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Being a Student or at Home: Does Topic Influence How Bilinguals Process Words in Each Language?

Veniamin Shiron [1], Huanhuan Liu [2] and Angela de Bruin [1,*]

1 Department of Psychology, University of York, York YO10 5DD, UK; vs814@york.ac.uk
2 Research Center of Brain and Cognitive Neuroscience, Liaoning Normal University, Dalian 116029, China; 104130@lnnu.edu.cn
* Correspondence: angela.debruin@york.ac.uk

Abstract: Research has assessed how language use differences between bilinguals (e.g., whether two languages are used approximately equally often or not) influence language processing. However, first (L1) and second (L2) language use might also differ within bilinguals, depending on the topic of conversation. For example, a Mandarin–English bilingual studying in North America or the UK might talk about exams in English but about their childhood in Mandarin. In this study, we therefore examined how topics associated with either the L1 or L2 can influence language processing. Twenty-nine Mandarin–English students in North America/the UK completed a lexical decision task in single-language contexts (all words/pseudowords in one language) and in dual-language contexts (alternating between Mandarin and English). Half of the words referred to L1-associated topics (childhood and family life) and half were L2-associated (studying and life at university). Topic influenced L2 processing, with L2-associated topics being processed faster than topics associated with the L1 in single- and dual-language contexts. In contrast, topic did not influence L1 processing. This suggests that L2 processing might not only be influenced by differences between bilinguals but also by differences within bilinguals. In contrast, L1 processing might be less susceptible to influences of topic-specific language use.

Keywords: bilingualism; language processing; language context; language use

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1. Introduction

In our international society, many people speak more than one language, including a large number of people who are studying and working in a language they did not grow up with. These many bilinguals differ from each other in various ways, including in their proficiency (i.e., how competent they are in each language) and their language use (i.e., how often or in which contexts they use each of their languages). Various research studies have examined how these differences *between bilinguals* in terms of overall proficiency and use in their second language (L2) can influence first language (L1) and L2 processing (e.g., Blumenfeld and Marian 2007; Chaouch-Orozco et al. 2021; Van Hell and Tanner 2012).

However, language proficiency and use do not just differ between bilinguals but also *within* bilinguals. As Grosjean's Complementarity Principle (Grosjean 2016) outlines, bilinguals can acquire and use their languages for different purposes, domains, and people. For example, an international student in the UK or North America might mainly acquire English as their second language for purposes related to studying. As a consequence, their proficiency and use might be much higher when considering words related to studying than when assessing other topics (cf. Brysbaert et al. 2021). In contrast, their native language might mainly be used when talking about topics associated with their life in their country of origin. Previous research assessing more global differences between bilinguals (asking, e.g., how often a bilingual uses a language in their daily lives) overlooks these more domain- or topic-specific differences *within* bilinguals. Studying the relationship between topic-specific language use and language processing within the same group of bilinguals is crucial to better understand how bilinguals comprehend and process words in their native and non-native language. In this study, we examined if and how topic-specific words associated with either the participant's L1 or L2 influence bilingual processing. We focused on Mandarin–English bilinguals who grew up speaking Mandarin but are studying in their L2 (English) in North America or the UK. As a measure of "topic-specific" language use, we focused on words referring to family life/childhood at home (L1) or to life as a student (L2) (see also Brysbaert et al. 2021).

1.1. Cues Associated with a Language or Culture

Previous research has shown that cues associated with a language or culture can influence both bilingual comprehension and production. For example, Zhang et al. (2013) looked at how L1 culture cues (images and faces) influenced language production in Chinese students living in the US. They found that cues associated with the L1 disrupted L2 fluency, suggesting that bilingual processing is flexible and can differ within bilinguals depending on the surrounding context being associated with a certain language or culture. Similar findings were shown by Roychoudhuri et al. (2016). Bengali–English participants were slower to name pictures in English (L2) when they were presented with an image typically associated with Bengali (L1) culture. Increased activation of the L1, as a consequence of L1-associated cues, potentially led to increased interference with the L2 and, consequently, slower L2 naming. Similar findings have been observed in studies using faces as cues (e.g., Molnar et al. 2015; Woumans et al. 2015).

Beyond contextual cues, Jared et al. (2013) showed that the type of object can influence L1 and L2 naming. Chinese–English bilinguals were asked to name images associated with a specific country (e.g., a variety of cabbage more typically eaten in China or in Canada). Participants' responses were faster in Chinese than English when naming a "Chinese" cabbage, while the opposite was found when naming a "Canadian" cabbage. These results suggest that bilinguals associate newly acquired words with specific concepts that are closely associated with a given culture (cf. Berkes et al. 2018, for similar findings in comprehension). This reinforces the idea underlying Grosjean's Complementarity Principle, stating that bilingual proficiency and use might differ between bilinguals depending on the domain (in this case, objects associated with a specific culture).

