




The role of cognateness in native spoken word recognition*

A Preprint

Gonzalo Garcia-Castro 
Center for Brain and Cognition
Universitat Pompeu Fabra
Barcelona, 08005
gonzalo.garciadecastro@upf.edu

Serene Siow 
Department of Experimental Psychology
University of Oxford
Oxford, OX2 6GG
siow.serene@gmail.com

Kim Plunkett 
Department of Experimental Psychology
University of Oxford
Oxford, OX2 6GG
kim.plunkett@psy.ox.ac.uk

Nuria Sebastian-Galles 
Center for Brain and Cognition
Universitat Pompeu Fabra
Barcelona, 08005
nuria.sebastian@upf.edu

January 22, 2025

Abstract

1 While listening to speech in an unfamiliar language, words and phrases in the native lan-
2 guage are activated, leading to common auditory illusions like Soramimi, a particular case
3 of homophonic translation. Homophonic translation has received little attention as a psy-
4 cholinguistic phenomenon. In this study, we explored the mechanisms underlying lexical
5 activation and selection in homophonic translation. Across three studies, English and Span-
6 ish native adults completed a translation elicitation task, in which they listened to a series
7 of Catalan or Spanish words (to which participants were unfamiliar), and then had to type
8 their best-guess translation in their native language. Both English and Spanish natives were
9 surprisingly good at translating unfamiliar words, efficiently exploiting the phonological sim-
10 ilarity between the presented (unfamiliar) words and their correct translation. When the
11 correct translation belonged to high-density phonological neighbours, participants' ability to
12 benefit from phonological similarity decreased. Finally, Spanish natives exploited phonolog-
13 ical similarity more efficiently: provided identical phonological similarity, Spanish natives
14 were more likely to guess the correct translation of the unfamiliar word than English na-
15 tives. Overall, we show that speech in an unfamiliar language triggers equivalent dynamics
16 of lexical selection than native speech, providing a psycholinguistic account for homophonic
17 translation.

*The authors declare no conflicts of interest with regard to the funding source of this study. This study was supported by the Spanish Ministry for Science and Innovation and State Research Agency (Project PGC2018-101831-B-I00 financed by Spanish Ministry of Science Innovation and Universities (MCIU), Spanish Research Agency (AEI) and the European Regional Development Fund (ERDF), and by the Economic and Social Research Council (ESRC) (ES/S010947/1, UK). GGC was supported by a FPI research contract (PRE2019-088165). SS was supported by XXXXXXXXXXXXXXXX. KP was supported by XXXXXXXXXXXXXXXX. NSG was supported by an ICREA Academia 2019 award from the Catalan Institution for Research and Advanced Studies (ICREA). We are grateful to Irina Lepadatu and Nicola Gillen, and to the Speech Acquisition and Perception research group for their helpful feedback. We thank Xavier Mayoral, Silvia Blanch, Pamela Miller, and Cristina Cuadrado for their technical support. We also thank all families and infants who participated in the experiments. This study was conducted according to guidelines laid down in the Declaration of Helsinki, and was approved by the Drug Research Ethical Committee (CEIm) of the IMIM Parc de Salut Mar, reference 2020/9080/I. The data and code necessary to reproduce the analyses presented here are publicly accessible, as are the materials necessary to attempt to replicate the findings. The analyses presented here were not preregistered. Data, code, and materials for this research are available at the following URLs: <https://osf.io/hy984/>, <https://github.com/gongcastro/translation-elicitation>.

Keywords cognate • spoken word recognition • phonology • bilingualism • non-native speech processing
• lexical access

1 Introduction

When some German speakers listen to the song *The Power* by SNAP! (*Coyote Ugly*, 2000), many of them mishear the line “I’ve got the power” as *Agatha Bauer*. When Spanish speakers listen to the line “Circumvent your thick ego” from the song *Pictures* by System of a Down (*Steal this Album!*, 2002), they tend to hear *Sácame de aquí, King-Kong* [take me out of here, King-Kong]. Outrageous as these examples might sound, the reader may know a few cases in their own native language. This auditory illusion is common across languages and cultures and can feel quite real, often inevitable (Dembeck, 2015; Efimova et al., 2018). In Japanese, this phenomenon takes the name *Soramimi* (lit. “empty ear”). From a linguistic point of view, *Soramimi* is a particular case of homophonic translation: words or phrases that appear in the speech stream in one language are translated into similar-sounding words and phrases in a different language, without necessarily preserving the meaning (Gasparov, 2006). Homophonic translation has mostly received attention as a perceptual curiosity, and as a literary figure, intentionally employed by translators to preserve the meter and “sound structure” (e.g., rhymes) of an original text in the language of translation (e.g., Levick, 2016; Pilshchikov, 2016)². Little attention has been paid to homophonic translation as a psycholinguistic event.

In one of the few available studies concerning homophonic translation as a psycholinguistic phenomenon, Otake (2007) analysed 194 instances of *Soramimi*, broadcasted between 1992 and 2007 by the Japanese TV show *Soramimi hour*, in which examples of *Soramimi* were presented to the audience for comedy purposes. These instances consisted of homophonic translations of English song lyrics to words and phrases in Japanese. The vast majority of the reported instances were phrases (96%) and a few, single words (4%). There was relatively high variability in the degree to which phonetic features of the presented English lyrics were preserved, with some resulting Japanese words or phrases sharing high overlap with the original English strings of sounds, and some sharing very little overlap. An analysis of the few instances of homophonic translations of single words revealed three main phonological processes that could explain how Japanese listeners reconstructed the English input to generate the Japanese words: insertion (e.g., *cry* /krai/ to *kurai*, /kurai/ [dark]), deletion (e.g., *go*, /gou/ to *go*, /go/ [go]), and alternation (e.g., *low*, /lou/ to *rou*, /roo/ [wax]). This suggests that the reported homophonic translations can be explained, to some extent, as the result of the Japanese listeners accommodating the strings of English sounds to the Japanese phoneme inventory and Japanese phonotactics (Dupoux et al., 1999; Peperkamp et al., 2008).

The phonological processes described by Otake (2007) do not take place in a vacuum, but rather in the context of a lexicon. As words or phrases in the native lexicon are activated by their acoustic similarity with the non-native speech stream, they trigger a series of mechanisms that result in the selection of one of the candidate word or phrase in the native language. In the present work, we investigated the interplay between phonological similarity and one of the main mechanisms involved in the dynamics of lexical selection: phonological neighbourhood density. The phonological neighbourhood density of a given word-form refers to the number of words-forms that differ in a single phoneme from the former. For instance, the English word *cat* belongs to a dense phonological neighbourhood, with 50 English phonological neighbours (e.g., hat, bat, cap), while the word *charger* belongs to a sparse phonological neighbourhood, with six neighbours (e.g., charged, larger, charter, charmer). Phonological neighbourhood density affects lexical processing. For instance, words from dense neighbourhoods are recognized more slowly and less accurately in the auditory modality than words from sparse neighbourhoods (Dufour & Frauenfelder, 2010; e.g., Luce & Pisoni, 1998; M. Vitevitch, 2006; Vitevitch & Luce, 1998). In this study, we examined how listeners may activate lexical representations in their native language when listening to an unfamiliar language.

Although homophonic translations rarely involve preservation of meaning, homophonic translations sometimes may lead to correct translations. For example, imagine an English native listening to Dutch for the first time. This listener may encounter the word /'pɪŋɡʊm/ (*penguin*), which sounds similar to its English translation /'pɛŋɡwɪm/ (penguin). Given enough phonological similarity between the non-native word and its translation in the native language, a naïve listener may succeed at word comprehension when listening to an unfamiliar language. Such phonological similarity between translation equivalents—known as *cognateness*—is common across many languages, and is often due to typological closeness and/or socio-historical events

²The rationale behind this translation approach is to “sacrifice[s] fidelity to the image rather than the melodiousness of verse” (Briusov, 1911). For instance, Edith Grossman’s translation of *El Quijote* (Cervantes & Grossman, 2002) present a similar case, in which formal aspects of the original text in Spanish are favoured to some degree over equivalence to English, even sometimes keeping Spanish words from the original text in the English translation (e.g., Señor, insula).

involving the speakers of these languages (e.g., migration, social contact). For example, Romance languages such as Spanish and Catalan share many form-similar translation equivalents (Schepens et al., 2012), as in the case of *puerta* and *porta* (*door* in Spanish and Catalan, respectively). Given no prior knowledge of either language, a Spanish native speaker is likely to be much more successful at correctly translating Catalan *porta* than English *door*, due to the phonological and (orthographic similarity) of the former to the equivalent in their native language.

To explore the lexical mechanisms triggered by unfamiliar speech listening, we used a translation elicitation task in which participants listened to words from an unfamiliar language, and then tried to guess the words translations in their native language. We will henceforth refer to the auditory-presented words heard by participants on each trial as *presented words*, and the correct translation for the presented words as *target translations*. By manipulating the amount of phonological similarity between the presented words and their target translations, we explored listeners' reliance on phonological similarity to succeed in the task. Since participants were unfamiliar with the presented language, they could only use phonological similarity between the presented language and their native language to successfully translate the words. We therefore predicted that participants' performance should increase when the translation pairs are phonologically more similar. We also predicted that there is a minimum threshold of phonological similarity to be sufficient for correct translation.

