fim, lei, leite, luz, mão, mar, marca, mas, mau, meu, meus, ponte, ponto, portanto, rede, santo, sei, seu, sol, som, útil, ver. Mean log frequency: 3.85 (SD: 0.62).

Unrelated priming condition: amor, ar, arte, bala, bom, campo, cartaz, choque, dar, dez, dor, faca, filme, gás, ilha, já, lar, líder, lista, mãe, não, ovo, pai, país, pão, paz, pé, por, prova, rei, renda, suco, texto, venda, vez, voz. Mean log frequency: 3.24 (SD: 0.89).

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