These previous studies, however, have focused on non-linguistic cues (e.g., Zhang et al. 2013) or concepts that are uniquely associated with one culture/language (e.g., Jared et al. 2013). An open question remains how bilinguals process words that do exist in both languages/cultures but that are more closely associated with one language due to the bilingual's personal experiences (e.g., using one language at home and one language for studying). Although this is a situation in which many bilinguals find themselves, little is known about how topic-dependent associations influence L1 and L2 word processing.

1.2. Language Interference and Control

In addition, from the previous literature, it is unclear whether any topic-dependent associations should influence the L2 only or both languages. In some studies, only one language is examined (e.g., Zhang et al. 2013), while studies that do directly compare both languages show mixed results. The L2 (when acquired later in life and when having a lower proficiency) might be more easily influenced than the L1 that was acquired from birth, potentially because L1 representations are more strongly entrenched in memory (e.g., Diependaele et al. 2013). For example, previous research has suggested that frequency effects, such as faster processing of high-frequency words, are more pronounced in an L2 than L1 (e.g., Van Wijnendaele and Brysbaert 2002). Roychoudhuri et al.'s (2016) findings are, to some extent, in line with this. Cues had a significantly larger influence on L2 than on L1 naming, with the cue-naming effect only being significant when using the L2. However, this study included only L1 cues, making it difficult to directly compare the two conditions. Furthermore, while the effect was not significant, L1 cues did numerically facilitate L1 naming. Other studies do find effects of language-/culture-specific cues on both L1 and

L2 naming or processing (e.g., Berkes et al. 2018; Jared et al. 2013; Woumans et al. 2015). However, when using faces or objects that are unique to one language/culture (such as cabbages associated with Western or Asian cultures), having to generate a word incompatible with the face or object (such as the Chinese word for a Canadian cabbage) might be so rare that it might cause a mismatch effect regardless of the language. It therefore remains unclear whether words that actually exist in both languages can influence L1 as well as L2 processing, depending on associations between the topic and the language.

Furthermore, it remains unclear (cf. Hartsuiker 2015) whether any effects of language or culture associations are due to matching associations facilitating performance (e.g., faster L2 processing because L2 words are more easily retrieved in combination with an L2 cue or object, cf. Li et al. 2013) or due to associations with the "other" language interfering with performance (e.g., slower L2 processing because L1 cues/objects activate L1 words that consequently interfere more strongly with L2 processing, cf. Zhang et al. 2013). In our study, we therefore included single- and dual-language contexts to manipulate the amount of language interference. In single-language conditions, words were presented in one language, while in dual-language conditions, words alternated between the two languages. Previous research has suggested that language co-activation, and consequently, interference and competition, is larger in dual- than single-language conditions, including in lexical decision tasks (e.g., Vanlangendonck et al. 2020). If topic associations influence language processing by facilitating word retrieval, we would expect these facilitatory effects to occur in both single- and dual-language conditions. However, if topic-associations influence language processing by (also) increasing interference from the "other" language, we would expect these effects to be larger in the dual-language condition (where the other language is present within the same context). Roychoudhuri et al. (2016) observed similar effects of cultural cues in single- and dual-language contexts. However, their English "single-language" contexts included Bengali cues, making it difficult to create truly "English-only" contexts. By using words without any cues, we were able to create pure single-language contexts without any direct task-induced interference from the other language.

1.3. Current Study

We examined whether topics associated with either the L1 or L2 can influence language processing in single- and dual-language contexts. We focused on Mandarin–English bilinguals who grew up in a Mandarin-language environment but are currently studying in English in the UK or North America. Contrary to previous studies (e.g., Jared et al. 2013) that focused on concepts uniquely associated with one culture/language, we used words with similar objective frequency scores in both languages. All words were highly frequent words that occur in both Mandarin and English. However, we selected words that *these bilinguals* more closely associated with L1 (family life) or L2 (studying).

Participants completed a lexical decision task in single-language contexts (all words presented in one language) and in dual-language contexts (words presented in Mandarin and English interchangeably). Our main question examined whether there were reaction time (RT) differences between words representing a topic associated with that language (e.g., words related to studying in English) versus topics that are associated with the other language (e.g., words related to family life in English). We hypothesised that both L1 and L2 should show faster processing of words associated with that language than of words associated with the other language. This would show whether language processing in L1 and L2 is stable and topic-independent or rather flexible and topic-specific. In addition, we also examined differences between single- and dual-language contexts. The interchangeable use of two languages in the dual-language context might increase cross-language interference. If this interference increases the effects of topic, these effects should be larger in the dual- than single-language context.

2. Methods

2.1. Participants

Thirty Mandarin–English bilinguals were recruited through Prolific.co. One participant was excluded from further analysis as their accuracy was below chance. The remaining 29 participants (20 female) were, on average, 23 years old (*SD* = 2.9). All participants had normal or corrected-to-normal vision, and no known neurological, hearing, or reading impairments. All apart from one were right-handed.

