Of *revistas* and *magacínes*

Lexical competition in the online processing of established loanwords

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The transfer of words from one language to another is ubiquitous in many of the world's languages. While loanwords have a rich literature in the fields of historical linguistics, language contact, and sociolinguistics, little work has been done examining how loanwords are processed by bilinguals with knowledge of both the source and recipient languages. The present study uses pupillometry to compare the online processing of established loanwords in Puerto Rican Spanish to native Spanish words by highly proficient Puerto Rican Spanish-English bilinguals. Established loanwords elicited a significantly larger pupillary response than native Spanish words, with the pupillary response modulated by both the frequency of the loanword itself and of the native Spanish counterpart. These findings suggest that established loanwords are processed differently than native Spanish words and compete with their native equivalents, potentially due to both intra- and inter-lingual effects of saliency.

Keywords: bilingualism, borrowing, loanwords, online processing, pupillometry

1. Introduction

A potential result of the close contact between people from different countries is the exchange and transfer of ideas, customs, traditions, and – the focus of the present paper – words. The transfer of words from the source language (the language from which the words are borrowed) to the recipient language (the language into which the words are borrowed) is ubiquitous in many of the world's languages. In the English language alone, borrowings or loanwords (as they are typically referred to) abound from languages such as Latin, French, German, Greek,

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Arabic, and American Indian languages, to name a few. What makes loanwords unique is that, thanks to decades or even centuries of integration and adaptation into the recipient language, their source language origins are masked, forgotten, or even unknown to child acquirers of the recipient language. In the field of linguistics, the study of loanwords has shed light on the rich and complex histories of languages in contact and have inspired a substantial literature on the process by which they become established in the recipient language. The study of loanwords has also overlapped considerably with the study of bilingualism, sparking a decades-long debate on the nature of the interface between language contact, borrowing, and language mixing (or codeswitching). While sociolinguistic and corpus-based studies addressing this debate are numerous, there is a distinct lack of psycholinguistic work examining how loanwords behave during online processing vis-à-vis other words in the bilingual lexicon. The present study seeks to fill this gap in the literature by comparing the processing of established loanwords borrowed from English into Puerto Rican Spanish to that of etymologically native[1] Spanish words that are not of English origin. We further investigate how the individual's experience with and knowledge of both the source and recipient languages modulates the online processing of established loanwords.

1.1 How do loanwords arise?

The process of integrating words from one language into another is tied part-and-parcel to both the sociocultural and linguistic processes by which words are integrated into the recipient language (Haspelmath, 2009: 36–42). With respect to the former, scholars have divided loanwords into two broad categories based on how they enter the recipient language: cultural and core borrowings. Cultural borrowings are loanwords which enter the language along with a novel concept that accompanies the contact situation (e.g., *piñata*, of Spanish origin, and *smorgasbord*, of Scandinavian origin; Myers-Scotton, 2002, 2006). Core borrowings are loanwords of the same meaning that come to be used alongside or in place of existing words in the recipient language, often adopted because of its prestige versus the native counterpart (e.g., *pork*, of French Saxon origin, alongside *pig*, of Germanic origin; Thomason & Kaufman, 1988; Myers-Scotton, 2006; Haspelmath, 2009: 48–49). In other words, as languages and cultures come into contact, there is an inevitable transfer of ideas, customs, cuisine, knowledge, and

1. In this paper, we use 'native' to refer to words that have been established in Puerto Rican Spanish but are not of English origin; ultimately, these words may not be traceable to the earliest stages of the language, but importantly they are *not* loanwords in the recent history of Puerto Rican Spanish.

power that begets the adoption of new terms for both familiar and unfamiliar items alike. Indeed, this is why, cross-linguistically, loanwords tend to be nouns (van Hout & Muysken, 1994); that is, they often come already attached to the borrowed referent that is new to both the language and the culture (see also Backus, 2012: 3). Adoption is facilitated when the source language (and usually, culture) is seen as more prestigious than the recipient language; inversely, strong attitudes of purism in the recipient language (rejection of non-native forms) hinder the adoption of loanwords (Haspelmath, 2009: 35).

The cognitive processes by which loanwords become established in the mental lexicon of recipient language speakers has also received scholarly attention. For example, one process that has been argued to play a role in the adoption of loanwords is entrenchment: the repeated usage of a particular item (or action, routine, etc.) in a particular context which leads to its strengthening and automatization (Schmid, 2007). Backus (2012: 6) proposes that the repeated use of loanwords over time leads to their gradual entrenchment in the mental lexicon of recipient language speakers, such that over time they become a true part of the mental lexicon of the recipient language. Similarly, Poplack (2018: 2–3) states that increasing frequency, recurrence, and diffusion in the recipient language speech community are key criteria that can be used to identify when loanwords have become established – characteristics that also signal greater entrenchment. Importantly, loanwords can become entrenched in the recipient language regardless of whether or not individuals have knowledge of the source language. One question that arises, however, is what happens when the individual is bilingual in both the source and recipient languages?

1.2 Loanwords and bilingualism

In the study of bilingualism, loanwords have garnered great attention, standing front-and-center in a decades-long debate regarding the interface between language contact and language mixing. This debate has centered on single-word insertions of one language into the other, which often "assume the morphological and syntactic identity of the recipient language *prior* to achieving the social characteristics of established loanwords [emphasis original]" (Poplack, 2012: 645). In other words, these nonce borrowings, as they are sometimes called, undergo all of the morphosyntactic adaptation that established loanwords do without becoming fully integrated into the speech community itself. Importantly, these nonce borrowings are proposed to be categorically distinct from multi-word alternations between stretches of speech in one language and in the other (e.g., codeswitches; see Poplack, Sankoff, & Miller, 1988; Sankoff, Poplack, & Vanniarajan, 1990; Poplack, 2012; 2018). This distinction, however, is not without criticism, and debates continue on the status of these so-called nonce borrowings and their relationship to the bigger picture of language contact (see Myers-Scotton, 1993; Stammers & Deuchar, 2012; and Backus, 2012 for further discussion). In addition, codeswitching in particular has also received a great deal of scholarly attention, both in sociolinguistics (Poplack, 1980; Poplack, Sankoff, & Miller, 1988; Muysken, 2013; Torres Cacoullos & Travis, 2015; 2018, among many others) and psycholinguistics (Grosjean, 1995; Adler, Valdés Kroff, & Novick, 2020; Blanco-Elorrieta & Pylkkänen, 2017, 2018; Litcofsky & Van Hell, 2017; Beatty-Martínez & Dussias, 2017, among many others). There even exist some studies that examine single-word insertions specifically, although these studies often do not make recourse to the ongoing debate on nonce borrowings (Johns et al., 2019; Moreno, Federmeier, & Kutas, 2002).

What is lacking in the psycholinguistic study of bilingualism, however, are studies examining the processing of established loanwords. A thorough search of the literature returned only two studies that used psycholinguistic methodologies to study the processing of established loanwords in bilingual speakers. Tamaoka and Miyaoka (2003) asked Japanese-English bilinguals to perform a lexical decision task in Japanese that included high- and low-frequency established loanwords from English (requiring a "yes" response), and unadopted or novel loanwords (English words adapted to Japanese phonology and written in katakana), pseudo-loanwords (established loanwords but with slight changes, such as changing a vowel or consonant), and non-words (all requiring a "no" response). The authors found that established loanwords exhibited the typical frequency effect found for etymologically native words; namely, higher frequency words were responded to faster and more correctly than lower frequency words. Interestingly, when examining those items that required a "no" response, the authors found that reaction times were fastest for non-words, slowest for unadopted loanwords, and intermediate for pseudo-loanwords. That unadopted or novel loanwords elicited the longest reaction times of these three conditions suggests the source language (in this case, English) may have been active as individuals attempted to process and classify these words as Japanese. Kuitert (2013) also used a lexical decision task to examine the processing of English loanwords in Norwegian, finding that the loanword's subjective rating on how Norwegian-like it is, its frequency, its length, and the English proficiency of the participants all modulated reaction times. What both of these studies lack, however, is a comparison to etymologically native words to determine if their processing differs from that of established loanwords.