We further investigated the effect of phonological competitors. Even if the presented word and its target translation share high phonological similarity, participants may still provide incorrect translations if the presented word also shares high phonological similarity with other words in the native language. Words with denser phonological neighbourhoods are recognised more slowly and less accurately than words with sparser phonological neighbourhoods (Dufour & Peereman, 2003; Goldinger et al., 1989; Hamburger & Slowiaczek, 1996; Luce et al., 1990; Luce & Pisoni, 1998). This is especially true if such neighbours share higher phonological similarity with the presented word, or are lexically more frequent than the target word (Luce & Pisoni, 1998). Such interference effect of phonological neighbourhood density has also been reported across languages (Weber & Cutler, 2004). We hypothesised that the size of the facilitatory role of phonological similarity would be inversely proportional to the amount of higher-frequency phonological neighbours of the presented word in the target language. In the case of non-native speech recognition, the presence of cross-linguistic pairs which are phonologically similar but differ in meaning (e.g., false friends) may act as distractors during lexical access, obstructing the selection of the appropriate target translation in the listener's lexicon. For instance, Otwinowska & Szewczyk (2019) reported that false friends were disadvantaged relative to non-cognates by Polish second language learners, in contrast to cognates which were known better. It is therefore important to investigate the joint effect of both cognates and false friends when investigating the effect that cross-linguistic phonological similarity has on word recognition in a foreign language. This could shed light on available strategies and challenges associated with the early stages of second language acquisition. For instance, one might expect English participants to incorrectly translate the Spanish word *botón* as *bottom* instead of as its correct translation *button*, due to the combined effect of the close phonological similarity between *botón* and *bottom* along with the high lexical frequency of *bottom* relative to *button*. To test this prediction, we developed a lexical frequency-dependent measure of cross-language phonological neighbourhood density, in which a neighbour is counted only if it is higher frequency and is one phoneme apart from the presented word. If the phonological neighbourhood density of the target translation affects participants' performance negatively, this would suggest that competitors in the native language affect recognition of non-native words during recognition of foreign speech. We conducted a series of three experiments to test these predictions.

In Experiment 1, we collected data from two groups of British English natives living in the United Kingdom. One group was presented with Catalan words, the other with Spanish words. We examined the extent to which participants were able to use the phonological similarity between the presented word (in Catalan or Spanish) and its target translation to provide accurate responses. In Experiment 2, we tested a group of (European) Spanish natives in the same task, who were presented with Catalan words. Catalan and Spanish are two Romance languages whose close typological distance is reflected in the fact that they share many cognates, where English is a Germanic language that shares considerably fewer cognates with Catalan and Spanish. By testing participants translating words from typologically close or distant languages, we expected to widen the range of the phonological similarity scores of the translation pairs involved in the experimental task, therefore allowing us to explore potential cross-language differences in participant's performance. One unexpected finding was that participants in Experiments 1 and 2 were surprisingly good at translating a subset of words which had low phonological similarity with their correct translation. We were concerned that this may be caused by some prior knowledge of specific words by our participants, as some Spanish words are

commonly seen in media or product labels, making them familiar even to monolingual speakers of English. In Experiment 3, we collected additional data from a new group of British English natives. The design was closely modelled after Experiment 1, except that after providing their response in each trial, participants reported whether they had previous knowledge of the presented word. In the final section of this article, we present analyses on the joint data sets of Experiments 1 to 3.

2 Experiment 1

2.1 Methods

All materials, data, and code used in this study are hosted in the Open Science Framework <https://osf.io/9fjxm/> and a GitHub repository <https://github.com/gongcastro/translation-elicitation.git>, along with additional notes.

2.1.1 Participants

We collected data from 71 British English-native adults living in the United Kingdom ($Mean = 21.76$ years, $SD = 2.15$, Range = 18-26, 46 female). Data collection took place from June 4th, 2020 to June 25th, 2020. Participants were recruited via Prolific (£5 compensation) and SONA (compensation in academic credits). Participants gave informed consent before providing any data. The study was conducted in accordance with ethical standards of the Declaration of Helsinki and the protocol was by the University of Oxford Medical Sciences Inter-Divisional Research Ethics Committee (IDREC) (R60939/RE007). Participants were asked to complete the experiment using a laptop in a quiet place with good internet connection.

Table 1: Participant details.

		Age		Second language
		Mean \pm SD	Range	
Experiment 1				
spa-ENG	35 (8)	21.80 \pm 2.08	18–26	Russian (1)
cat-ENG	36 (4)	21.72 \pm 2.25	18–25	French (1), German (1), Italian (1), Punjabi (1), Several (1)
Experiment 2				
cat-SPA	33 (12)	21.85 \pm 3.00	18–33	French (9), German (1), Italian (2)
Experiment 3				
spa-ENG	32 (1)	21.72 \pm 2.59	18–26	German (2), Japanese (1)
cat-ENG	32 (0)	22.31 \pm 2.39	18–26	Cantonese (1), Irish (1)

¹Number of included participants (number of excluded participants.)

2.1.2 Stimuli

We created two lists of words to be presented to participants in the auditory modality: one in Catalan and one in Spanish. Words in the Catalan list were 6.67 phonemes long on average ($SD = 2.06$, Range = 2-11), and the orthographic forms of their English translations (which participants had to type) were 5.12 characters long on average ($SD = 1.56$, Range = 3-9). Words in the Spanish list were 7.27 phonemes long on average ($SD = 2.05$, Range = 3-13), and the orthographic form of their English translations were 5.29 characters long on average ($SD = 1.77$, Range = 3-12).

In each trial, participants listened to one audio file, which contained a single word. The audio files were the same ones used in child experiments conducted in the Laboratori de Recerca en Infància of Universitat Pompeu Fabra (Barcelona, Spain). These audio files were recorded by a proficient Catalan-Spanish female bilingual from the Metropolitan Area of Barcelona in a child-directed manner. Catalan and Spanish words were recorded at 44,100 Hz in separate files in the same session, and then de-noised using Audacity and normalised at peak intensity using Praat (Broersma & Weenink, 2021). The average duration of the Catalan audio files was 1.24 seconds ($SD = 0.19$, Range = 0.8-1.58). The average duration of the Spanish audio files was 1.16 seconds ($SD = 0.15$, Range = 0.78-1.53).

For each word pair in the Catalan and Spanish lists, we defined three predictors of interest: the lexical frequency of the correct English translation (*Frequency*), the phonological similarity between the presented word and its correct English translation (*Similarity*), and the presented word’s number of cross-language

phonological neighbours (*CLPN*) in English. *Frequency* was included as a nuisance predictor, under the hypothesis that—keeping other predictors constant—participants would provide correct responses more often when the correct translations are high frequency words in their native language. Lexical frequencies of correct translations were extracted from SUBTLEX-UK (Van Heuven et al., 2014), and transformed to Zipf scores. Translations without a lexical frequency value were excluded from data analysis (2 in the Catalan list, 5 in the Spanish list). *Similarity*, our main predictor of interest, was calculated as the Levenshtein similarity between the X-SAMPA transcriptions of each pair of translations using the `stringdist` R package (van der Loo, 2014). The Levenshtein distance computes the edit distance between two character strings—in this case, two phonological transcriptions—by counting the number of additions, deletions, and substitutions necessary to make both strings identical (Levenshtein, 1966). We divided this edit distance by the number of characters in the longest X-SAMPA transcription of the translation pair. This transformation accounts for the fact that Levenshtein distance tends to increase with the length of the transcriptions. For interpretability, we subtracted this proportion from one, so that values closer to one correspond to higher similarity between phonological transcriptions, and values closer to zero correspond to lower similarity between phonological transcriptions. For example, the *table* (**tEɪbəl**)-*mesa* (**mesa**) translation pair had 17% similarity, while the *train* (**trEɪn**)-*tren* (**tREn**) translation pair had 60% similarity. We calculated the number of *CLPN* for each Catalan and Spanish word by counting the number of English words with same or higher lexical frequency, and whose phonological transcription (in X-SAMPA format) differed by up to one phoneme from that of the presented Catalan or Spanish word. Lexical frequencies and phonological transcriptions were extracted from the multilingual database CLEARPOND (Marian et al., 2012)³. Table 2 summarises the lexical frequency, phonological neighbourhood density and phonological overlap of the words included in the Catalan and the Spanish lists.

Table 2: Stimuli details.

	Frequency		Similarity		CLPN	
	Mean \pm SD	Range	Mean \pm SD	Range	Mean \pm SD	Range
spa-ENG	5.88 \pm 0.57	4.43–7.24	0.13 \pm 0.18	0.00–0.75	0.19 \pm 0.79	0–5
cat-ENG	5.89 \pm 0.59	4.43–7.27	0.16 \pm 0.18	0.00–0.67	0.76 \pm 2.53	0–15
cat-SPA	5.79 \pm 0.63	4.48–7.70	0.38 \pm 0.26	0.00–1.00	0.87 \pm 2.08	0–12
Mean	5.85	—	0.225	—	0.606	—

2.1.3 Procedure

The experiment was implemented online using Psychopy/Pavlovia (Peirce et al., 2019). Participants accessed the study from a link provided by Prolific or SONA and completed the experiment from an internet browser (Chrome or Mozilla). After giving their consent for participating, participants answered a series of questions about their demographic status, their language background, and the set up they were using for completing the study. Then, participants completed the experimental task. Participants were informed that they would listen to a series of pre-recorded words in either Catalan or Spanish. They were instructed to listen to each word, guess its meaning in English, and type their answer as soon as possible. Participants were randomly assigned to the Catalan or Spanish lists. Participants in the Catalan list were presented with 83 trials, and participants in the Spanish list were presented with 99 trials⁴.

Each trial started with a yellow fixation point presented during one second on the centre of the screen over a black background. After one second, the audio started playing while the dot remained being displayed until the audio ended. Upon the offset of the fixation point and audio, participants were prompted to write their answer by a > symbol. Typed letters were displayed on the screen in real time to provide visual feed-back to participants. Participants were allowed to correct their answer. Then, participants pressed the RETURN/ENTER key to confirm their answer and start a new trial. Figure 1 illustrates the time course of a trial in the translation elicitation task.

2.1.4 Data analysis

2.1.4.1 Data processing After data collection, participants’ answers were manually coded into the following categories: *Correct*, *Typo*, *Wrong*, *False friend*, *Other*. A response was coded as *Correct* if the provided string of characters was identical to the orthographic form of the correct translation. A response was coded as

³Phonological transcriptions in CLEARPOND were generated from eSPEAK, <http://espeak.sourceforge.net/>

⁴Stimuli lists were built from a pool of audio recordings made for a different study. The different number of trials in the Catalan and Spanish lists is due to more Spanish audios being available than Catalan audios.