Given that it was difficult to determine a realistic effect size (which largely depends on the stimulus materials created for this study) and run a power analysis, we based our sample size calculations on the recommendation to use 1600 observations per cell (e.g., 40 trials × 40 participants) for linear mixed-effects analyses (Brysbaert and Stevens 2018). In combination with 48 trials per condition, we aimed to recruit 32 participants. Due to difficulties recruiting more participants as a consequence of our strict language profiles, the final sample size of 29 is a little below our aim but is, in combination with our 48 trials per condition, still close to the recommended number of 1600 observations.

All participants grew up in a Mandarin-speaking household and spent their primary-school years in China, with limited exposure to other languages and were, at the moment of testing, living and studying in the UK (*N* = 19) or North America (*N* = 10). On average, participants had spent 4.4 years in an English-speaking country (*SD* = 3.3). Participants completed an English picture-naming task to measure vocabulary (De Bruin et al. 2017) and a language-background questionnaire based on (Anderson et al. 2018; see Tables 1 and 2). This confirmed that participants used English more often for education-related topics and Mandarin for topics related to family life (see Table 1). Participants generally used Mandarin more during childhood and to communicate with family members, while they used English more with roommates and classmates (Table 2).

Table 1. Means (and SDs) in the English picture-naming task, proficiency self-ratings, language use per topic, and overall use/exposure.

Item	English	SD	Mandarin	SD
	Mean		Mean	
Age of Acquisition	7.9	3.5	0	0
Picture naming (0–65) [a]	59.0	3.1	X	X
Self-rated proficiency (0–10)				
Speaking	6.6	1.4	9.4	1.0
Understanding	7.7	1.3	9.6	0.7
Writing	6.9	1.4	8.8	1.4
Reading	7.7	1.5	9.6	0.6
Language use per topic: (0–100)				
Family life/childhood	31.7	17.5	69.7	20.5
Studying	56.7	27.1	44.7	27.0
Overall exposure [b] (0–100)	68.9	25.5	56.7	23.9
Overall use [b] (0–100)	60.5	23.6	56.9	26.1

[a] Data from one participant could not be included because they responded in Mandarin. [b] For these questions, participants were asked to only consider their time spent in the UK/North America (i.e., their current/recent exposure and use). Participants responded on a scale from 0 ("never") to 100 ("all the time"), without those percentages necessarily adding up to 100% for the two languages together.

Table 2. Summary of self-rated language use in different contexts and tasks. Higher values (1–5) indicate more Mandarin use.

Item	Mean	SD
Language exposure during childhood: (1–5) [a]		
Infancy	4.9	0.3
Preschool age	4.6	0.7
Primary school	4.0	0.4
High school	3.6	0.7
Language use by activity [c]: (1–5) [a]		
Reading	2.3	0.9
Emailing	1.4	0.6
Texting	2.5	0.9
Social media	2.4	0.9
Watching TV	2.5	1.0
Listening to music	2.4	0.9
Watching movies	2.2	0.8
Language use with different people [c]: (1–5) [a]		
Roommates	2.9	1.3
Classmates	2.4	1.1
Friends	3.0	1.1
Parents	4.9	0.3
Grandparents	5.0	0.2
Other relatives	4.7	0.6
Siblings	4.7	0.6
Partner	3.7	1.3
Language switching per context [c]: (1–5) [b]		
On a daily basis	3.3	0.9
In a conversation	3.0	0.9
In a sentence	2.6	0.9
With family	1.6	0.9
With classmates	2.8	1.2
Talking about family life/childhood	2.1	1.0
Talking about studying/student life	3.1	1.2

[a] Scoring system: 1 (all English)–5 (only Mandarin). [b] Scoring system: 1 (Never)–5 (Always). [c] Participants rated their use/switching while being in the UK/North America (i.e., recent/current use and switching).

2.2. Materials

We created two sets of 24 words each. One set focused on words associated with family life and childhood (L1-association). The other set focused on life as a student (L2-association). At the end of the study, our bilingual participants rated daily life language use for each stimulus (0 "always English" to 100% "always Mandarin"). Participants indicated lower Mandarin (L1) use for words in the L2-association condition (M = 39.3%, SD = 13.8) than for words in the L1-association condition (M = 58.3, SD = 19.3; $t(28) = -6.791$, $p < 0.001$).

Conditions were matched on frequency, valence, and word length (see Appendix A). Within each language, we matched the two conditions (words associated with L1 and L2) on frequency and length (number of letters, phonemes, and syllables for English, and number of characters for Mandarin). Using ZIPF scores[1] to compare frequency across databases (Cai and Brysbaert 2010; Van Heuven et al. 2014), we also matched the English and Mandarin words on objective frequency. While we initially considered creating neutral words too, we decided against this as it is very difficult to find words that are truly neutral in their language association across a group of participants.