While few studies have focused on the processing of established loanwords, some insight on their processing can be gained from the plethora of work examining cross-language interaction in bilinguals at the lexical level. One finding that seems to be indisputable in the bilingual literature is that the two languages of a bilingual are always active (Dijkstra, Grainger, & van Heuven, 1999; Thierry & Wu, 2007; Lagrou, Hartsuiker, & Duyck, 2011; Goldrick, Putnam, & Schwartz, 2016, among many others) and influence each other during production and comprehension (Hartsuiker, Pickering, & Veltkamp, 2004; Schoonbaert, Hartsuiker, & Pickering, 2007; Linck, Kroll, & Sunderman, 2009; Torres Cacoullos & Travis, 2015; Travis, Torres Cacoullos, & Kidd, 2017). At the lexical level, this cross-language interaction has been demonstrated via priming (translation, semantic, and orthographic), in interlingual homographs, and – of particular importance to the present study – cognates.

Loanwords and cognates are similar in that they share both form and meaning across two languages but differ in how they came to be in the recipient language. Loanwords emerge through language contact, potentially between completely unrelated languages; cognates, on the other hand, are traditionally viewed as words that are etymologically related to one another and can be traced back to a single shared origin in a predecessor language, though more generally the term is used to describe words that share form and meaning across languages, whether or not they share an origin (see Carroll, 1992). Nonetheless, psycholinguistic studies that use cognates do not always distinguish between the two. For example, Hoshino and Kroll (2008) examined the processing of cognates in Japanese-English bilinguals, using words like *guitar* (*gitā* in Japanese) and *shirt* (*shatsu* in Japanese). These cognates are in fact loanwords, given that Japanese and English are not etymologically related and their entry into the language can be traced from contact with English (see Kay, 1995). Despite this, the general finding from the cognate literature is that cognates benefit from their highly overlapping representations across the two languages, bolstering (or facilitating) lexical access particularly in instances where lexical access is difficult. For example, using a picture naming task, Costa, Caramazza, and Sebastian-Gallés (2000) found that bilinguals named cognates significantly faster than non-cognates, but that this difference was greatest when naming in the non-dominant language (see also Hoshino & Kroll, 2008; Van Assche, Duyck, Hartsuiker, & Diependaele, 2009; Bosma, Blom, Hoekstra, & Versloot, 2019, among many others). In addition, the cognate facilitation effect is modulated not only by language dominance, but also by the frequency of the cognate words in both languages. For example, Peeters, Dijkstra, and Grainger (2013) asked French-English bilinguals to perform a lexical decision task in English and found that the cognate facilitation effect was largest for English words that were highly frequent in both English *and* French. Given this, loanwords might be expected to show a facilitatory effect because of their similarities to cognates but also because many studies on the cognate facilitation effect have, in fact, used loanwords as stimuli. The cognate facilitation effect, however, does not always surface, and can be modulated or even reversed by a number of different factors. For example, in a lexical decision task, Dijkstra, Grainger, and van Heuven (1999) found that, while the semantic and orthographic similarity of Dutch-English cognates led to a cognate facilitation effect, their phonological similarity led to an inhibitory effect. In addition, when the task was to decide whether a given word was a member of a specific language, cognates exhibited strong interference effects, presumably because their status as belonging to one language or the other is more difficult to discern, particularly when the words were identical cognates (e.g., they are spelled the same way, such as *lamp* which is identical in both form and meaning in Dutch and English; see Dijkstra, Miwa, Brummelhuis, Sappelli, & Baayen, 2010). The present study takes direction from the literature summarized above to examine how adult bilingual speakers process established loanwords when they have knowledge of both the source and recipient languages.

1.3 Using pupillometry

As opposed to using behavioral tasks that examine single words in isolation, the present study seeks to examine how bilinguals process established loanwords when they are presented auditorily in sentential contexts. Words are rarely devoid of greater context, and previous literature has found that the surrounding context can modulate cross-linguistic activation and, in turn, lexical access (Libben & Titone, 2009; Titone, Libben, Mercier, Whitford, & Pivneva, 2011). The present study also eschews written stimuli in favor of auditorily-presented stimuli for two main reasons. First, this ensures for a more ecologically valid presentation of the stimuli, particularly when using established loanwords which – despite being well-established and documented in Puerto Rican Spanish – may nonetheless be stigmatized when presented in writing. Second, given that the primary goal of this study was to examine lexical access, we sought to circumvent potential effects of orthography (e.g., the loanwords and their English source words have substantial orthographic overlap). As a result, the present study makes use of pupillometry – a method that is relatively new to the language sciences and that lends itself well to the study of online language comprehension.

Psychological and neurological work over the past several decades has shown that the changes in pupil size are linked not only to changes in ambient luminance, but also to aspects of the sympathetic nervous system (Goldwater, 1972), the locus coeruleus and norepinephric system (LC-NE; Samuels & Szabadi, 2008; Aston-Jones & Cohen, 2005). The LC-NE has been associated with memory retrieval (Beatty & Kahneman, 1996; Attar, Schneps, & Pomplun, 2013), selective attention (Foote & Morrison, 1987), and arousal (Bradshaw, 1967). For example, when selective attention is engaged either due to increased cognitive demands or attentional requirements, the pupil involuntarily dilates due to its connection to the LC-NE system. Recently, pupillometry has been applied to a variety of language-related processes, such as effortful speech processing (Kuchinsky et al., 2013), lexical retrieval (Schmidtke, 2014), bilingual cognate facilitation (Guasch, Ferré, & Haro, 2017), and the processing of language mixing (Byers-Heinlein, Morin-Lessard, & Lew-Williams, 2017), highlighting its sensitivity to a variety of language processing phenomena (see Schmidtke, 2018). Under this approach, an increase in pupil size with respect to a particular linguistic stimulus is assumed to be indicative of greater cognitive load that results from an increase in the allocation of attentional resources (Gabay, Pertzov, & Henik, 2011; Alnæs, Sneve, Espeseth, Endestad, Van de Pavert, & Laeng, 2014). Such an increase is congruent with, for example, increased reaction times as a result of cross-language activation (at least in interpretation, though not necessarily in terms of the underlying mechanisms driving them).

1.4 Research questions and hypotheses

Our main question is: how does knowledge of and experience with both the recipient (Spanish) and source (English) languages affect the processing of English loanwords in Puerto Rican Spanish? We hypothesize that, because loanwords are similar to cognates in that they share both form and meaning, loanwords should exhibit a facilitatory effect, which would manifest itself as a reduced pupillary response compared to native Spanish words. We further ask three ancillary questions: (1) how does the frequency of the loanword itself, (2) the frequency of its 'standard'[2] Spanish counterpart, (3) and the frequency of its English source word modulate this effect? We use these frequency measures as proxies for experience and hypothesize the following: First, less frequent loanwords will elicit a larger pupillary response compared to more frequent loanwords, given that low-frequency items are less accessible (in the L1, see Segui, Mehler, Frauenfelder, & Morton, 1982: 616–618; Andrews, 1992: 237–238; in the L2, see Strijkers, Costa, & Thierry, 2010 and Gollan, Slattery, Goldenberg, Van Assche, Duyck, & Rayner, 2011 among many others). Second, loanwords with highly frequent Spanish standard counterparts (synonyms) will elicit a larger pupillary response compared to those whose standard Spanish counterparts are less frequent (e.g., competition between the 'preferred' vs. 'non-preferred' synonyms; see Jescheniak & Schriefers, 1998 for a discussion on the co-activation of lexical items and synonymous lexical

2. Similarly to the use of 'native', we use 'standard' to refer to the non-loanword equivalent of the loanword.

competitors). Third, loanwords whose English source words are less frequent will elicit a larger pupillary response compared to those whose English source words are more frequent (e.g., Peeters et al., 2013).