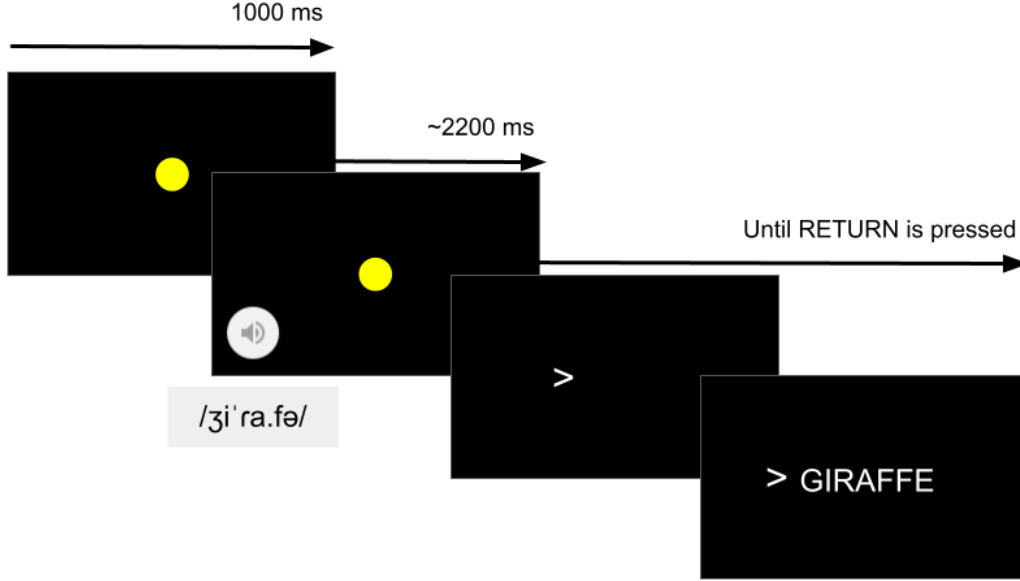


Figure 1: Schematic representation of a trial in the experimental task. The trial starts with the presentation of a fixation point in the centre of the screen (yellow dot). After 1,000 ms, the auditory word was presented while the fixation point remained on screen. After the offset of the audio, the fixation point disappeared and a visual prompt (>) was presented. Participants then wrote their answer and clicked **RETURN**, making the end of the trial.

Typo if the participant provided a string of characters that was only one edit distance (addition, deletion, or substitution) apart from the orthographic form of the correct translation (e.g., “pengiun” instead of “penguin”), as long as the response did not correspond to a distinct English word. A response was coded as *False friend* if the participant’s response was incorrect, but phonologically similar to the presented word. Responses not meeting the criteria for previous categories were labelled as *Wrong* or *Other* (see Data analysis section for more details). Both *Correct* and *Typo* responses were considered as correct, while *Wrong* and *False friend* responses were considered as incorrect. *Other* responses were excluded from data analysis. Trials in which participants took longer than 10 seconds to respond were also excluded. Participants contributed a total of 5,206 valid trials (2,604 in Catalan, 2,602 in Spanish). The task took approximately 15 minutes to complete.

2.1.4.2 Modelling approach and statistical inference We modelled the probability of participants guessing the correct translation of each presented word using a generalised multilevel Bayesian regression model with a Bernoulli logit link distribution. We included as fixed effects the intercept, the main effects of *Frequency*, *Similarity*, *CLPN*, and *Group* (sum-coded as *cat-ENG* = -0, *spa-ENG* = +0.5, [Schad et al., 2020](#)) and the three-way interaction between *Similarity*, *CLPN*, and *Group*. The predictor *Group* was included to account for any differences in task performance between English participants translating Catalan and Spanish words. We also included participant-level random intercepts and slopes for the main effects and the interaction. Eq. 1 shows a formal description of the model.

Likelihood

$$y_i \sim \text{Bernoulli}(p_i)$$

Parameters

$$\begin{aligned} \text{Logit}(p_i) = & \beta_{0[p,w]} + \beta_{1[p]} \text{Frequency}_i + \beta_{2[p]} \text{Similarity}_i + \beta_{3[p]} \text{CLPN}_i + \beta_{4[p]} \text{Group}_i + \\ & \beta_{5[p]} (\text{Similarity}_i \times \text{CLPN}_i) + \beta_{6[p]} (\text{Similarity}_i \times \text{Group}_i) + \\ & \beta_{7[p]} (\text{CLPN}_i \times \text{Group}_i) + \beta_{8[p]} (\text{Similarity}_i \times \text{CLPN}_i \times \text{Group}_i) \end{aligned} \quad (1)$$

$$\beta_{0-8[p,w]} \sim \mathcal{N}(\mu_{\beta_j}, \sigma_{\beta_j}), \text{ for participant } p \text{ in } 1, \dots, P \text{ and word } w \text{ in } 1, \dots, W$$

$$\beta_{1-8[p]} \sim \mathcal{N}(\mu_{\beta_j}, \sigma_{\beta_j}), \text{ for participant } p \text{ in } 1, \dots, P$$

Prior

$$\begin{aligned} \mu_{\beta_{p,w}} & \sim \mathcal{N}(0, 0.1) \\ \sigma_{\beta_p}, \sigma_{\beta_w} & \sim \text{HalfCauchy}(0, 0.1) \\ \rho_p, \rho_w & \sim \text{LKJCorr}(8) \end{aligned}$$

To test the practical relevance of each predictor we followed Kruschke & Liddell (2018). We first specified a region of practical equivalence (ROPE) around zero $([-0.1, +0.1], \text{ in the logit scale})$. This area indicates the values of the regression coefficients that we considered as equivalent to zero. We then computed the 95% posterior credible intervals (CrI) of the regression coefficients of interest. Finally, we calculated the proportion of the 95% CrI that fell inside the ROPE. This proportion indicates the probability that the true value of the coefficient is equivalent to zero. All analyses were performed in the R environment (R Core Team, 2013). We used the tidyverse family of R packages (Wickham et al., 2019) to process data and to generate figures. We used the brms R package (Bürkner, 2017) using the cmdstanr back-end to the Stan probabilistic language (Carpenter et al., 2017) to estimate and compare the models (see Appendix 1 for more details on the models). Numeric predictors were standardised before entering the model by subtracting the mean and dividing by the standard deviation. Categorical predictors were sum-coded as -0.5 and $+0.5$ (Schad et al., 2020).

2.2 Results

We collected data for a total of 6,446 trials completed by 72 participants. We excluded trials in which participants did not enter any text ($n = 72$), in which a response in a language other than English was provided (e.g., “agua”, $n = 51$), in which participants did not provide a whole word (e.g., “f”, $n = 5$), and in which participants added comments to the experimenter (e.g., “unsure”, $n = 13$). In addition, we excluded data from participants that self-rated their oral and/or written skills in Catalan and Spanish, or any other second language as four or higher in a five-point scale ($n = 2$), were diagnosed with a language disorder ($n = 1$), or did not contribute more than 80% of valid trials ($n = 9$).

After applying trial-level and participant-level exclusion criteria, the resulting dataset included 5,204 trials provided by 54 participants. Of those trials, 2,602 were provided by 27 participants who listened to Catalan words, and 2,604 trials were provided by 32 participants who listened to Spanish words. Responses given by English participants to Catalan presented words were 5.35 characters long on average ($\text{Median} = 5$, $SD = 1.79$, $\text{Range} = 1-14$), while their translations to Spanish responses were 5.57 characters long on average ($\text{Median} = 5$, $SD = 1.97$, $\text{Range} = 2-21$).

Table 3 shows a summary of participants’ accuracy across Experiments 1, 2, and 3. MCMC chains in the model showed strong evidence of convergence ($\hat{R} < 1.01$) (see Appendix 2 for more detailed model diagnostics). Participants translating Catalan words and participants translating Spanish words performed equivalently, as indicated by the regression coefficient of *Group* ($\beta = -0.165$, 95% CrI = $[-0.482, 0.125]$, $p(\text{ROPE}) = 0.302$). Overall, participants responded less accurately to words with more CLPNs than to words with fewer CLPNs, regardless of the amount of phonological similarity between the presented word and its translation. This is indicated by the size of the regression coefficient of the two-way interaction between *Similarity* and *CLPN* ($\beta = -0.236$, 95% CrI = $[-0.362, -0.118]$, $p(\text{ROPE}) = 0.015$). As anticipated, participants’ performance benefited from an increase in *Similarity* ($\beta = 1.437$, 95% CrI = $[1.314, 1.544]$,

259 $p(\text{ROPE}) = 0$), while the number of *CLPN* had the opposite effect ($\beta = -0.167$, 95% CrI = $[-0.352, -0.01]$,
 260 $p(\text{ROPE}) = 0.2$). Figure 2 illustrates the posterior of the average predictions of the model for words with
 261 different values of *Similarity* and *CLPN*.

Table 3: Summary of participants' accuracy in the translation elicitation task across Experiments 1, 2, and 3.