We also created a pseudoword for each word using Wuggy (Keuleers and Brysbaert 2010) by changing, on average, half of the letters of the English word and one character per Mandarin word to create a non-existing combination.

While we carefully matched our stimuli on various background characteristics, we wanted to make sure that our stimulus conditions would not differ in lexical processing times when processed by monolinguals. We therefore ran a pilot study with 15 English monolingual native speakers (five additional participants were excluded due to low performance or not meeting background criteria) and 24 Mandarin native speakers (with limited English use) to assess whether there were any baseline differences between the L1- and L2-associated stimuli. Neither accuracy nor RTs showed a significant difference between conditions in either English or Mandarin native speakers (see Table 3).

Table 3. Mean (and SDs) for accuracy and RTs in the English native and Mandarin native control groups (pseudowords not included in the analysis).

Measure	English/L2-Topic	Mandarin/L1-Topic	Paired T-Test
English native			
Accuracy	97.9 (2.8)	96.1 (4.6)	t(14) = 1.233, p = 0.238
RTs	594.5 (73.1)	601.8 (78.3)	t(14) = −0.844, p = 0.413
Mandarin native			
Accuracy	95.9 (5.8)	96.0 (5.1)	t(23) = −0.100, p = 0.921
RTs	694.6 (100.0)	689.6 (107.6)	t(23) = 0.824, p = 0.418

2.3. Tasks and Procedure

The study was run online in one session using Gorilla (www.gorilla.sc, Anwyl-Irvine et al. 2020) and lasted 30–45 min. Participants completed a lexical decision task in which they had to press a button indicating whether a letter/character string was an existing word or not. The task included three within-subject variables: Language (Mandarin/English); Condition (L1-associated Topic/L2-associated Topic); Context (Single-/Dual-language). The task followed the order single-language/dual-language/single-language (a frequently used design in studies using single- and dual-task contexts, e.g., Rubin and Meiran 2005). In the single-language contexts, all stimuli were presented in either English or Mandarin, with the order of languages counterbalanced across participants. Instructions were provided in the language of the context. Prior to the first single-language task, participants completed a practice lexical decision task on each word/pseudoword in each language. This way, we aimed to minimise item-repetition or task-practice effects by making sure that participants had already responded to each word once before the task started. In the dual-language task, participants interchangeably saw English and Mandarin words and pseudowords. Instructions were given in both languages. Participants were asked to indicate whether the stimulus was a word or not regardless of the language. This task was preceded by eight practice trials.

The single-language context included 24 words and pseudowords per condition (L1/L2 association) that were presented twice each (48 words per condition per language). The dual-language context included 192 words (48 words per condition per language). Across the experiment, each word/pseudoword was repeated four times per language. Each condition had a similar number of words and pseudowords. Each word occurred an equal number of times in each condition and was preceded by a word/pseudoword an equal number of times. There were no more than three consecutive stimuli of each type (word/pseudoword) or condition (L1/L2 association) and words and their corresponding pseudowords were not presented consecutively. Each trial started with a fixation cross that was presented for 300 ms. Next, the stimulus was shown on the screen for 2500 ms or until a response was given.

After the lexical decision task, participants completed a task indicating for each target word how likely they were to use Mandarin or English in daily life (0–100%).

This was followed by the picture-naming task and language-background questionnaire described above.

2.4. Data Analysis

The data and the analysis script are available at: https://osf.io/vjgwx/.

Analyses only included word responses. Data were analysed using generalised linear mixed-effect models (for accuracy) and linear mixed-effect models (for RTs) using lme4 package version 1.1-23 and lmerTest 3.1.-2 in R 4.0.2. Analyses started with a maximal structure that included fixed effects and random intercepts and slopes for all within-participant and within-item predictors. We first removed correlations between random slopes and intercepts when models did not converge, followed by removal of by-item slopes explaining the lowest amount of variance until convergence was reached. The script with final models can be found on the OSF page. The two-level categorical variables were coded as −0.5 and 0.5. Continuous fixed effects were centred and scaled.

We first analysed accuracy by using incorrect (0) and correct (1) responses as the dependent variable. We included condition (L2-associated topic = −0.5; L1-associated topic = 0.5), language (Mandarin = −0.5; English = 0.5), and context (single = −0.5; dual = 0.5) as predictors. The same model was run for RTs as the DV, which were log transformed. Next, we replaced condition (L1-/L2-associated topic) with the actual daily life language use for each item, using the average language-use ratings participants provided for each item, with higher scores indicating more Mandarin use. This analysis examined whether there was a direct relationship between how often specific words were used in daily life by our participants in each language and their RTs in the lexical decision task.