2. Methodology

2.1 Participants

Early Spanish-English bilinguals were recruited from the University of Puerto Rico at Río Piedras, all of whom were originally from Puerto Rico. As a U.S. territory, Puerto Rico has employed both Spanish and English as official languages since the Foraker Act of 1900. As such, the two languages have been in contact for almost 120 years, leading to an ideal opportunity for the two languages to borrow from one another (particularly from English into Spanish; see Morales, 2009: 9–10). English loanwords have made their way into the Puerto Rican lexicon, and in some instances have become more prevalent than their original Spanish counterparts. For these reasons, the bilingual population found at the University of Puerto Rico was chosen for the present study. A total of 60 participants were recruited with 8 participants removed due to not completing all of the tasks (the loanword recognition questionnaire, see Section 2.4 below) and a further participant removed for insufficient data per condition after data cleaning (see Section 3.1 below). A total of 51 participants were included in the analyses. Participants completed a detailed language history questionnaire and a lexical decision task administered in both Spanish and English. The language history questionnaire asked about the languages the participants knew and/or were learning; usage patterns for each language across different domains (e.g., home, school, work, etc.); self-rated proficiency in speaking, understanding, reading, and writing in each language; and codeswitching/language mixing tendencies at different levels (e.g., across sentences, within words) and across different domains. The average age of acquisition of Spanish was 1.3 years ($sd = 1.5$ years) and the average age of acquisition of English was 4.4 years ($sd = 2.2$ years; $p < 0.01$). Participants stated that they used both Spanish and English frequently in their daily lives, and self-rated themselves as highly proficient in both languages, though generally more proficient in Spanish (see Table 1).

In the lexical decision task, participants saw 100 letter strings in Spanish and English (separated into two blocks with the order counterbalanced by participant), with 50 real words (e.g., *bolsa*, 'bag') and 50 matched pseudowords (e.g., *veem*, *panselo*) generated using Wuggy (Keuleers & Brysbaert, 2010). Participants saw each letter string on screen one-at-a-time and were instructed to indicate as quickly and accurately as possible if the letter string was or was not a real word of the appropriate language. D-prime scores were calculated for each language based on the accuracy data using the dprime function in the psycho package (v. 0.5.0; Makowski, 2018). A paired two-sample t-test revealed no significant difference in the d-prime scores for Spanish and English (see Table 1). It is important to note, however, that English words were significantly more frequent than Spanish words ($t = 2.51$, $p = .02$) and had significantly fewer letters ($t = 3.55$, $p < .001$) than Spanish words, which may account for better performance in the English task relative to the Spanish task. The data from the language history questionnaire and the lexical decision task thus suggest that, while these bilinguals are Spanish dominant, they are nonetheless highly proficient in English (the average self-rated proficiency scores for English are 8.81/10 or higher).

Table 1. Self-rated proficiency and lexical decision scores. *Standard Deviation in Parentheses*

	Speaking	Reading	Writing	Understanding	D-prime
English	8.93.10 (0.88)	9.24/10 (0.84)	8.81/10 (1.22)	9.43/10 (0.82)	3.27 (0.64)
Spanish	9.41/10 (0.79)	9.52/10 (0.73)	9.00/10 (1.15)	9.71/10 (0.56)	3.16 (0.58)
p-value	<.01*	.01*	.18	<.01*	.28

2.2 Stimuli

The experimental items consisted of 120 sentences with a target noun occurring in an adjectival phrase at the end of each sentence. The target nouns consisted of 30 established loanwords selected using the *Diccionario de anglicismos actuales* ('Dictionary of Current Anglicisms'; Morales, 2009) and a further 90 etymologically native Spanish nouns that matched the frequencies of the established loanwords (see Supplementary materials). These 90 native Spanish nouns were divided into three lists of 30 nouns, selected by choosing a noun that matched the frequency of each of the 30 established loanwords as closely as possible such that all three lists did not differ in frequency from both the established loanwords and one another. All frequencies were taken from the Puerto Rican sub-section of the *Corpus del español* (Davies, 2016-). One-hundred and twenty unique adjectives were selected and paired with each target noun. None of the native Spanish nouns were cognates nor were they equivalent to the established loanword (e.g., the word *revista* 'magazine' was avoided because the established loanword *magacín* was used). It is also important to note that nouns were selected based on their meaning in Puerto Rican Spanish; for example, while *pantallas* means 'screens' in Peninsular Spanish, it means 'earrings' in Puerto Rican Spanish.

Two conditions were created: the established loanword condition contained an established loanword as the target noun (*no había sitio para nuestro carro en el parking* [paɾkiŋ] *lleno*, 'there wasn't room for our car in the full parking lot'); the etymologically Spanish condition had a target noun that was an etymologically Spanish noun (*el novio le regaló unas pantallas plateadas*, 'the boyfriend bought him/her some silver earrings'). Target nouns (and their accompanying adjective) always occurred at the end of the sentence to ensure that no additional material affected the pupillary response (see Section 2.3 below). Half of the target nouns occurred as the direct object of the main verb and the other half as the object of a prepositional phrase serving as an adjunct to the main verb.

Given limitations on the number of available established loanwords that could be used, each participant saw the same 30 sentences in the established loanword condition. The remaining 90 etymologically Spanish targets were divided into three lists of 30 items and were counterbalanced across participants. An additional 60 filler items were created which contained none of the nouns or adjectives used in the target sentences, such that each participant was presented with a total of 30 items in the established loanword and the etymologically Spanish conditions, and 60 fillers (120 sentences total). Example stimuli are given in Table 2.

Table 2. Example stimuli

	Experimental Items
Unilingual Spanish	El novio le regaló unas pantallas plateadas. 'The boyfriend bought her/him some silver earrings'
Established loanword	No había sitio para nuestro carro en el parking lleno. 'There wasn't any space for our car in the full parking lot'
	Filler Items
	El pintor abrió el cuaderno para dibujar. 'The painter opened the notebook to draw'
	La investigadora trabajadora encontró la evidencia. 'The hardworking investigator found the evidence.'

All stimuli were presented aurally and were recorded by a native Puerto Rican Spanish-English bilingual who was of the same demographic as the target population of the present study (highly proficient college-aged bilinguals). Stimuli were recorded with neutral intonation in a sound-attenuated booth using a Shure SM35 head-worn cardioid condenser headset microphone and were then normalized for intensity in Praat (Boersma & Weenink, 2020). English nouns and adjectives were not spliced into the unilingual Spanish condition in order to create more naturalistic stimuli free from any artefacts that may influence online processing (e.g., Fricke, Kroll & Dussias, 2016). This is particularly important given that the measure chosen – the pupillary response – is sensitive to changes in attention and arousal that could be brought on by unexpected qualities in the stimuli (e.g., Wetzel, Buttelmann, Schieler, & Widmann, 2016).

2.3 Design

The use of pupillometry begets certain requirements in the design and presentation of stimuli. First, and perhaps most important, is that the overall luminance or brightness of the display screen must be kept constant. To achieve this, participants were instructed to fixate on a drawing of an ear presented in the middle of the screen. This image was presented throughout the duration of the stimulus period, ensuring no changes in luminance throughout the trial. Second, gaze position has been found to systematically influence the calculation of pupil size (Gagl, Hawelka & Hutzler, 2011). To address this, participants were instructed to not move their eyes away from the image presented in the middle of the screen; samples that did not fall on this image were excluded from analysis (see Section 4.5). Third, pupil size not only changes in response to particular stimuli (termed the task-evoked pupillary response), but also changes over longer periods of time due to natural fluctuations in overall attention levels and sustained processing (Sirois & Brisson, 2014: 680; Schmidtke, 2018: 531). To account for this, the pupillary response was time-locked to the onset of the target noun/adjective pair (e.g., at the onset of *pantallas* in *pantallas plateadas*) and extended for 3000 ms. This served as the primary interest period for analysis (see Section 4.5). Likewise, a 1000 ms neutral period, where no audio was playing, was presented before each stimulus to ensure that there was sufficient time for the pupillary response to stabilize before the next sentence began. Fourth, the pupillary response is most robust when the participant must actively engage with the stimuli and perform an additional task. In the present study, participants were instructed to repeat aloud the sentence they had just heard once a drawing of a mouth appeared on screen (after the 3000 ms offset period). Abiding by these constraints, each trial consisted of the following:

1. A 1000 ms neutral period without audio displaying a drawing of an ear in a central 300-by-300-pixel interest area.
2. The stimulus, which began playing after the 1000 ms baseline period; the drawing of the ear remained on-screen such that the luminance did not change.