		Accuracy (%)				Valid trials				
		N	Mean	SD	SE	Range	Mean	N trials	SD	Range
Experiment 1										
spa-ENG	27	15.86	5.20	3.05	8.82–28.71	96.37	2,602	2.88	87–98	
cat-ENG	32	18.48	4.89	3.27	10.84–32.56	81.38	2,604	3.17	71–83	
Experiment 2										
cat-SPA	21	48.30	5.29	10.54	38.27–58.97	79.14	1,662	3.14	72–82	
Experiment 3										
spa-ENG	31	20.92	8.29	3.76	5.88–44.12	97.45	3,021	1.80	88–98	
cat-ENG	32	19.74	4.94	3.49	10.34–27.91	82.75	2,648	0.44	82–83	

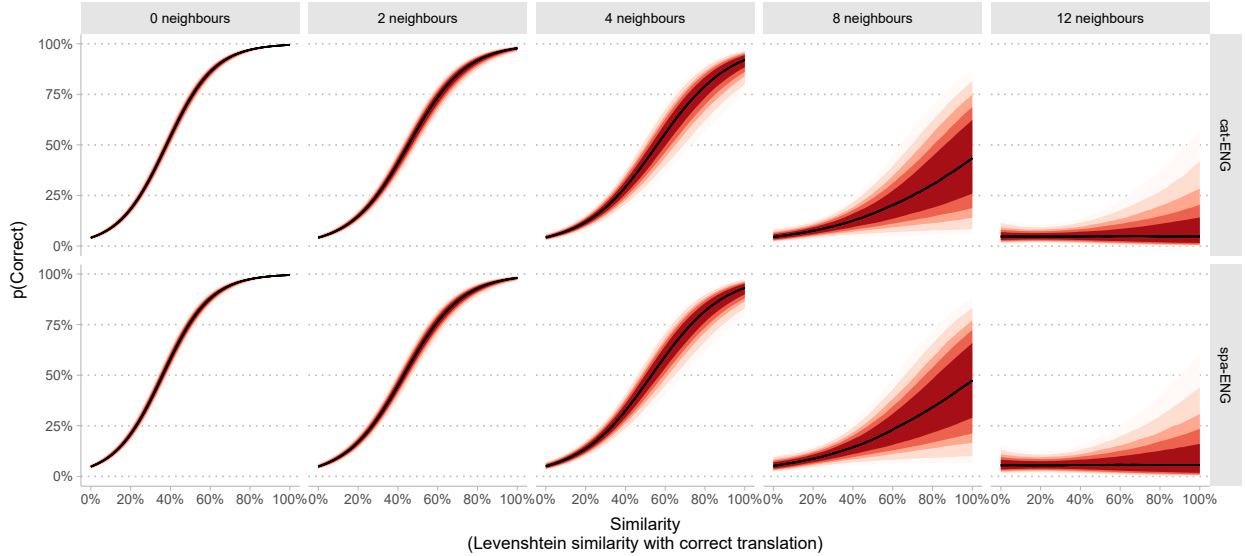


Figure 2: Posterior model-predicted mean accuracy in Experiment 1. Predictions were generated from 4,000 posterior samples, extracted for different values of *CLPN* (0, 2, 4, 8, 12) and *Similarity* (1-100). Predictions are plotted separately for English participants translating Catalan words, and for English participants translating Spanish words. Lines indicate mean predictions, and intervals indicate 95%, 89%, 78%, 67%, and 50% credible intervals (CrI).

2.3 Discussion

In Experiment 1, we investigated the extent to which the phonological similarity between translation equivalents is sufficient for successful word translation, in the absence of conceptual knowledge about the presented word. We tested two groups of monolingual British English-native adults in a translation task that involved words in Catalan or Spanish, two languages participants reported having no prior familiarity with. Participants benefited strongly from phonological similarity when the correct translation of the presented words in Catalan or Spanish had few English phonological neighbours with higher lexical frequency. As the number of higher-frequency English phonological neighbours increased, both participants' accuracy and the impact of phonological similarity approached zero. This suggests that word-forms in an unfamiliar language have a strong potential to activate their translation equivalents in the native language, provided some phonological similarity between both words, and the absence of more frequent phonological neighbors.

Participants in Experiment 1 were surprisingly good at translating words from Catalan and Spanish (two unfamiliar languages) to their native language. If English participants were likely to activate the correct English translations of the presented words in Catalan and Spanish, it is possible that speakers of typologically closer languages to Catalan and Spanish may benefit even more strongly from phonological similarity in the same task. English is a Germanic language (like Dutch or German), while Catalan and Spanish are Romance languages (like Italian, French, Portuguese). English shares fewer phonologically similar translations with Romance languages than Romance languages share with each other. It is possible that the probability of homophonic translations is higher when listening to an unfamiliar language from the same typological family as the native language. We tested this hypothesis in Experiment 2.

3 Experiment 2

Results in Experiment 1 suggest that English natives were able to exploit the phonological similarity between unfamiliar words in Catalan and Spanish to provide accurate translations to English. English, a Germanic language, is relatively distant from Catalan and Spanish, two Romance languages. In comparison, Catalan and Spanish are typologically close languages that share many more cognates. In Experiment 2, we investigated whether listeners of an unfamiliar but typologically closer language benefit more strongly from phonological similarity when performing the same task as in Experiment 1. To this aim, we presented Spanish participants, who reported little-to-no prior familiarity with Catalan, with Catalan words.

3.1 Methods

We collected data from 33 Spanish native adults living in Spain ($Mean = 21.85$ years, $SD = 3$, Range = 18-33, 28, 5 female). Data collection took place from June 8th, 2020 to June 28th, 2020. Participants in Spain were contacted via announcements at the University campus(es), and were compensated €5 or an Amazon voucher for the same value. Participants gave informed consent before providing any data and the study was conducted in accordance with ethical standards of the Declaration of Helsinki and the protocol was approved by the Drug Research Ethical Committee (CEIm) of the IMIM Parc de Salut Mar (2020/9080/I).

Stimuli were the same list of Catalan stimuli as in Experiment 1. Procedure and data analysis were identical as in Experiment 1, with the only exception that the statistical model did not include the *Group* predictor, given that only one group (*cat-SPA*) participated in this experiment.

3.2 Results

We collected data for a total of 5,412 trials completed by 33 participants. We excluded trials in which participants did not enter any text ($n = 44$), in which a response in a language other than Spanish was provided ($n = 51$), in which participants did not provide a whole word ($n = 7$), and in which participants added comments to the experimenter ($n = 1$). In addition, we excluded data from participants that self-rated their oral and/or written skills in Catalan and Spanish, or any other second language as four or higher in a five-point scale ($n = 22$), were diagnosed with a developmental language disorder ($n = 1$), or did not contribute more than 80% of valid trials ($n = 9$). After applying trial-level and participant-level inclusion criteria, the resulting dataset included 1,662 trials provided by 42 participants. Of those trials, 1,662 were provided by 21 participants who listened to Catalan words, and 1,662 trials were provided by 21 participants who listened to Spanish words. Responses given by participants were 5.6 characters long on average ($Median = 5$, $SD = 1.6$, Range = 2-12).

MCMC chains in the model showed strong evidence of convergence ($\hat{R} < 1.01$) (see Appendix 2 for more detailed model diagnostics). Overall, participants responded less accurately to words with more CLPNs than to words with fewer CLPNs, regardless of the amount of phonological similarity between the presented word and its translation. This is indicated by the size of the regression coefficient of the two-way interaction between *Similarity* and *CLPN* ($\beta = -0.162$, 95% CrI = [-0.369, 0.032], $p(\text{ROPE}) = 0.268$). As anticipated, participants' performance benefited from an increase in *Similarity* ($\beta = 1.906$, 95% CrI = [1.712, 2.086], $p(\text{ROPE}) = 0$), while the number of *CLND* had the opposite effect ($\beta = -0.274$, 95% CrI = [-0.613, 0.088], $p(\text{ROPE}) = 0.14$). Figure 3 illustrates the posterior of the average predictions of the model for words with different values of *Similarity* and *CLPN*.

In order to compare the results from Experiments 1 and 2 directly, we fit a model on the joint datasets from both experiments. This model included all predictors from the models presented in Experiments 1 and 2, and the predictor *Experiment* with levels "Experiment 1" and "Experiment 2", and a three-way interaction between *Experiment*, *Similarity*, and *CLPN*. The *Experiment* variable was sum-coded as $-0.5 = \text{Experiment 1}$ and $+0.5 = \text{Experiment 2}$. All two-way interactions between the three predictors were also included. The effect of *CLPN* on *Similarity* was equivalent in both groups, as indicated by the coefficient

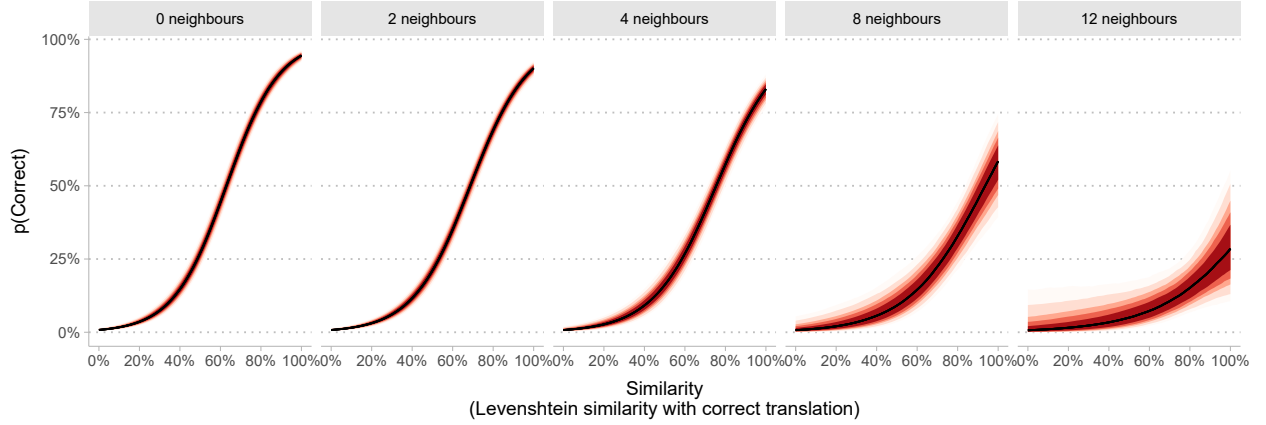


Figure 3: Posterior model-predicted mean accuracy in Experiment 1. Predictions were generated from 4,000 posterior samples, extracted for different values of CLPN (0, 2, 4, 8, 12) and Similarity (1-100). Lines indicate mean predictions, and intervals indicate 95%, 89%, 78%, 67%, and 50% credible intervals (CrI).

of the three-way way interaction ($\beta = 0.105$, 95% CrI = $[-0.151, -0.043]$). The posterior probability of this coefficient being equivalent to zero— $p(\text{ROPE})$ —was 0.422, that is, inconclusive. The coefficient of the interaction term between *Experiment* and *CLPN* was also equivalent to zero ($\beta = -0.09$, 95% CrI = $[-0.458, 0.346]$, $p(\text{ROPE}) = 0.361$), suggesting that participants from Experiments 1 and 2 were affected by CLPN on a similar basis. Finally, the coefficient of the interaction between *Experiment* and *Similarity* was different from zero ($\beta = -0.09$, 95% CrI = $[0.326, 0.785]$, $p(\text{ROPE}) = 0$), with a positive sign indicating that the increments in *Similarity* were associated with a larger increment in probability of correct translation in Experiment 2, compared to in Experiment 1: for an average value of *CLPN*, participants in Experiment 2 benefited more strongly from *Similarity* than participants in Experiment 1.