3. Results

3.1. Accuracy

Accuracy was very high overall (>90% for all participants). It was higher for the Mandarin words (M = 96.7%, SD = 2.5) than the English words (M = 95.2%, SD = 3.2; β = −0.358, SE = 0.178, z = −2.012, p = 0.044). Accuracy was similar in the single- (M = 96.0%, SD = 2.1) and dual-language contexts (M = 95.9%, SD = 2.7; β = −0.012, SE = 0.101, z = −0.117; p = 0.907) and for L2-associated (M = 96.9%, SD = 2.2) and L1-associated topic words (M = 94.9, SD = 3.1; β = −0.412, SE = 0.230, z = −1.793, p = 0.073). There was a significant interaction between condition and language (β = −0.727, SE = 0.297, z = −2.449, p = 0.014). In English, there was an effect of condition, with higher accuracy for L2 (English)-associated topic words (M = 96.9%, SD = 3.1) than for L1 (Mandarin)-associated topic words (M = 93.4%, SD = 4.8; β = −0.658, SE = 0.279, z = −2.355, p = 0.019). In Mandarin, accuracy did not differ between conditions (L2-topic M = 96.9%, SD = 2.6; L1-topic M = 96.5%, SD = 2.9; β = −0.143, SE = 0.225, z = −0.636, p = 0.525). There were no other significant interactions (all zs < |1.88|).

3.2. Reaction Times

First, we removed incorrect responses and RT outliers below or above 2.5 SD per participant and per condition, language, and context (2.7% of correct responses).

3.2.1. Main Analysis

The main analysis[2] included condition, context, and language. There was a main effect of condition (β = 0.035, SE = 0.014, t = 2.596, p = 0.012) that interacted with language (β = 0.048, SE = 0.019, t = 2.537, p = 0.014). This reflected that L1- and L2-associated topic words were processed differently in English and Mandarin. In English, there was a main effect of condition (β = 0.060, SE = 0.019, t = 3.151, p = 0.003), with L2 (English)-associated topic words (M = 612.6 ms, SD = 50.0) being processed faster than L1 (Mandarin)-associated topic words (M = 655.4 ms, SD = 67.9; see Figure 1). In Mandarin, there was no effect of condition (β = 0.011, SE = 0.014, t = 0.810, p = 0.422; L2-topic M = 604.8 ms, SD = 71.8; L1-topic M = 613.0 ms, SD = 81.1; see Figure 1 and Table 4).

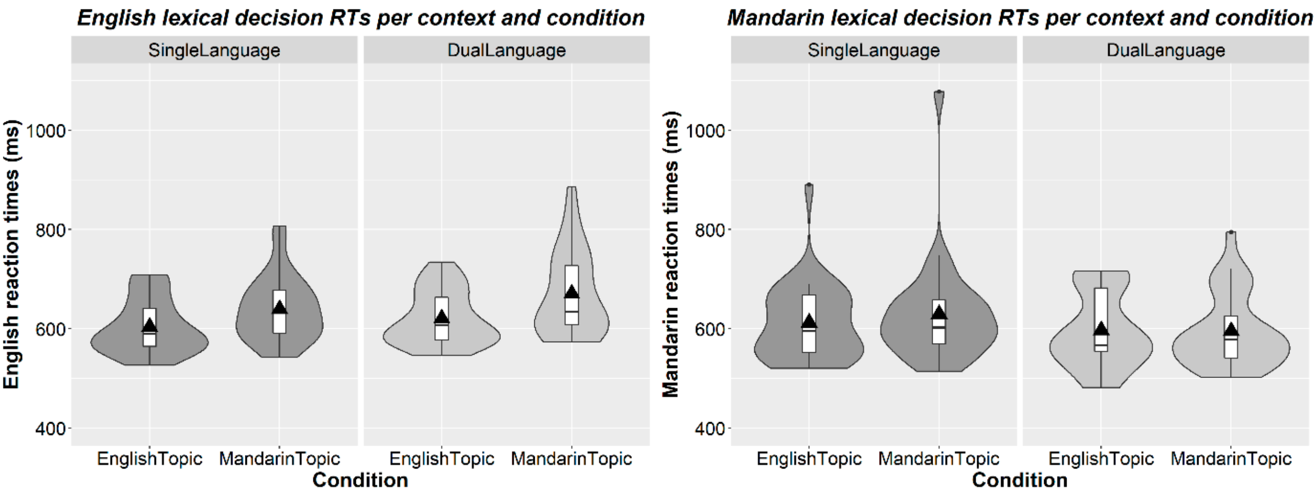

Figure 1. Violin plots showing the distribution of the lexical decision RTs for English (**left**) and Mandarin (**right**). Within each language plot, the single-language context is presented on the left and the dual-language context on the right. Within each context, English/L2 topic RTs are presented on the left and Mandarin/L1 topic RTs on the right. The outline of the violin plot shows the density of data points for the different RTs, with the boxplot showing the interquartile range. The thin horizontal line shows the median and the black triangle the mean.

Table 4. Table showing the mean RTs (and SDs) per context (single-language/dual-language), language (English/Mandarin) and condition (L2/English or L1/Mandarin topic).