3. The target period, beginning at the onset of the target noun/adjective pair and extending 3000 ms; the drawing of the ear remained on-screen.
4. The repetition task, beginning after the 3000 ms offset period and indicated by the drawing of the ear change to the drawing of a mouth.

Figure 1 below illustrates the trial design. Note that for fillers, which did not include a target noun/adjective pair, the image of the ear remained on-screen for 2000ms after the end of the sentence finished playing, at which point the image of the mouth appeared prompting the participant to repeat the sentence aloud. This ensured that there was a delay after the sentence finished playing and before the image of the mouth appeared, congruent with experimental items which also had approximately 2000ms of silence after the sentence finished playing and before the image of the mouth appeared.

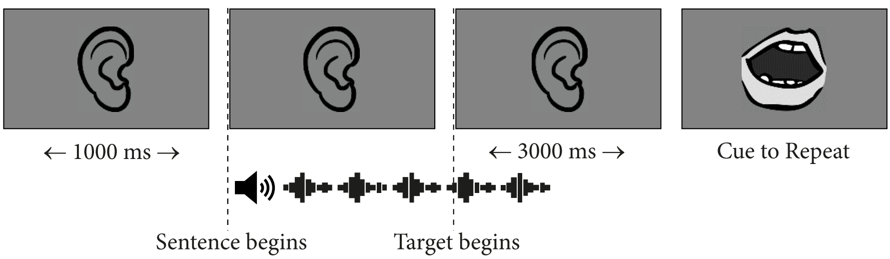


Figure 1. Trial design

2.4 Procedure

All data were collected at the University of Puerto Rico, Río Piedras campus. Participants were seated in a quiet room with a constant light source located above and behind the participant. Windows were obscured such that no external light was visible. After informed consent was obtained, the participants began the eye-tracking task. Data were collected using an EyeLink Portable Duo eye-tracker (SR Research) recording at 1000 Hz in head-stabilized mode using the right eye pupil and corneal reflection. After the task had been thoroughly explained and an example trial given, a nine-point calibration was performed such that the average error was no greater than 0.5 degrees and the maximum error was no greater than 1.0 degrees. The task then began with a practice consisting of five items, during which the participant could ask questions or re-do the practice if necessary. Once the practice was complete, participants began the actual task. After 60 trials, participants were encouraged to take a break to prevent fatigue. After the break, calibration was performed again, and the remaining 60 trials were completed. Once the eye-tracking task was complete, participants completed the language history questionnaire and the lexical decision tasks in Spanish and English, with the order of the two languages counterbalanced by participant. After the participants completed the session, they were e-mailed a short questionnaire where they were presented with all 30 established loanwords that were shown in the experiment. Participants were asked to indicate whether or not they recognized the words. This questionnaire was used to exclude any items containing loanwords that the participant did not recognize. Eight participants did not complete this questionnaire, and as such they were excluded from all analyses. Participants were paid at the end of each session at a rate of 10 USD per hour, with the session lasting 2 hours on average.

3. Analysis

3.1 Pre-processing and data cleaning

Initial data extraction took place in SR Research DataViewer (v. 4.1.1) using a Sample Report with the interest period beginning 1000 ms prior to the onset of the target noun and ending 3000 ms post-target onset. Data were then imported into R (v. 4.1.0; R Core Team, 2021) for pre-processing and cleaning. Data were downsampled from 1000 Hz to 50 Hz to create 20 ms bins. For each bin, the following information was calculated:

- The average right-eye pupil size across all non-blink samples.
- The average right-eye x- and y-gaze position across all non-blink samples.
- The proportion of samples that occurred during a blink.
- The proportion of samples that occurred during a saccade.
- The proportion of samples for which a pupil size was missing.
- The proportion of samples that did not fall on the image of the ear.

Gaze position was entered into the model to account for the fact that pupil size as measured by the eye tracker is affected by gaze position, even if the actual size of the pupil does not change (Gagl, Hawelka, & Hutzler, 2011). Samples that occurred during blinks or saccades, samples for which a pupil size was missing, and samples that did not fall on the image of the ear were excluded from analysis, and the proportion of missing samples for each was used to calculate how much data were missing for each trial. Trials with more than 35% missing data in either the pre-stimulus baseline period or the stimulus period itself were excluded (see below). The average pupil size in the 300 ms pre-stimulus onset period was used to baseline correct the pupil size during the 3000 ms post-stimulus onset period. Baseline correction was performed by subtracting each trial's average pupil size in the pre-stimulus baseline period from the average pupil size in each bin of the post-stimulus onset period (see van Rij, Hendriks, van Rijn, Baayen, & Wood, 2019: 3–6).

Eight of the 60 participants were removed from the analysis because they did not complete the questionnaire indicating which established loanwords they recognized, resulting in 3,119 usable trials. A further 62 (2.0%) trials where the participant did not recognize the established loanword were removed. Lastly, any trials where more than 35% missing data in either the pre-stimulus baseline period or the stimulus period itself were excluded (357 trials, 11.7%), as were any participants who had less than 15 trials per condition remaining after this exclusion (only 1 participant). This was done to ensure a sufficient number of trials per condition per participant for adequate modelling. This resulted in a final total of 2,700 trials across 51 participants.

3.2 GAMMs

To analyze the time course of the pupillary response, generalized additive mixed-effects models (GAMMs) were employed. GAMMs are ideal in the analysis of time series data versus other methods (e.g., growth curve analysis) in both their ability to model non-linear dependencies as well as to account for the inherent autocorrelation of time series data using an embedded autoregressive-1 (AR1) model. All models were created using the mgcv package (v. 1.8–33; Wood, 2003; 2011, 2017) in R. Model criticism, testing, and visualization was conducted using the itsadug package (v. 2.3; van Rij, Wieling, Baayen, & van Rijn, 2017) and the mgcViz package (v. 0.1.6; Fasiolo, Nedellec, Goude, & Wood, 2018). Two models were created: the first examined the general difference between established loanwords and native Spanish words (our main research question), and the second examined the pupillary response to established loanwords as a function of the frequency of the loanword itself (to examine the first ancillary question), its standard Spanish counterpart (the second ancillary question) and its English source word (the third ancillary question).

For each model, the procedure was the same. First, a maximally specified reference model was fit without the inclusion of an AR1 model to estimate the autocorrelation coefficient *rho*, extracted using the start_value_rho function in the itsadug package, which was subsequently adjusted accordingly to properly account for autocorrelation. For both models, the optimal *rho* value was 0.95. Next, the model was re-run with an AR1 model with this *rho* value. All models were specified to use a scaled-*t* distribution to account for the non-normal distribution of the data (Wood, Pya, & Saefken, 2016). The function check.gamViz from the mgcViz package was used to perform model diagnostics – specifically, to determine the appropriate number of knots, *k*, for each smooth term and to assess the model residuals – while the acf_resid function from the itsadug package was used to visualize the autocorrelation in the model and assure that it had been reduced with the inclusion of the AR1 model. The number of knots for each smooth term was initially set to 10 (the default), but the check.gamViz function suggested that this value was not enough. As such, all *k*'s were doubled to 20, which was sufficient according to the check.gamViz function for both models. Autocorrelation was considered sufficiently reduced when (1) the autocorrelation value at lag 1 was non-negative and (2) all autocorrelation values after lag 0 were less than 0.2. This was the case for both models. Summary information for the models is presented in Table 3, and the full R script used to conduct these analyses is included in the Rmarkdown file in the Supplementary materials.