3.3 Discussion

Experiment 2 was an extension of Experiment 1 to a population of monolinguals whose native language is typologically close to the presented language. We presented Catalan words to Spanish native adults who were reportedly unfamiliar with Catalan. Our results indicate a similar pattern of results as those in Experiment 1: participants were able to provide correct translations of presented Catalan words, provided that the Catalan words shared some degree of phonological similarity with their Spanish translation, and that the number of phonological neighbours with higher lexical frequency was reduced. In contrast with the results in Experiment 1, the positive impact of phonological similarity on participants' performance in Experiment 2 larger. Spanish natives in Experiment 2 provided exploited phonological similarity more strongly than English natives in Experiment 1. Overall, this suggests that participants in Experiment 2, who were natives of a typologically similar language (Spanish) to the presented language (Catalan), benefited more strongly from phonological similarity than participants in Experiment 1, who were natives of typologically less similar language (English) to the presented language (Catalan, Spanish). Participants from both Experiment 1 and 2 benefited strongly from phonological similarity to correctly translate words from a non-native, reportedly unfamiliar language. This pattern of results holds for most of the presented stimuli, but some low-similarity Catalan and Spanish words were responded to surprisingly accurately by English listeners. Given that participants were reportedly unfamiliar with both languages, it was expected that participants would be very unlikely to provide correct translations for words sharing little to no phonological similarity to their correct translation. Table 4 shows a list of Catalan and Spanish words to which participants provided responses with ≥ 10 average accuracy.

It is likely that participants had prior knowledge of these words despite having reported little to no familiarity with the presented language (Catalan or Spanish). One possibility is that participants had previously encountered these words embedded in English linguistic input. Spanish words percolate English speech with relative frequency, via different sources such as popular culture, songs, TV programs, etc. In addition, words from languages other than Spanish or Catalan, but with high similarity to the Spanish or Catalan words (e.g., cognates from Italian or French) might appear in English speech as well. Such prior knowledge might not be specific to the low-similarity words highlighted before. Participants may also have had prior knowledge about higher-similarity words, which could have contributed to participants responding to such words more

Table 4: List of items with unexpectedly high accuracy: the Levenshtein similarity score between the presented word (in Catalan or Spanish) and their correct English translation is zero, but participants, who are reportedly unfamiliar with the presented language, were on average >10% likely to guess the correct translation.

Translation	IPA	Accuracy (%)	SE
Experiment 1 (cat-ENG)			
cavall - horse	/kə'baɫ/ - /hɔ:s/	17.14	6.37
llibre - book	/'li.βrə/ - /bʊk/	17.14	6.37
camisa - shirt	/ka.'mi.za/ - /ʃɜ:t/	16.67	6.21
poma - apple	/'po.ma/ - /'aepl/	16.67	6.21
cama - leg	/'ka.mə/ - /lɛg/	11.11	5.24
Experiment 2 (spa-ENG)			
pantalón - trousers	/paŋ.ta'lon/ - /'traʊzəz/	77.42	7.51
naranja - orange	/na'raŋ.xa/ - /'ɒrɪndʒ/	41.94	8.86
leche - milk	/'le.tʃe/ - /mɪlk/	35.48	8.59
toro - bull	/'to.ro/ - /bʊl/	33.33	8.61
libro - book	/'li.βro/ - /bʊk/	30.00	8.37
cebra - zebra	/'θe.bra/ - /'zi:brə/	29.03	8.15
pan - bread	/pan/ - /brɛd/	29.03	8.15
pollo - chicken	/'po.ɫo/ - /'tʃɪkɪn/	26.67	8.07
jirafa - giraffe	/xi'ra.fa/ - /dʒɪ'ra:f/	20.69	7.52
perro - dog	/pe.ro/ - /dɒg/	16.13	6.61
pluma - feather	/plu.ma/ - /'fɛðə/	16.13	6.61
puerta - door	/pwer.ta/ - /dɔ:/	16.13	6.61
pie - foot	/pje/ - /fʊt/	12.90	6.02
caballo - horse	/ka'βa.ɫo/ - /hɔ:s/	10.34	5.66
bocadillo - sandwich	/bo.ka'di.ɫo/ - /'saɛnwɪdʒ/	10.00	5.48
globo - balloon	/'glo.βo/ - /bə'lʊn/	10.00	5.48
Experiment 3 (cat-SPA)			
fulla - hoja	/'fu.ɫə/ - /'o.xa/	30.43	9.59
ull - ojo	/uɫ/ - /'o.xo/	21.74	8.60
got - vaso	/'gɔt/ - /'ba.so/	20.00	8.00
entrepà - bocadillo	/en.trə'pa/ - /bo.ka'di.ɫo/	13.04	7.02
mirall - espejo	/mi'raɫ/ - /es'pe.xo/	12.50	6.75

accurately than without such prior knowledge. In the case of higher-similarity words, it is more difficult to disentangle the extent to which participants' accuracy is a function of pure phonological similarity, or prior knowledge they had about the meaning of Spanish words. Experiment 3 was addressed at investigating the issue of prior knowledge.

4 Experiment 3

Experiment 3 is a replication of Experiment 1, in which we collected additional data about participants' prior familiarity with the presented Catalan and Spanish words, in addition to the same translation task presented to participants in Experiment 1.

4.1 Methods

We collected data from 64 British English native adults living in United Kingdom ($Mean = 22.02$ years, $SD = 2.49$, Range = 18-26, 36, 28 female). Data collection took place from October 22th, 2022 to October 23th, 2022. Participants were recruited via Prolific (5£ compensation) and SONA (compensation in academic credits), and gave informed consent before providing any data and the study was conducted in accordance with ethical standards of the Declaration of Helsinki and the protocol was by the University of Oxford Medical Sciences Inter-Divisional Research Ethics Committee (IDREC) (R60939/RE007). Participants were asked to complete the experiment using a laptop in a quiet place with good internet connection. Stimuli were the same lists of Catalan and Spanish stimuli as in Experiment 1.

The experiment was implemented online using Qualtrics (Qualtrics, Provo, UT). This platform was chosen to allow easier presentation of survey questions aimed to probe prior understanding of the presented words and participants' confidence ratings of their answers. With the exception of these additional questions, we attempted to replicate the procedure of Experiment 1 as closely as possible. The Spanish and Catalan audio stimuli used were identical the materials in Experiment 1. Participants were randomly assigned to the Catalan or Spanish lists. The Catalan list had 83 trials and the Spanish list had 99 trials. Participants first completed the consent form followed by the questionnaire about demographic status, language background and set up. They then proceeded to the experimental task.

In each trial, participants listened to the audio stimulus by clicking on the PLAY button. For comparability to the PsychoPy version, participants were only allowed to play the audio one time. Participants were explicitly told that they would be only allowed to listen once. The PLAY button vanished after one playthrough. Participants then had to answer three questions based on the audio they had heard on that trial. These questions were presented on the same page, directly below the audio player. They were first asked whether they knew the presented word (multiple choice—*yes/no*). Regardless of their answer on the first question, participants were asked what they thought the translation of the word was in English (or their best guess), and instructed to type their answer in the provided text box. Finally, they were asked to rate how confident they were in their answer on a scale of 0 to 7, where 7 was “very confident” and 0 was “not confident”. There was no time limit on the response phase. All questions had to be answered to proceed to the next trial.

Participants first completed 5 practice trials with English words as the audio stimulus (ambulance, cucumber, elephant, pear, turtle). The words were recorded by a female native speaker of British English. These trials acted as attention checks, as participants should always answer “yes” to the first question on prior word knowledge and be able to accurately transcribe the word they heard. Following the practice phase, participants completed the test phase where they heard either Spanish words or Catalan words.

4.2 Results

We collected data for a total of 6,016 trials completed by 64 participants. We excluded trials in which participants did not enter any text ($n = 0$), provided a response in a language other than English ($n = 9$), did not provide a whole word ($n = 0$), or added comments to the experimenter ($n = 0$). In addition, we excluded data from participants that self-rated their oral and/or written skills in Catalan and Spanish, or any other second language as four or higher in a five-point scale ($n = 2$), were diagnosed with a language disorder ($n = 0$), or did not contribute more than 80% of valid trials ($n = 1$).

After applying trial-level and participant-level inclusion criteria, the resulting dataset included 5,888 trials provided by 63 participants. Of those trials, 3,145 were provided by 31 participants who listened to Catalan words, and 2,743 trials were provided by 32 participants who listened to Spanish words.

From the 3,145 total responses provided by English participants who listened to Catalan words, participants reported having prior knowledge of the presented Catalan words in 446 (14.18%) of them. In those responses, participants reported an average of 5.05 confidence in the 0-8 scale ($SD = 1.94$). For responses where no prior

knowledge of the presented word was reported, average confidence was 1.13 ($SD = 1.38$). From the 2,743 total responses provided by English participants who listened to Spanish words, participants reported having prior knowledge of the presented Spanish words in 197 (7.18%) of them. In those responses, participants reported an average of 4.79 confidence in the 0-8 scale ($SD = 1.82$). For responses where no prior knowledge of the presented word was reported, average confidence was 1.25 ($SD = 1.66$). Before data analysis, responses where participants reported prior knowledge about the meaning of the presented Catalan or Spanish word were excluded from the dataset.

Responses given by English participants to Catalan presented words were 5.49 characters long on average ($Median = 5$, $SD = 1.71$, $Range = 1-14$), while their translations to Spanish responses were 5.39 characters long on average ($Median = 5$, $SD = 1.75$, $Range = 1-20$).