Condition	L2/English Topic	L1/Mandarin Topic
Single-language		
English	604.0 (53.9)	639.6 (64.7)
Mandarin	612.3 (78.3)	629.8 (104.1)
Dual-language		
English	621.1 (53.7)	670.9 (85.1)
Mandarin	597.0 (75.0)	595.6 (74.3)

In addition, there was a main effect of language (β = 0.047, *SE* = 0.012, *t* = 4.027, $p < 0.001$), reflecting faster overall responses in Mandarin (*M* = 608.9 ms, *SD* = 75.1) than in English (*M* = 633.6 ms, *SD* = 57.5). There was no main effect of single/dual-language context (β = 0.0001, SE = 0.011, t = 0.010, p = 0.992), nor an interaction between context and condition (β = −0.005, *SE* = 0.011, *t* = −0.451, *p* = 0.655). However, there was an interaction between language and context (β = 0.078, *SE* = 0.015, *t* = 5.042, $p < 0.001$). This reflected that while Mandarin responses were faster in the dual- (*M* = 596.3 ms, *SD* = 72.1) than in the single-language condition (*M* = 621.3 ms, *SD* = 89.5; β = −0.039, *SE* = 0.014, *t* = −2.750, *p* = 0.010), the opposite was true for English responses (single *M* = 621.4 ms, *SD* = 55.9, dual *M* = 645.6 ms, *SD* = 67.3; β = 0.039, *SE* = 0.012, *t* = 3.240, *p* = 0.003). Figure 1 suggests that English responses to L1 (Mandarin)-topic words were especially slow in the dual-language condition. However, the three-way interaction among context, language, and condition did not reach significance (β = 0.037, *SE* = 0.020, *t* = 1.903, *p* = 0.068).

3.2.2. Percentage Language Use

Next, we included percentage English/Mandarin use per item rather than the two-level condition English/Mandarin topic[3]. This analysis showed very similar results, with a significant interaction between %language use and language (β = 0.026, *SE* = 0.009, *t* = 2.914, *p* = 0.005). In English, there was a significant relationship between %language use and RTs (β = 0.023, *SE* = 0.010, *t* = 2.374, *p* = 0.021), with faster RTs for items used more often in English in daily life (see Figure 2). In contrast, in Mandarin, there was no such relationship (β = −0.003, *SE* = 0.007, *t* = −0.387, *p* = 0.701; see Figure 2). There was no three-way interaction between %language use, language, and context (β = 0.008, *SE* = 0.009,

$t = 0.910$, $p = 0.371$), suggesting that the relationship between %language use and English RTs but not Mandarin RTs was similar in the single- and dual-language contexts.