Table 3. Model summaries

Model 1				
Parametric Coefficients				
	Estimate	*Std. Error*	*t*	*p*
Intercept	−159.91	7.77	−20.59	<.001
Established Log WPM	−3.80	2.16	−1.79	0.08
Smooth Terms				
	EDF	*Ref.df*	*F*	*p*
s(Time)	9.82	12.71	4.39	<.001
s(Time):IsEstablished	4.83	6.00	2.20	0.04
s(Gaze X, Gaze Y)	28.50	28.98	7173.45	<.001
s(Time, Participant)	196.49	255.00	0.09	<.001
s(Time, Item)	245.57	505.00	1.88	<.001
R-sq. (adj) = 0.24; Deviance Explained = 18.5%; fREML = 1.475*105				
Model 2				
Parametric coefficients				
	Estimate	*Std. error*	*t*	*p*
(Intercept)	−143.74	7.458	−19.27	<.001
Smooth Terms				
	EDF	*Ref.df*	*F*	*p*
s(Time)	8.22	10.90	4.94	<.001
s(Established Log WPM)	1.01	1.01	2.57	0.11

Table 3. *(continued)*

s(Standard Log WPM)	1.00	1.00	1.56	0.21
s(English Source Log WPM)	1.01	1.01	1.18	0.27
ti(Time, Established Log WPM)	1.96	2.10	8.39	<.001
ti(Time, Standard Log WPM)	1.08	1.12	5.12	0.02
ti(Time, English Source Log WPM)	6.39	7.96	0.97	0.46
s(Gaze X, Gaze Y)	27.98	28.92	3634.94	<.001
s(Time, Participant)	172.86	254.00	5.50	<.001
s(Time, Item)	59.48	126.00	1.96	<.001
R-sq. (adj) = 0.25; Deviance Explained = 19.3%; fREML = 70429				

The first model sought to determine if there exists a difference in the pupillary response between established loanwords and native Spanish words. As opposed to using a two-level factor, which would model separate smooths for native Spanish words and established loanwords, this model used a numeric binary coding (native Spanish words = 0, established loanwords = 1) to model the difference between the two conditions itself as a term within the model (Wieling, 2018). One benefit of this is that it provides information on whether or not this difference is significant: in a factorized model, whether a particular smooth term is significant or not simply indicates if the pupillary response in that particular condition is significantly different from 0 (if so, it is significant). If there is a pupillary response at all, it will be different from 0, so this is not immediately informative. When using binary coding, however, this statistic is now meaningful as it indicates whether or not the difference between two conditions is significantly different from 0. This model predicted the baseline subtracted pupil size by:

- a smooth term across time using penalized thin plate regression splines,
- a smooth term across time by the binary term IsEstablished (native Spanish words = 0, established loanwords = 1) using penalized thin plate regression splines,
- a smooth term capturing the interaction between the x- and y-gaze positions, used to account for the effects of gaze position on pupil size (Gagl et al., 2011).
- by-participant and by-item nonlinear random smooths.

The second model examined just the established loanwords to determine how the frequency of the loanword itself, its standard Spanish counterpart, and its English source word modulate the pupillary response. To accomplish this, the model was specified with three decomposed tensor product interactions. Tensor product interactions model a three-dimensional surface rather than a two-dimensional smooth. For example, while a simple smooth term models the non-linear value of the dependent variable over time, a tensor product interaction models the non-linear value of the dependent variable as a function of both time and a second, continuous predictor (see Wood, 2017, Section 5.6.3 for more information). The tensor products were decomposed so that the independent effects of time, frequency, and their interaction could be investigated individually. For example, the full tensor product smooth te(time, frequency) was decomposed into two smooth terms and one interaction term: s(time) + s(frequency) + ti(time, frequency). This allows us to separate independent effects of time (pupil size changes over time), frequency (pupil size changes across different frequencies), and their interaction (pupil size changes over time and across different frequencies). Frequencies for the loanwords and their standard Spanish counterparts were extracted from the Puerto Rican subsection of the Corpus del español (Davies, 2016-), while frequencies for the English source words were extracted from the SUBTLEX-US database. All three frequency measures were entered into the model as log-transformed words per million (WPM), given the non-normal distribution of word frequencies. Because the frequency values from the two corpora were of different scales, they were subsequently centered. This model predicted the baseline subtracted pupil size by:

- separate smooths for time, the frequency of the loanword, the frequency of its standard Spanish counterpart, and the frequency of the English source word, all using penalized thin plate regression splines.
- separate tensor product interactions of time by the frequency of the loanword, the frequency of its standard Spanish counterpart, and the frequency of the English source word, all using penalized thin plate regression splines.
- a smooth term capturing the interaction between the x- and y-gaze positions, used to account for the effects of gaze position on pupil size (Gagl et al., 2011).
- by-participant and by-item nonlinear random smooths.

4. Results

4.1 Comparing established loanwords and native Spanish words

The fitted smooths from the first model are shown in Figure 2. The model indicated that the difference in the pupillary response between established loanwords and native Spanish words was significant ($F = 2.20$, $p = .04$). Established loanwords elicited a larger pupillary response than native Spanish words starting at approximately 1374 ms post-stimulus onset and lasting until the end of the epoch. This difference is visualized in Figure 3.

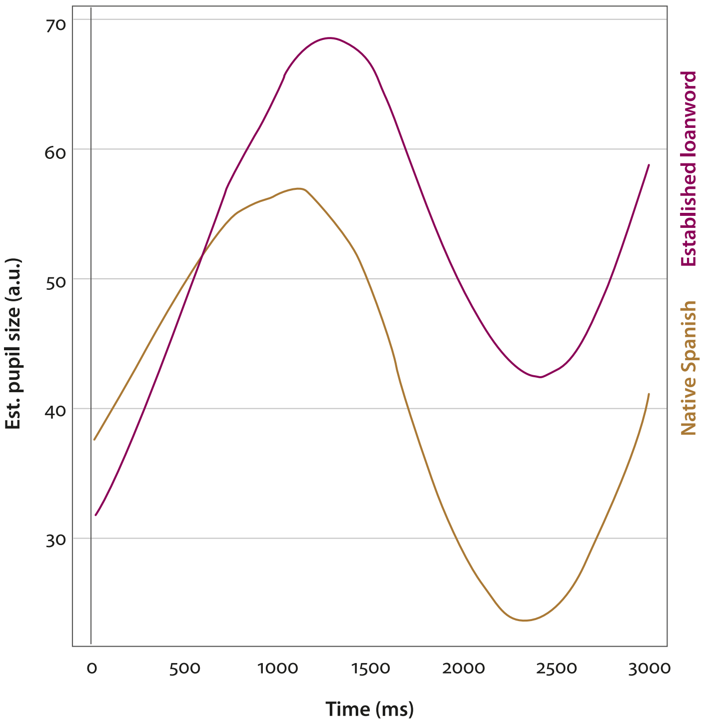


Figure 2. Pupillary response to established loanwords and native Spanish words

4.2 Frequency effects on the pupillary response

The second model indicated that there was a significant non-linear effect of the frequency of the loanword ($F = 5.52$, $p = .03$) and a significant interaction between time and the frequency of the loanword ($F = 9.86$, $p < .001$). Because the interaction is significant, we will report only on the interaction. Figure 4 visualizes this interaction in a heatmap, with time on the x-axis, the frequency of the loanword on the y-axis, and the estimated pupil size represented with color. Warmer (orange) colors indicate larger estimated pupil sizes, while cooler (blue) colors indicate smaller estimated pupil sizes. As can be seen in Figure 4, there is a larger and more sustained (i.e., more orange) pupillary response for low-frequency loanwords (lower y-axis values), which gradually diminishes (i.e., more blue) as the frequency increases (higher y-axis values). This can further be exemplified by visualizing the difference in the pupillary response between low- and high-frequency values (in this case, log WPM values of –2 and 3, respectively). Figure 5 shows this difference, which is significant starting from approximately 1645 ms post-stimulus onset until the end of the epoch.