MCMC chains in the model showed strong evidence of convergence ($\hat{R} < 1.01$) (see Appendix 2 for more detailed model diagnostics). Overall, participants reported prior knowledge more often for the Spanish words that showed unexpectedly high accuracy in Experiment 1 (see Discussion in Experiment 2) than for words with expected accuracy (see Figure 4). Participants reported prior knowledge of Catalan words with unexpected accuracy in Experiment 1 as often as those with expected accuracy. This suggests that participants in Experiment 1 may have relied, to some extent, on their prior knowledge about form-meaning mappings to correctly translate some Spanish words. To isolate such an effect of prior Spanish knowledge, we run the same analysis as in Experiment 1 on the newly collected translations from Experiment 3, now excluding responses to words for which participants reported prior knowledge.

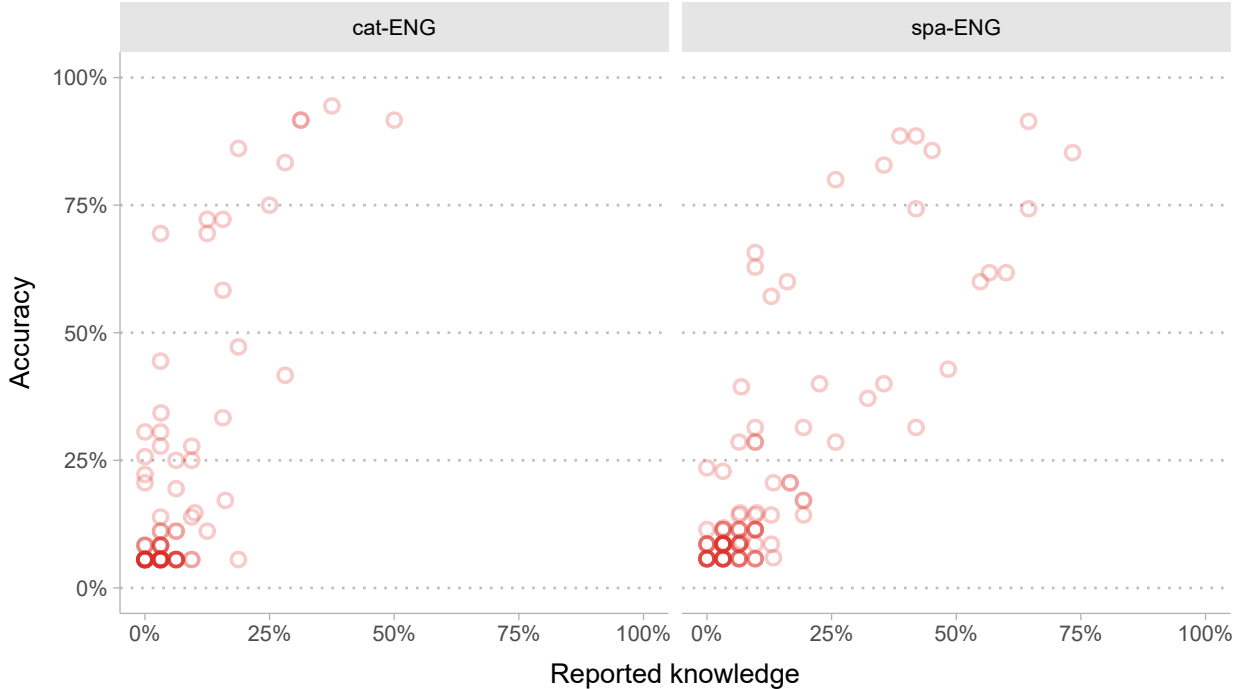


Figure 4: Catalan and Spanish prior word knowledge, as reported by English native participants in Experiment 3. The X-axis indicates the proportion of participants that reported prior knowledge with the word. The Y-axis indicates participants' accuracy (the proportion of correct responses by participants). Each colour indicates whether the data point corresponds to a word that participants answered to with expected accuracy (red) or with unexpectedly high accuracy (blue), as defined by (no phonological similarity with the correct translation, by accuracy higher than 10%).

Participants translating Catalan words and participants translating Spanish words performed similarly, as indicated by the regression coefficient of *Group* ($\beta = -0.065$, 95% CrI = [-0.389, -0.118], $p(\text{ROPE}) = 0.422$). Overall, both groups of participants responded less accurately to words with more CLPNs than to words with fewer CLPNs, regardless of the amount of phonological similarity between the presented word and its translation. This is indicated by the size of the regression coefficient of the two-way interaction between *Similarity* and *CLPN* ($\beta = -0.252$, 95% CrI = [-0.385, -0.118], $p(\text{ROPE}) = 0.015$). As anticipated, partici-

442 pants' performance benefited from an increase in *Similarity* ($\beta = 1.532$, 95% CrI = [1.41, 1.657], $p(\text{ROPE})$
 443 = 0), while the number of *CLPN* had the opposite effect ($\beta = -0.288$, 95% CrI = [-0.523, -0.082], $p(\text{ROPE})$
 444 = 0.023). Figure 5 illustrates the posterior of the average predictions of the model for words with different
 445 values of *Similarity* and *CLPN*.

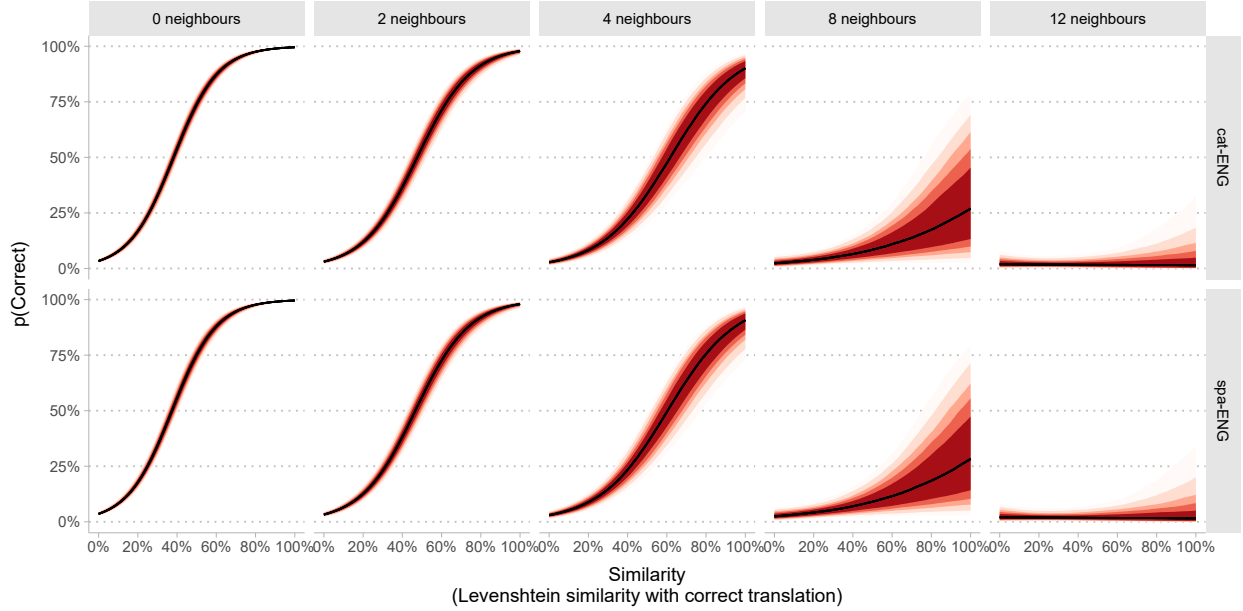


Figure 5: Posterior model-predicted mean accuracy in Experiment 3. Predictions were generated from 4,000 posterior samples, extracted for different values of CLPN (0, 2, 4, 8, 12) and Similarity (1-100). Predictions are plotted separately for English participants translating Catalan words, and for English participants translating Spanish words. Lines indicate mean predictions, and intervals indicate 95%, 89%, 78%, 67%, and 50% credible intervals (CrI).

446 4.3 Discussion

447 Experiment 3 was a conceptual replication of Experiment 1 in which we gathered additional information about
 448 English native participants' prior familiarity with the meaning of the Catalan and Spanish words presented.
 449 After each trial, participants reported whether they had prior knowledge about the word meaning, and how
 450 confident they were about such information in a numeric scale from 0 to 7. To control for the effect of
 451 participants' prior knowledge about form-meaning mappings, we excluded from the analyses those words
 452 in which participants reported such prior knowledge. We found equivalent results to those in Experiment 1,
 453 indicating that participants' surprisingly good performance in the translation elicitation task was not due
 454 to being familiar with the meaning of words they were presented with.

455 5 General discussion

456 The present work explored the lexical processing bases of homophonic translation, a phenomenon in which
 457 listening to speech in a non-native—perhaps unfamiliar—language leads to the activation of lexical represen-
 458 tations in the native language, without necessarily preserving the meaning. We investigated how phonological
 459 similarity and its interaction with phonological neighbourhood density impact the dynamics of lexical acti-
 460 vation and selection during non-native word processing. We designed a translation elicitation task in which
 461 participants listened to individual words in a non-native, unfamiliar language. After listening to each word,
 462 participants were asked to provide their best-guess translation for each word in their native language. In
 463 Experiment 1, British English-native adults listened to a list of words in Catalan or Spanish. Participants
 464 reported no prior familiarity with Catalan, Spanish, or any other Romance language, yet provided accurate
 465 translations for words that shared some degree of phonological similarity with their correct English trans-
 466 lation. We calculated phonological similarity between word pairs as the Levenshtein similarity between the
 467 X-SAMPA transcription of their phonological forms (see Floccia et al., 2018 for a similar approach). Using
 468 this measure, we found that participants were able to exploit the phonological similarity between the pre-
 469 sented words and their correct translation, even when both words-forms shared few phonemes. This points

to listeners accommodating non-native phonological forms to their native phoneme inventory, resulting in the activation of native lexical representations.