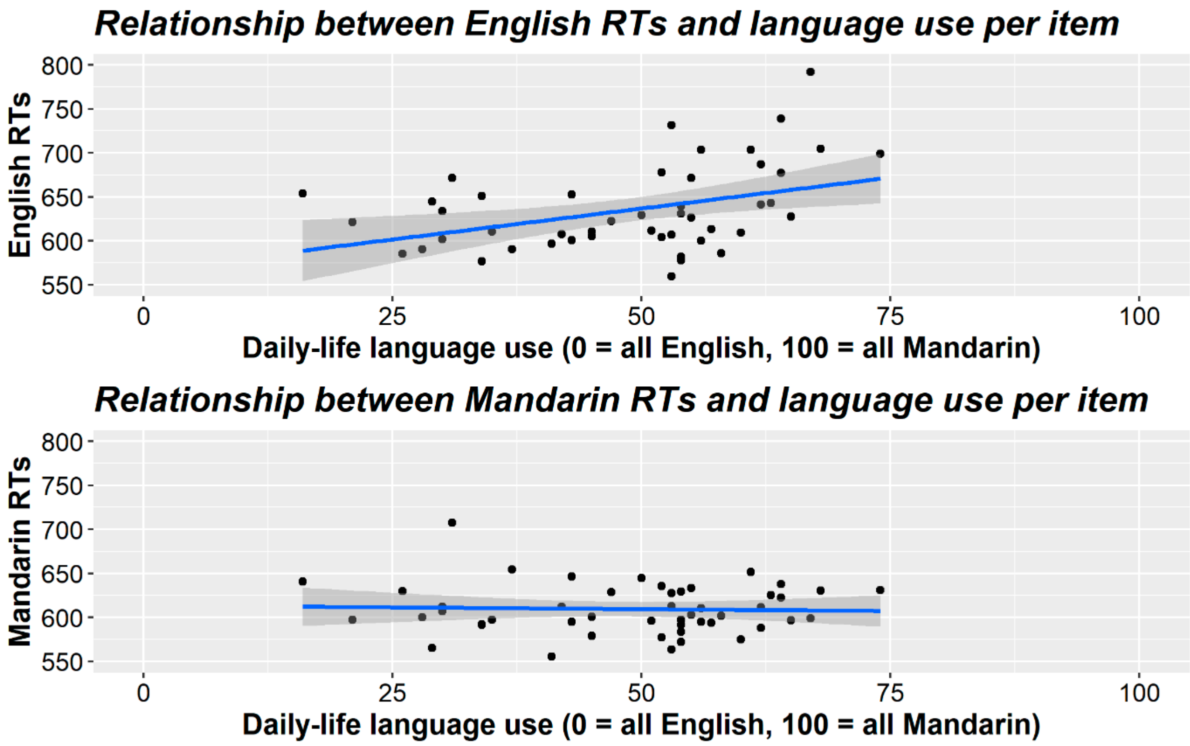

Figure 2. Scatter plots showing the correlation between daily-life language use and lexical decision RTs in English (**top**) and Mandarin (**bottom**). Each dot represents an individual item. Daily-life language use scores are averaged across participants for each item, with lower scores representing more English use and higher scores representing more Mandarin use in daily life.

4. Discussion

We assessed if topic influences processing of words more closely associated with L1 or L2. Both accuracy and RT analyses showed an influence of topic on L2 processing, with faster and more accurate responses to words associated with L2 than L1. This was directly associated with daily life language use: Words that were used more often by our participants in their L2 English were processed faster than words used more often in their L1 Mandarin. Effects of topic on L2 processing were found in both single- and dual-language contexts. However, this effect was not observed in L1 processing.

4.1. Topic Specific Effects on Language Processing

These topic-specific findings support the Complementarity Hypothesis (Grosjean 2016), which highlights that a bilingual's use and proficiency might depend on the domain, topic, and people one is interacting with. Here, we show that topic can influence lexical processing in a bilingual's non-native language. While these findings are specific to international students who associate their L1 with home/family life and their L2 with studying, associating certain languages with certain topics is not unique to this group of participants. Many bilinguals will recognise the feeling of using one language more often with certain people (e.g., a different language when talking with grandparents than with friends) or for certain topics (e.g., researchers using English to write a paper but perhaps not when talking about their favourite food at home). Our study emphasises that L2 proficiency and use are not global and topic-independent (cf. Brysbaert et al. 2021), even though it is often assessed as if it is.

Our findings are also in line with studies showing influences of L1-associated cues on L2 processing (e.g., Jared et al. 2013; Zhang et al. 2013). However, in the current study, words existed and were of similar objective frequency in both languages. Topic effects thus did not occur because stimuli were uniquely associated with or far more frequent in a language/culture but rather because of the bilingual's personal experiences with certain topics. This is an important aspect to consider in future studies on bilingual processing, which often match languages/stimulus conditions on objective frequency but typically do not consider how closely stimuli are associated with each of their bilingual participants' languages.

4.2. Language Context

While topic effects on L2 processing were somewhat larger in the dual-language context, the difference with single-language contexts was not significant. This suggests that these topic-dependent processing effects are present even when the other language is not directly present in the context. The finding that these topic-effects were present in both single- and dual-language contexts suggests that effects of topic might arise because of frequency of use facilitating language processing. That is, because bilinguals use and experience certain words more frequently in their L2 (e.g., words related to studying at an English-speaking University), their lexical processing of these words might be facilitated. This explanation would be in line with the common finding that words with a higher objective frequency level (e.g., words such as "table" that occur more often than words such as "hammer") take less time to process. While these "objective" (e.g., derived from corpora) global frequency differences are often considered in experiments and language models, more subjective, individual (in this case topic-dependent) frequency differences are often not. Our findings, however, can be explained by considering subjective, topic-specific frequency of use in commonly used models of bilingual word comprehension such as the BIA (Dijkstra and Van Heuven 1998) or BIA+ (Dijkstra and Van Heuven 2002). These models incorporate frequency differences between languages, with L2 words having lower resting level activation due to lower frequency of use in bilinguals who use their L1 more often. In a similar manner, L2 words more frequently used in the L2 could have a higher resting level activation level than L2 words more frequently used in the L1.

We hypothesised that if topic effects are due or related to language interference, these effects should be larger in a dual-language environment, in which the "other" language is likely to interfere more than in a single-language environment in which it is not present. Effects of topic were somewhat larger in dual-language contexts with more cross-language interference, suggesting that topic effects in the L2 might increase when L1 interference increases. However, this interaction was not significant and future research is needed to evaluate whether topic effects are indeed modulated by contexts with different levels of language competition.

Overall, RT differences between the single- and dual-language contexts varied between the languages. In English, participants showed longer RTs in dual- than single-language contexts. This dual-language cost is likely to reflect a combination of increased language interference and competition in the dual-language context as well as switches between scripts that were present in the dual- but not in the single-language context. In contrast, however, Mandarin RTs were slower in the single-language context than in the dual-language context. Closer inspection suggested that this was purely due to the first Mandarin single-language condition eliciting relatively long RTs. The second Mandarin single-language condition was completed faster than the dual-language condition, in line with English responses. Responses in this first Mandarin single-language condition were the slowest of all conditions, including the English trials. This is a surprising finding but could potentially be due to participants living in North America/UK and having limited exposure to Chinese characters at the moment of testing, which could potentially lead to participants needing more time to process the Mandarin words at the start. Although participants completed a practice round with all stimuli prior to starting the first single-language block, this might not have been sufficient practice.