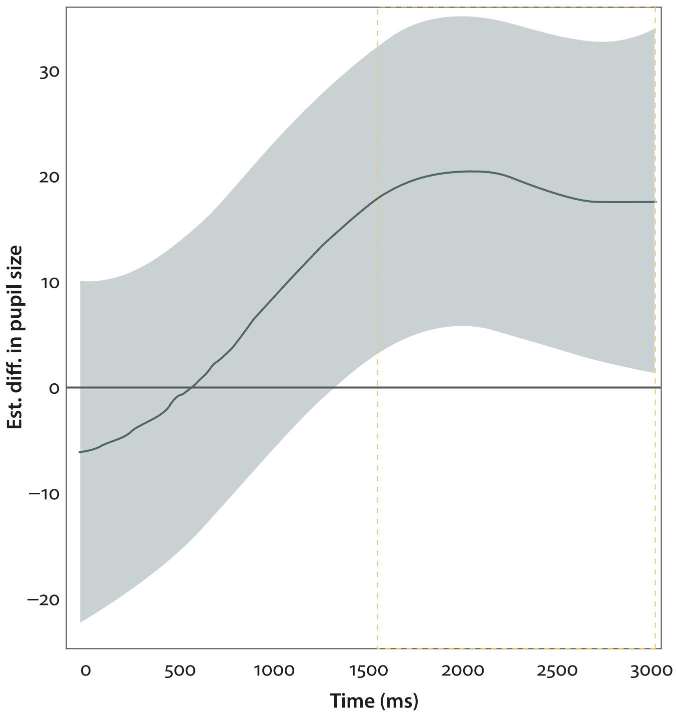


Figure 3. Difference between established loanwords and native Spanish words

The second model also indicated a significant interaction between time and the frequency of the standard counterpart ($F = 3.49$, $p = .049$). Figure 6 visualizes this interaction in a heatmap, with time on the x-axis, the frequency of the loanword on the y-axis, and the estimated pupil size represented with color. As can be seen in Figure 6, there is a larger and more sustained pupillary response for established loanwords whose standard counterparts are high frequency, which gradually diminishes as the frequency of the standard counterpart decreases. This can further be exemplified by visualizing the difference in the pupillary response between loanwords with high- and low-frequency standard counterparts (in this case, log WPM values of 4 and −1, respectively). Figure 7 shows this difference, which is significant starting from approximately 2066 ms post-stimulus onset until the end of the epoch.

Lastly, the second model revealed no significant non-linear effect of the frequency of the English source word ($F = 1.24$, $p = .19$) nor an interaction between time and the frequency of the English source word ($F = 1.48$, $p = .17$).

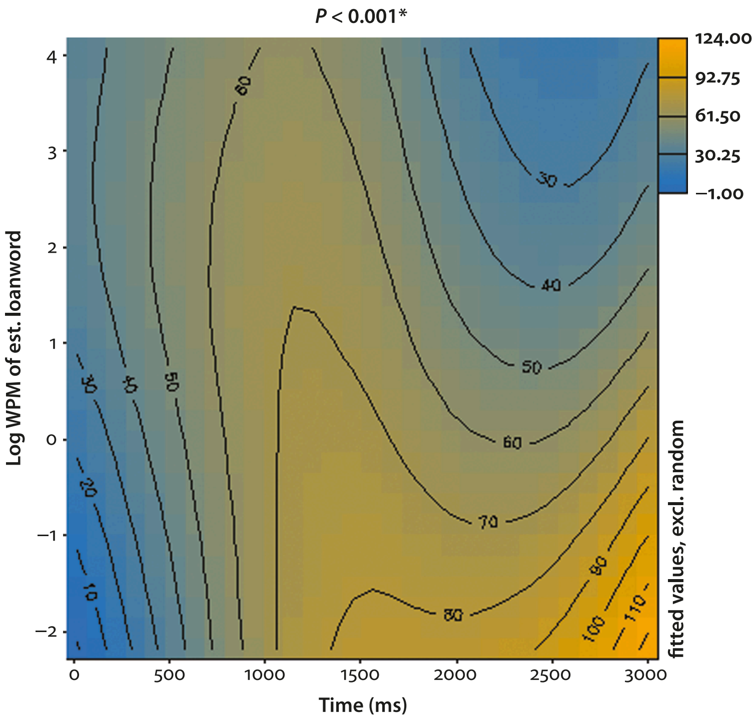


Figure 4. Effect of frequency of established loanword across time on pupillary response

5. Discussion

Our findings can be summarized as follows:

1. Established loanwords elicited larger pupillary responses than native Spanish words.
2. Low-frequency loanwords elicited larger pupillary responses than high-frequency loanwords
3. Loanwords with high-frequency standard counterparts elicited larger pupillary responses than loanwords whose standard counterparts were low-frequency.

With these findings in mind, let us return to our hypotheses. We predicted that because loanwords, just like cognates, overlap in both form and meaning, they would display a facilitation effect. Quite the contrary, however, we found that loanwords instead show evidence of increased difficulty in processing compared to native Spanish words of equivalent frequency. We also predicted that less frequent loanwords would elicit a larger pupillary response relative to more fre-

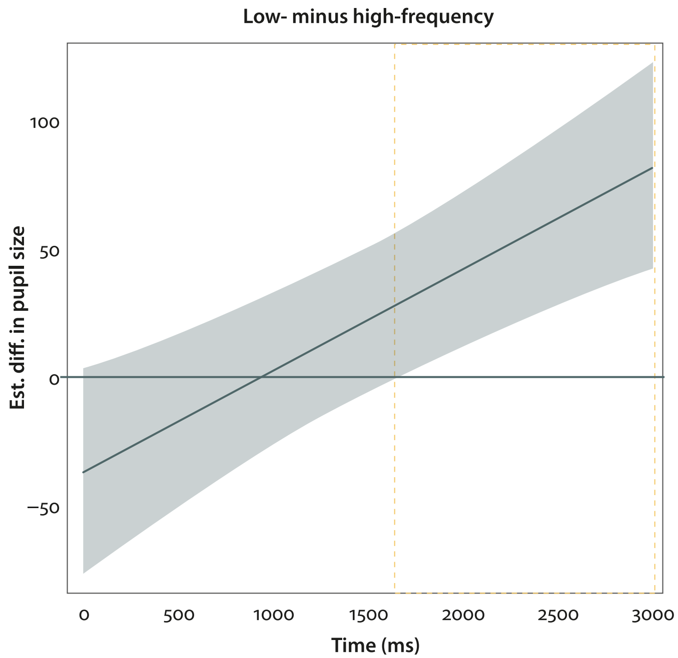


Figure 5. Difference in pupillary response between high- and low-frequency loanwords

quent loanwords, and that loanwords with highly frequent standard counterparts would exhibit an inhibitory effect; both predictions were born out in our findings. Finally, we did not find the expected effect of the frequency of the English source words, which was predicated on previous findings in the cognate literature (e.g., Peeters et al., 2013); we return to this point later in the discussion.

Given that loanwords are functionally identical to cognates, sharing both form and meaning across the two languages, the finding that they did not exhibit a facilitative effect compared to native Spanish words was surprising. Even if we assume that loanwords do not behave similarly to cognates, they are nonetheless part of the Puerto Rican Spanish lexicon; that they differed at all from native Spanish words was thus also unexpected. This begs the question: what is unique about established loanwords? The finding that increasing frequency of the standard Spanish counterpart likewise increased the pupillary response, coupled with the fact that the community under study is highly proficient in both the recipient and source languages, may shed some light.