Experiment 2 was aimed at extending our findings to a population of participants whose native language was typologically closer to the unfamiliar language presented. We tested a group of Spanish native adults who listened to a list of Catalan words. Again, participants reported no prior familiarity with Catalan, or any other Romance language other than Spanish. In line with the results with English natives, we found an interaction between phonological similarity and phonological neighbourhood size. Spanish natives in Experiment 2 exploited phonological similarity more strongly than English natives in Experiment 1: the association between phonological similarity and the probability of correct translation was stronger in Experiment 2, compared to in Experiment 1.

Experiment 3 was a replication of Experiment 1, in which we collected additional information about participants' prior familiarity with the presented Catalan and Spanish words. This follow-up experiment was designed to address concerns that participants in Experiments 1 and 2 might have managed to provide correct translations for some words thanks to having prior experience with those words. The design of Experiment 3 was closely modelled after Experiment 1, except that after providing their response in each trial, participants reported whether they had previous knowledge of the presented word. After removing responses where participants reported prior knowledge about the meaning of the presented Catalan or Spanish word, we ran the same analyses as in Experiment 1, and found parallel results. Overall, our results suggest that participants were able to rely on the phonological similarity between the presented Catalan and Spanish words and their correct translation to guide word recognition in an unfamiliar language.

Future studies may consider comparing the suitability of other measures of phonological similarity that take into account finer-grained phonetic or prosodic cues present in the acoustic signal presented to participants. Phonological transcriptions like X-SAMPA are abstract representations that ignore non-phonological contrasts (e.g., phones), and consider different symbols as completely different phonemes, disregarding the fact that some phonemes share more phonetic features than others. Additionally, prosodic cues such as lexical stress, which our measure of phonological similarity does not include, might also provide participants further information about the correct translation of the presented word-forms. Altogether, it is likely that participants in the present study were able to exploit additional cues in the acoustic signal to provide correct translations. Future studies may explore the relative contribution of such cues in the occurrence of homophonic translation. Overall, the present study provides some insights into the role of phonological similarity in the auditory presentation of words in an unfamiliar language.

Our findings also suggest that the facilitation effect of phonological similarity was moderated by phonological neighbourhood density. This is in line with previous studies suggesting that the presence of (high-frequency) phonological neighbours interferes with the lexical selection in word comprehension tasks (e.g., [Dufour & Frauenfelder, 2010](#); [Grainger, 1990](#); [Luce & Pisoni, 1998](#); [Vitevitch & Luce, 1998](#); [Vitevitch & Luce, 1999](#)). Our translation elicitation task can be understood as a particular instance of an auditory word recognition task, in which the presented unfamiliar words have the potential to activate phonological neighbours in participants' lexicon. We calculated a measure of cross-linguistic neighbourhood size by counting, for each presented word the number of phonologically related words (with a Levenshtein distance of one) in the target language (English in Experiments 1 and 3, Spanish in Experiment 2). To account for the fact that competition between phonological neighbours is sensitive to lexical frequency—high-frequency neighbours produce stronger interference effects ([Dufour & Frauenfelder, 2010](#); [Luce & Pisoni, 1998](#))—we only counted neighbours with a lexical frequency higher than the correct translation. Using this measure, we found that participants' ability to exploit phonological similarity to produce correct translations declined as the number of phonological neighbours increased. This suggests that listening to words in an unfamiliar language triggered similar mechanisms of lexical activation and selection that listening to words in a native language does. The generalisability of these findings can be tested by increasing the repertoire of words involved in the translation elicitation task. In Experiments 1 to 3, participants answered to a maximum of 105 words. All words had high frequency and low age-of-acquisition. To better characterise the factors that guide listeners' ability to match words from an unfamiliar language with words in their native language lexicon, words with varying levels of difficulty should be included in future studies.

A comparison between the results in Experiments 1 and 2 suggested that the performance of Spanish participants translating Catalan was more resilient to the interfering effects of phonological neighbourhood density than the performance of English participants translating Catalan or Spanish. As highlighted before, Catalan and Spanish (both Romance languages) are typologically closer to each other than to English (a Germanic language). Catalan and Spanish share a higher proportion of cognates than Catalan and English, or Spanish

and English. Overall, our findings suggest that the typological distance between the presented and target language is associated with a more robust facilitation effect of phonological similarity.

The specific mechanisms behind this effect are unclear. One possibility is that there were subphonemic features of similarity between Catalan and Spanish words that were not adequately captured by our relatively coarse measure of similarity. Phonological transcriptions like X-SAMPA are abstract representations that ignore non-phonological contrasts (e.g., phones), and consider different symbols as completely different phonemes, disregarding the fact that some phonemes share more phonetic features than others. Additionally, prosodic cues such as lexical stress, which our measure of phonological similarity does not include, might also provide participants with further information about the correct translation of the presented word-forms. There may be more of these subphonemic cues available between the typologically close Spanish and Catalan than between the more distant English and Spanish, or English and Catalan. In addition, it remains to be tested whether the effect of typological distance is linear (i.e., robustness of facilitation increases linearly with typological distance), proportional, and whether other close or distant language pairs show the same pattern of results. Future studies may consider comparing the suitability of other measures of phonological similarity that take into account finer-grained phonetic or prosodic cues present in the acoustic signal, and explore the relative contribution of such cues in the occurrence of homophonic translation.

In summary, the present paper provides insights into the processing mechanisms underlying homophonic translation. English and Spanish native adults were tested in a translation elicitation task in which they had to guess the English or Spanish translation of a series of words in an unfamiliar language. Participants successfully exploited phonological similarity between the presented words and their correct translations to provide correct answers. Participants' performance in the task only benefited from phonological similarity when the presented word had few higher-frequency phonological neighbours in the target language. Finally, the facilitation effect of phonological similarity was stronger in the Spanish native participants, who translated words from a typologically closer language than English participants. Overall, the findings presented in the present paper suggest that the processing of words in a non-native, unfamiliar language recruits mechanisms of lexical activation, selection, and interference parallel to those recruited by listening to words in a native language.

6 References

- Briusov, V. Y. (1911). *Ot perevodchika*. Skorpion.
- Broersma, P., & Weenink, D. (2021). *Praat: Doing phonetics by computer [Computer program]* (Version 6.1.54). <http://www.praat.org/>
- Bürkner, P.-C. (2017). Brms: An R package for Bayesian multilevel models using Stan. *Journal of Statistical Software*, 80(1), 1–28.
- Carpenter, B., Gelman, A., Hoffman, M. D., Lee, D., Goodrich, B., Betancourt, M., Brubaker, M., Guo, J., Li, P., & Riddell, A. (2017). Stan: A probabilistic programming language. *Journal of Statistical Software*, 76(1), 1–32.
- Cervantes, M. de, & Grossman, E. (2002). First part of the ingenious nobleman don quixote of la mancha. *Conjunctions*, 38, 207–225. <http://www.jstor.org/stable/24518146>
- Dembeck, T. (2015). Oberflächenübersetzung: The poetics and cultural politics of homophonic translation. *Critical Multilingualism Studies*, 3(1), 7–25.
- Dufour, S., & Frauenfelder, U. H. (2010). Phonological neighbourhood effects in french spoken-word recognition. *Quarterly Journal of Experimental Psychology*, 63(2), 226–238.
- Dufour, S., & Peereboom, R. (2003). Lexical competition in phonological priming: Assessing the role of phonological match and mismatch lengths between primes and targets. *Memory & Cognition*, 31, 1271–1283.
- Dupoux, E., Kakehi, K., Hirose, Y., Pallier, C., & Mehler, J. (1999). Epenthetic vowels in japanese: A perceptual illusion? *Journal of Experimental Psychology: Human Perception and Performance*, 25(6), 1568.
- Efimova, N. N., Ruzhnikova, M. L., & Violina, M. I. (2018). Homophonic translation as humpty-dumpty's choice. *SHS Web of Conferences*, 50, 01049.
- Floccia, C., Sambrook, T. D., Delle Luche, C., Kwok, R., Goslin, J., White, L., Cattani, A., Sullivan, E., Abbot-Smith, K., Krott, A., et al. (2018). I: Introduction. *Monographs of the Society for Research in Child Development*, 83(1), 7–29.
- Gasparov, M. L. (2006). *Semen kirsanov*. Akademicheskij proekt.