The relationship between established loanwords and their native Spanish counterparts can be viewed as similar to that of synonyms: within the language, there are multiple labels that overlap significantly in their meaning (e.g., sofa-couch; harbor-port; proof-evidence). If one is preferred over the other (e.g., is

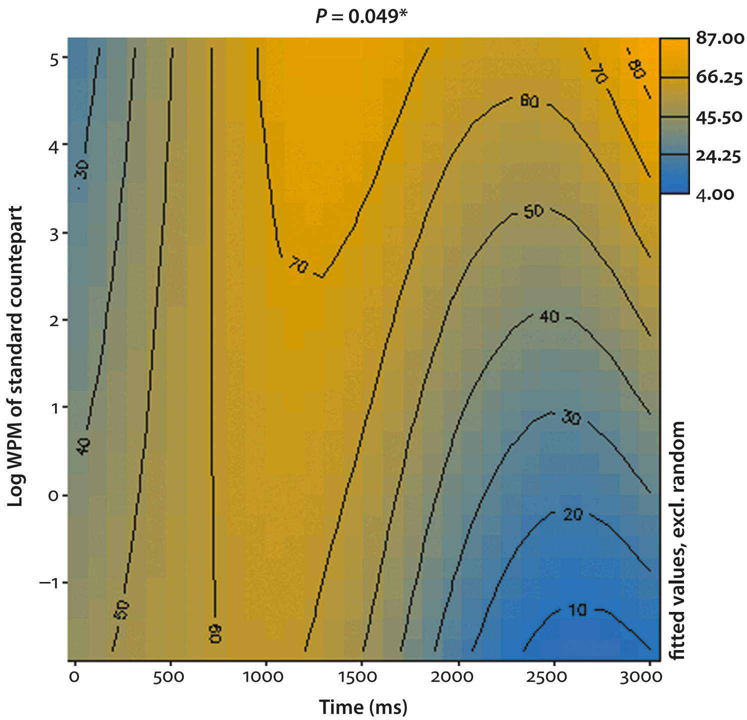


Figure 6. Effect of frequency of standard counterpart across time on pupillary response

more frequent), then encountering the less-preferred alternative may be surprising. This is reflective in the difference between low-cloze (less expected given the context) and high-cloze (more expected given the context) probability words. For example, Gunter, Friederici, and Schriefers (2006; see also Kutas and Hillyard, 1980a, 1980b, 1984) found that low-cloze nouns elicited a larger N400 effect compared to high-cloze nouns in German monolinguals, suggesting that they were more difficult to integrate. Similar effects of expectancy have been reported in numerous studies examining predictive processing in monolinguals (Delong, Urbach, Groppe, & Kutas, 2011; Schuster, Himmelstoss, Hutler, Richlan, Kronbichler, & Hawelka, 2021, among others). Similarly, Moreno, Federmeier, and Kutas (2002) found that highly proficient English-Spanish bilinguals showed an N400 effect to 'lexical switches', or synonyms, in both regular sentences and idiomatic expression (e.g., 'Out of sight, out of mind/brain') as well as a late frontal positivity to single word language switches (e.g., 'Out of sight, out of *mente*'). Lastly, Boada, Sánchez-Casas, Gavilán, García-Albea, and Tokowicz (2013) found similar interference effects in a translation recognition task where the words could have multiple viable translations in the other language. Given

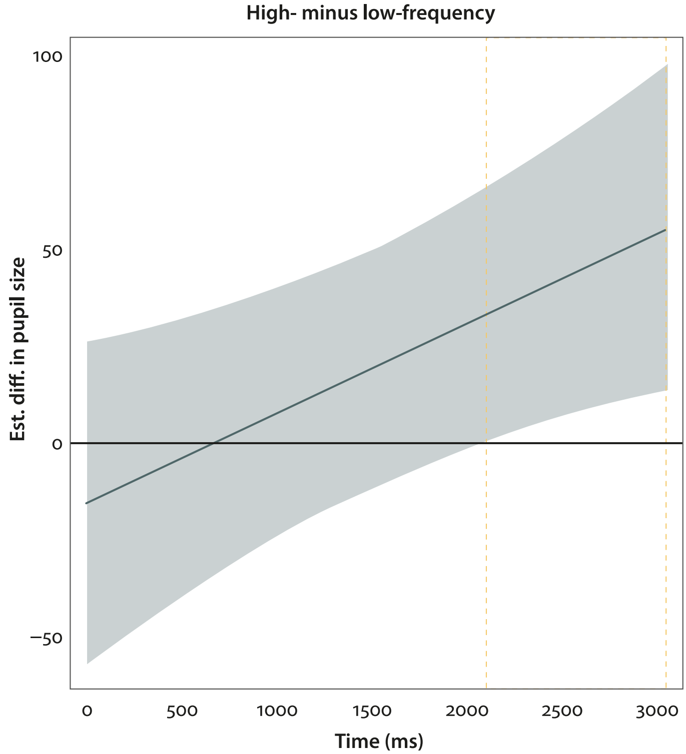
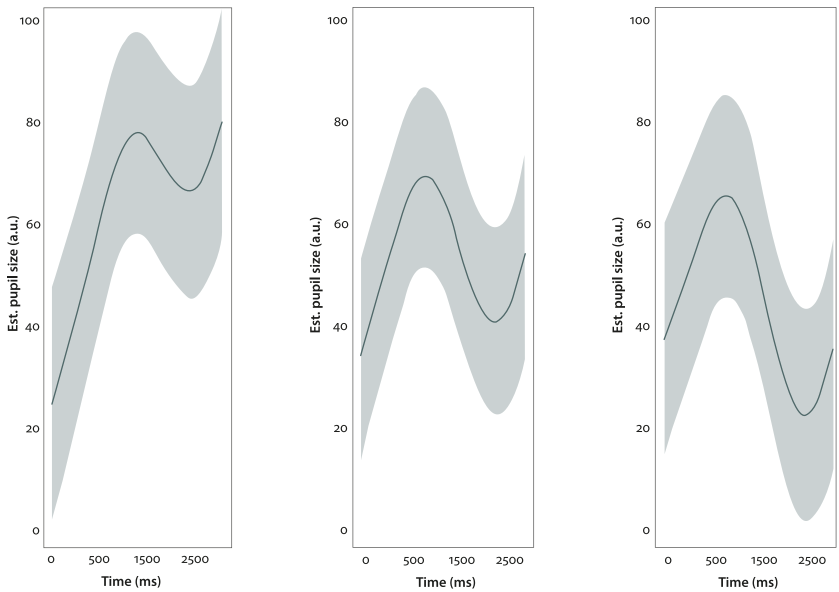


Figure 7. Difference in pupillary response between loanwords with high- and low-frequency standard counterparts

this, the finding that established loanwords elicited larger pupillary responses compared to native Spanish words may be driven in part by the competition between the loanword and its native Spanish counterpart. This difference is compounded when the frequency of the native Spanish counterpart is high, which again lends credence to competition effects as opposed to (or masking) facilitative effects.

The lack of an effect of the frequency of the English source words was also somewhat surprising but recall that Peeters and colleagues (2013) found that cognate facilitation effects were strongest for English cognates when *both* the English and French words were highly frequent. In the second model presented earlier, the frequency measures did not interact with one another, simply as a way to limit model complexity; however, because all three frequency measures were entered into the same model, it is possible to visualize the effect of the frequency of the loanword at various levels of the frequency of the English source word. Using the plot_smooth function in the itsadug package, fitted smooths were extracted with both frequency values fixed to the 25th, 50th, and 75th percentiles,[3] representing when both the loanword and its English source word were low, median, and high frequency, respectively. As can be seen in Figure 8, the largest numeric pupillary response occurs when both the loanword and its English source word are low frequency (panel a); as the frequency of both words increase, however, the pupillary response diminishes (panels b and c), particularly later in the epoch (approximately 1525 ms post-stimulus onset until the end of the epoch). This difference is visualized in Figure 9.



a. Established low English low **b.** Established median English median **c.** Established high English high

Figure 8. Interaction between frequency of loanword and English source word

Thus, it does indeed appear, at least numerically, that the established loanwords in the present study behave similarly to the identical cognates used by Peeters and colleagues (2013), with facilitation observed specifically for items that are highly frequent in both languages. Despite this similar behavior, loanwords themselves do not demonstrate a facilitation effect when compared to native

3. For established loanwords: 0.15, 1.44, and 2.86 log WPM; for English source words: 2.49, 2.94, and 3.19 log WPM.

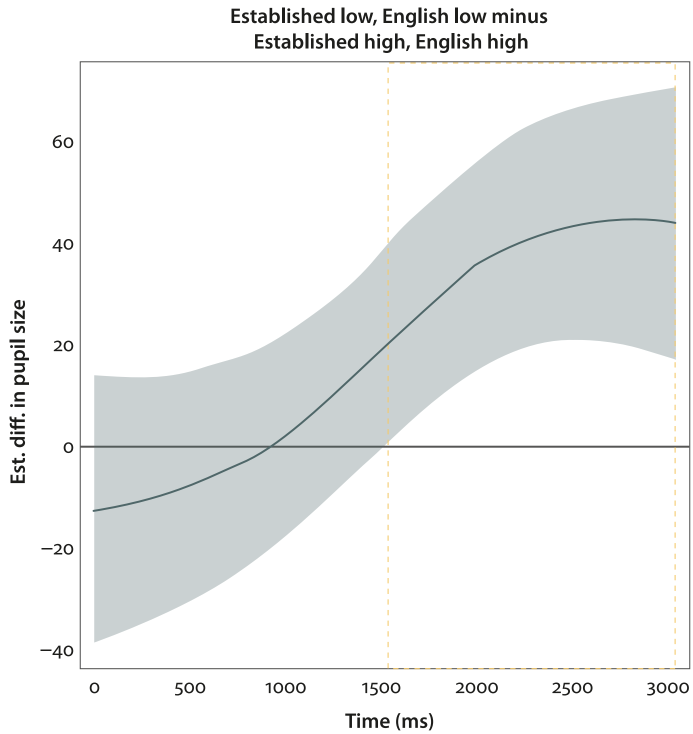


Figure 9. Difference between Panels (a) and (c)

Spanish words. To determine why this might be the case, we return to the unique status of loanwords for bilingual speakers who know *both* the recipient and source languages. To set the stage, Backus (2012) highlights the importance of two factors in the representation of established loanwords (and, indeed, all lexemes) in a speaker's mental lexicon: community-based conventionalization, which refers to 'the degree to which the loanword has become a conventional choice for the various members of the community'; and person-based entrenchment, which is 'the psycholinguistic notion [that] deals with the degree to which a particular speaker knows the word' (ibid. p.10). In monolingual communities, the adoption of a loanword is associated with the gradual increase in both conventionalization and entrenchment that over time erodes speakers' potential to identify the source language origin of the loanword. Importantly, however, "[a]s long as the population is bilingual, though, this potential can never be zero" (ibid. p.12). Thus, regardless of whether or not the loanword is established in the community or entrenched in the mind of the speaker, bilinguals nonetheless retain some sensitivity to the fact that these words are not *just* Spanish but also have some connection to English, which in turn influences their processing when compared to native Spanish words.

This influence may surface in the form of ambiguity in language membership. Recall that Dijkstra and colleagues (2010) found that cognates suffered when the goal of the task was to determine language membership. In the present study, all of the materials were presented in Spanish, with no priming of English built into the task. As such, it is possible that the loanwords were more salient precisely because of their connection to English. In other words, their similarity to their English source words and the fact no other words with ties to English were present in the task may have made them more salient, such that they stood out to participants, who may not have been expecting such words. Indeed, only 30 of the 120 sentences in this task contained a loanword, and none of the sentences contained any other cognate or cognate-like words. Based on this, we argue that what sets loanwords apart from native Spanish words with respect to their online processing is that, by virtue of being bilingual, speakers maintain at least some sensitivity to the fact that loanwords are intrinsically tied to their source language, a characteristic we call *other-language salience*. Compared to native words and cognates, which have connections to their translation equivalents in the other language, loanwords are not merely connected to their equivalents in the other language, they are *derived* from the other language – in this case, English. It is this knowledge, be it explicit or implicit, that increases their other-language salience, particularly when presented within a task exclusively in Spanish, as in the present study. In other words, when 'zooming in' on Spanish (as Elston-Güttler, Gunter, and Kotz [2005] discuss), finding a loanword derived from English becomes surprising. This builds upon the competition elicited by the presence of each loanword's native Spanish counterpart, which itself may be more expected than the loanword when the focus of the task is on Spanish rather than English. These two sources of competition – within-language, with the native Spanish counterpart, and across-language, with the English source word – together result in the increased processing demands for established loanwords found in the present study.

6. Conclusion

The present study set out to build upon the small literature examining how bilinguals process established loanwords vis-à-vis native words. At first glance, their similarity to cognates and the fact that they are morphosyntactically identical to native words suggests that, if anything, the processing of loanwords would be facilitated. The picture that emerges, however, is more complex: the processing of loanwords appears to be more effortful compared to frequency-matched native words, driven, as we argue, by the other-language salience that is present for bilingual speakers with knowledge of both the source and recipient languages. This study constitutes merely a first step in understanding the complexities behind how loanwords are represented in the bilingual lexicon. For example, future work should compare the processing of loanwords with native counterparts to native words with synonyms that may elicit similar competition – something that the present study was unable to do. Another important step would be to add a group of monolingual Puerto Rican Spanish speakers to examine the predictions that stem from the accounts that we have offered here to explain our findings. Likewise, different bilingual populations and bilinguals with differing levels of proficiency in the source and recipient languages should be examined in order to determine how the relationship between the two languages – both within the community and within the individual speaker – affect the complex dynamic between loanwords and their source words.

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Supplementary materials. Experimental stimuli

Established loanwords

Loanword	Gender	Source word	Native equivalent
audiencia	F	audience	público
bate	M	bat	pala
batería	F	battery	pila
cafetería	F	cafeteria	comedor
cloche	M	clutch	embrague
convención	F	convention	congreso
demanda	F	demand	exigencia
eslogan	M	slogan	consigna
ganga	F	gang	banda
ícono	M	icon	símbolo
incidente	M	incident	accidente
jungla	F	jungle	selva
lonchera	F	lunchbox	fiambrera
lote	M	lot	parcela
magacín	M	magazine	revista
mánager	M	manager	gerente
mascara	F	mascara	rímel
membresía	F	membership	afiliación
mítin	M	meeting	reunión
operación	F	operation	procedimiento
parada	F	parade	desfile
parking	M	parking	estacionamiento
ponche	M	punch	N/A
póster	M	poster	cartel
privacidad	F	privacy	aislamiento
récord	M	record	archivo
registración	F	registration	registro
reservación	F	reservation	reserva
switche	M	switch	interruptor
tique	M	ticket	boleto

Native Spanish words

Native word	Translation	Gender
abeja	bee	F
ajo	garlic	M
alfombra	carpet	F
algodón	cotton	M
almohada	pillow	F
anillo	ring	M
araña	spider	F
bandera	flag	F
barco	boat	M
basura	trash	F
blusa	blouse	F
burro	donkey	M
caja	box	F
caldo	broth	M
cama	bed	F
camión	truck	M
camisa	shirt	F
canasta	basket	F
cangrejo	crab	M
cárcel	prison	F
cena	dinner	F
cerdo	pig	M
cerveza	beer	F
chinas	oranges	F
cocina	kitchen	F
cohete	rocket	M
collar	necklace	M
corbata	tie	F
correa	belt	F
cuchillo	knife	M
diente	tooth	M
espejo	mirror	M

Native word	Translation	Gender
faldas	skirts	F
foca	seal	F
fogata	campfire	F
fresas	strawberries	F
galletas	cookies	F
gallo	rooster	M
globos	balloons	M
goma	wheel	F
gorra	hat	F
guantes	gloves	M
helado	ice cream	M
hielo	ice	M
hojas	leaves	F
hueso	bone	M
huevos	eggs	M
impresora	printer	F
jabones	soaps	M
jardín	garden	M
jaula	cage	F
lago	lake	M
lápiz	pencil	M
lazo	bow	M
llave	key	F
lluvia	rain	F
luna	moon	F
maíz	corn	M
mariposas	butterflies	F
miel	honey	F
mono	monkey	M
moscas	flies	F
nariz	nose	F
nido	nest	M
nieve	snow	F

Native word	Translation	Gender
nube	cloud	F
oso	bear	M
pájaro	bird	M
pantallas	earrings	F
pañuelo	handkerchief	M
pavo	turkey	M
peine	brush	M
pescado	fish	M
piedra	rock	F
piernas	legs	F
pincel	paintbrush	M
plátanos	plantains	M
rama	branch	F
ratón	mouse	M
reloj	clock	M
semáforo	stop sign	M
sillón	armchair	M
sudadera	sweatshirt	F
tarjeta	card	F
tazas	cups	F
teclado	keyboard	M
toro	bull	M
traje	suit	M
vaca	cow	F
vestido	dress	M

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