- Goldinger, S. D., Luce, P. A., & Pisoni, D. B. (1989). Priming lexical neighbors of spoken words: Effects of competition and inhibition. *Journal of Memory and Language*, 28(5), 501–518. [https://doi.org/10.1016/0749-596X\(89\)90009-0](https://doi.org/10.1016/0749-596X(89)90009-0)
- Grainger, J. (1990). Word frequency and neighborhood frequency effects in lexical decision and naming. *Journal of Memory and Language*, 29(2), 228–244.
- Hamburger, M., & Slowiaczek, L. M. (1996). Phonological priming reflects lexical competition. *Psychonomic Bulletin & Review*, 3(4), 520–525.
- Kruschke, J. K., & Liddell, T. M. (2018). The Bayesian New Statistics: Hypothesis testing, estimation, meta-analysis, and power analysis from a Bayesian perspective. *Psychonomic Bulletin & Review*, 25, 178–206.
- Levenshtein, V. I. (1966). Binary codes capable of correcting deletions, insertions, and reversals. *Soviet Physics Doklady*, 10, 707–710.
- Levick, T. (2016). Translating homophonic wordplay in patrick goujon’s moi non: A case study. *Sound/Writing: On Homophonic Translation*.
- Luce, P. A., & Pisoni, D. B. (1998). Recognizing spoken words: The neighborhood activation model. *Ear and Hearing*, 19(1), 1.
- Luce, P. A., Pisoni, D. B., & Goldinger, S. D. (1990). *Similarity neighborhoods of spoken words*.
- Marian, V., Bartolotti, J., Chabal, S., & Shook, A. (2012). *CLEARPOND: Cross-linguistic easy-access resource for phonological and orthographic neighborhood densities*.
- Otake, T. (2007). Interlingual near homophonic words and phrases in L2 listening: Evidence from misheard song lyrics. *Proceedings of the 16th International Congress of Phonetic Sciences (ICPhS 2007)*, 777–780.
- Otwinowska, A., & Szewczyk, J. M. (2019). The more similar the better? Factors in learning cognates, false cognates and non-cognate words. *International Journal of Bilingual Education and Bilingualism*.
- Peirce, J., Gray, J. R., Simpson, S., MacAskill, M., Höchenberger, R., Sogo, H., Kastman, E., & Lindeløv, J. K. (2019). PsychoPy2: Experiments in behavior made easy. *Behavior Research Methods*, 51(1), 195–203. <https://doi.org/10.3758/s13428-018-01193-y>
- Peperkamp, S., Vendelin, I., & Nakamura, K. (2008). On the perceptual origin of loanword adaptations: Experimental evidence from japanese. *Phonology*, 25(1), 129–164.
- Pilshchikov, I. (2016). The semiotics of phonetic translation. *Studia Metrica Et Poetica*, 3(1), 53–104.
- R Core Team. (2013). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing. <http://www.R-project.org/>
- Schad, D. J., Vasishth, S., Hohenstein, S., & Kliegl, R. (2020). How to capitalize on a priori contrasts in linear (mixed) models: A tutorial. *Journal of Memory and Language*, 110, 104038.
- Schepens, J., Dijkstra, T., & Grootjen, F. (2012). Distributions of cognates in Europe as based on Levenshtein distance. *Bilingualism: Language and Cognition*, 15(1), 157–166.
- van der Loo, M. P. J. (2014). The stringdist package for approximate string matching. *The R Journal*, 6(1), 111–122. <https://CRAN.R-project.org/package=stringdist>
- Van Heuven, W. J., Mandera, P., Keuleers, E., & Brysbaert, M. (2014). SUBTLEX-UK: A new and improved word frequency database for British English. *Quarterly Journal of Experimental Psychology*, 67(6), 1176–1190.
- Vitevitch, M. (2006). The clustering coefficient of phonological neighborhoods influences spoken word recognition. *The Journal of the Acoustical Society of America*, 120(5), 3252–3252. <https://doi.org/10.1121/1.4788314>
- Vitevitch, M. S., & Luce, P. A. (1998). When words compete: Levels of processing in perception of spoken words. *Psychological Science*, 9(4), 325–329.
- Vitevitch, M. S., & Luce, P. A. (1999). Probabilistic Phonotactics and Neighborhood Activation in Spoken Word Recognition. *Journal of Memory and Language*, 40(3), 374–408. <https://doi.org/10.1006/jmla.1998.2618>
- Weber, A., & Cutler, A. (2004). Lexical competition in non-native spoken-word recognition. *Journal of Memory and Language*, 50(1), 1–25.
- Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L. D., François, R., Grolemund, G., Hayes, A., Henry, L., Hester, J., Kuhn, M., Pedersen, T. L., Miller, E., Bache, S. M., Müller, K., Ooms, J., Robinson, D., Seidel, D. P., Spinu, V., ... Yutani, H. (2019). Welcome to the tidyverse. *Journal of Open Source Software*, 4(43), 1686. <https://doi.org/10.21105/joss.01686>
- Briusov, V. Y. (1911). *Ot perevodchika*. Skorpion.
- Broersma, P., & Weenink, D. (2021). *Praat: Doing phonetics by computer [Computer program]* (Version 6.1.54). <http://www.praat.org/>
- Bürkner, P.-C. (2017). Brms: An R package for Bayesian multilevel models using Stan. *Journal of Statistical Software*, 80(1), 1–28.

- Carpenter, B., Gelman, A., Hoffman, M. D., Lee, D., Goodrich, B., Betancourt, M., Brubaker, M., Guo, J., Li, P., & Riddell, A. (2017). Stan: A probabilistic programming language. *Journal of Statistical Software*, 76(1), 1–32.
- Cervantes, M. de, & Grossman, E. (2002). First part of the ingenious nobleman don quixote of la mancha. *Conjunctions*, 38, 207–225. <http://www.jstor.org/stable/24518146>
- Dembeck, T. (2015). Oberflächenübersetzung: The poetics and cultural politics of homophonic translation. *Critical Multilingualism Studies*, 3(1), 7–25.
- Dufour, S., & Frauenfelder, U. H. (2010). Phonological neighbourhood effects in french spoken-word recognition. *Quarterly Journal of Experimental Psychology*, 63(2), 226–238.
- Dufour, S., & Peereman, R. (2003). Lexical competition in phonological priming: Assessing the role of phonological match and mismatch lengths between primes and targets. *Memory & Cognition*, 31, 1271–1283.
- Dupoux, E., Kakehi, K., Hirose, Y., Pallier, C., & Mehler, J. (1999). Epenthetic vowels in japanese: A perceptual illusion? *Journal of Experimental Psychology: Human Perception and Performance*, 25(6), 1568.
- Efimova, N. N., Ruzhnikova, M. L., & Violina, M. I. (2018). Homophonic translation as humpty-dumpty’s choice. *SHS Web of Conferences*, 50, 01049.
- Floccia, C., Sambrook, T. D., Delle Luche, C., Kwok, R., Goslin, J., White, L., Cattani, A., Sullivan, E., Abbot-Smith, K., Krott, A., et al. (2018). I: Introduction. *Monographs of the Society for Research in Child Development*, 83(1), 7–29.
- Gasparov, M. L. (2006). *Semen kirsanov*. Akademicheskij proekt.
- Goldinger, S. D., Luce, P. A., & Pisoni, D. B. (1989). Priming lexical neighbors of spoken words: Effects of competition and inhibition. *Journal of Memory and Language*, 28(5), 501–518. [https://doi.org/10.1016/0749-596X\(89\)90009-0](https://doi.org/10.1016/0749-596X(89)90009-0)
- Grainger, J. (1990). Word frequency and neighborhood frequency effects in lexical decision and naming. *Journal of Memory and Language*, 29(2), 228–244.
- Hamburger, M., & Slowiczek, L. M. (1996). Phonological priming reflects lexical competition. *Psychonomic Bulletin & Review*, 3(4), 520–525.
- Kruschke, J. K., & Liddell, T. M. (2018). The Bayesian New Statistics: Hypothesis testing, estimation, meta-analysis, and power analysis from a Bayesian perspective. *Psychonomic Bulletin & Review*, 25, 178–206.
- Levenshtein, V. I. (1966). Binary codes capable of correcting deletions, insertions, and reversals. *Soviet Physics Doklady*, 10, 707–710.
- Levick, T. (2016). Translating homophonic wordplay in patrick goujon’s moi non: A case study. *Sound/Writing: On Homophonic Translation*.
- Luce, P. A., & Pisoni, D. B. (1998). Recognizing spoken words: The neighborhood activation model. *Ear and Hearing*, 19(1), 1.
- Luce, P. A., Pisoni, D. B., & Goldinger, S. D. (1990). *Similarity neighborhoods of spoken words*.
- Marian, V., Bartolotti, J., Chabal, S., & Shook, A. (2012). *CLEARPOND: Cross-linguistic easy-access resource for phonological and orthographic neighborhood densities*.
- Otake, T. (2007). Interlingual near homophonic words and phrases in L2 listening: Evidence from misheard song lyrics. *Proceedings of the 16th International Congress of Phonetic Sciences (ICPhS 2007)*, 777–780.
- Otwinowska, A., & Szewczyk, J. M. (2019). The more similar the better? Factors in learning cognates, false cognates and non-cognate words. *International Journal of Bilingual Education and Bilingualism*.
- Peirce, J., Gray, J. R., Simpson, S., MacAskill, M., Höchenberger, R., Sogo, H., Kastman, E., & Lindeløv, J. K. (2019). PsychoPy2: Experiments in behavior made easy. *Behavior Research Methods*, 51(1), 195–203. <https://doi.org/10.3758/s13428-018-01193-y>
- Peperkamp, S., Vendelin, I., & Nakamura, K. (2008). On the perceptual origin of loanword adaptations: Experimental evidence from japanese. *Phonology*, 25(1), 129–164.
- Pilshchikov, I. (2016). The semiotics of phonetic translation. *Studia Metrica Et Poetica*, 3(1), 53–104.
- R Core Team. (2013). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing. <http://www.R-project.org/>
- Schad, D. J., Vasisht, S., Hohenstein, S., & Kliegl, R. (2020). How to capitalize on a priori contrasts in linear (mixed) models: A tutorial. *Journal of Memory and Language*, 110, 104038.
- Schepens, J., Dijkstra, T., & Grootjen, F. (2012). Distributions of cognates in Europe as based on Levenshtein distance. *Bilingualism: Language and Cognition*, 15(1), 157–166.
- van der Loo, M. P. J. (2014). The stringdist package for approximate string matching. *The R Journal*, 6(1), 111–122. <https://CRAN.R-project.org/package=stringdist>

- Van Heuven, W. J., Mandera, P., Keuleers, E., & Brysbaert, M. (2014). SUBTLEX-UK: A new and improved word frequency database for British English. *Quarterly Journal of Experimental Psychology*, 67(6), 1176–1190.
- Vitevitch, M. (2006). The clustering coefficient of phonological neighborhoods influences spoken word recognition. *The Journal of the Acoustical Society of America*, 120(5), 3252–3252. <https://doi.org/10.1121/1.4788314>
- Vitevitch, M. S., & Luce, P. A. (1998). When words compete: Levels of processing in perception of spoken words. *Psychological Science*, 9(4), 325–329.
- Vitevitch, M. S., & Luce, P. A. (1999). Probabilistic Phonotactics and Neighborhood Activation in Spoken Word Recognition. *Journal of Memory and Language*, 40(3), 374–408. <https://doi.org/10.1006/jmla.1998.2618>
- Weber, A., & Cutler, A. (2004). Lexical competition in non-native spoken-word recognition. *Journal of Memory and Language*, 50(1), 1–25.
- Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L. D., François, R., Grolemund, G., Hayes, A., Henry, L., Hester, J., Kuhn, M., Pedersen, T. L., Miller, E., Bache, S. M., Müller, K., Ooms, J., Robinson, D., Seidel, D. P., Spinu, V., ... Yutani, H. (2019). Welcome to the tidyverse. *Journal of Open Source Software*, 4(43), 1686. <https://doi.org/10.21105/joss.01686>