4.3. First versus Second Language

Effects of topic were observed only in the L2 but not in the L1. These findings are in line with recent research showing greater topic specificity in the non-dominant language (Tiv et al. 2020). It also suggests that the L1 is less susceptible to topic–language associations, in line with studies showing larger frequency effects in the L2 than L1 (e.g., Van Wijnendaele and Brysbaert 2002). L1 representations, which in this case were acquired earlier in life, are likely to be more strongly entrenched and, therefore, less susceptible to differences in (subjective) frequency (e.g., Diependaele et al. 2013). Furthermore, it is possible that L1 processing is only influenced when objects are uniquely associated with one language (e.g., Jared et al. 2013) but not when words or concepts exist in both languages.

In our study, each word was presented multiple times, which could have diminished effects as the words became associated with both languages throughout the task. It is possible that this especially diminished the effects of topic in the L1, the language that might be influenced less by topic effects in the first place. However, even in the very first practice block (in which participants saw each word for the very first time), topic effects were found in the L2 (L2-associated topic responses were 81ms faster than L1-associated topics responses) but not in the L1 (a difference of 3ms between L1- and L2-associated topics). This suggests that even upon first presentation, effects of topic were only present in the L2 and not in the L1.

5. Conclusions

While much research has focused on differences between bilinguals (for example, some bilinguals using a language more often than other bilinguals), language use might also differ within bilinguals depending on the topic of conversation. Here, we show that the topic can influence bilingual processing times, with L2 words associated with an L1 topic requiring longer processing times than L2 words associated with an L2 topic. These findings show the importance of considering *within-participant* patterns of language use over and beyond global proficiency or language use differences between bilinguals. The topic of conversation, and the materials researchers use, can influence bilingual processing and can consequently lead to, or mask, differences between bilinguals and languages.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are available at: https://osf.io/vjgwx/.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

The English (L2) and Mandarin (L1) words and pseudowords are presented in the table below. Words in the "L2-associated Topic" condition were associated with life as a student (e.g., life at university, activities associated with student life). Words in the "L1-associated Topic" condition were associated with life at home (e.g., words related to childhood experiences, family, and the home environment). The languages and conditions were matched on ZIPF frequency scores from SUBTLEX-UK (Van Heuven et al. 2014) and SUBTLEX-CH (Cai and Brysbaert 2010): English words associated with English/L2 topic:

$M = 4.0$, $SD = 0.9$; English words associated with Mandarin/L1 topic: $M = 4.0$, $SD = 0.7$; Mandarin words associated with Mandarin/L1 topic: $M = 4.1$, $SD = 0.7$; Mandarin words associated with English/L2 topic Topic: $M = 4.1$, $SD = 0.6$. English words in the L2-topic and L1-topic conditions were similar in terms of number of letters ($M = 7.3$, $SD = 2.1$ vs. $M = 6.7$, $SD = 2.4$), syllables ($M = 2.4$, $SD = 0.9$ vs. $M = 2.2$, $SD = 0.8$), and phonemes ($M = 6.5$, $SD = 2.0$ vs. $M = 5.3$, SD = 2.1). We also matched the two English conditions on valence ($M = 5.8$, $SD = 0.8$ vs. $M = 6.3$, $SD = 1.1$; Warriner et al. 2013). Only two- and three-character Chinese words were included, and the number of three-character words was similar for the two conditions.

Table A1. Stimuli (words and pseudowords) used in the experiment by condition (English or Mandarin topic).

Condition	Word English	Pseudoword English	Word Mandarin	Pseudoword Mandarin
EnglishTopic	Exam	emap	考试	灭试
EnglishTopic	Assignment	antointint	作业	作仁
EnglishTopic	Plagiarism	scafeirism	剽窃	蚕窃
EnglishTopic	Degree	dechie	学位	额位
EnglishTopic	Lecture	tuffure	讲座	讲兔
EnglishTopic	Seminar	selilir	研讨会	研讨炎
EnglishTopic	Tutorial	bumonial	教程	甘程
EnglishTopic	Library	fidrory	图书馆	图书饼
EnglishTopic	Research	resonfed	研究	研怕
EnglishTopic	Notes	nopto	笔记	笔逃
EnglishTopic	Society	somiely	社团	社楠
EnglishTopic	Event	enant	事件	事门
EnglishTopic	Pub	wuy	酒吧	酒答
EnglishTopic	Community	corcaroty	社区	者区
EnglishTopic	Trip	snix	行程	灰程
EnglishTopic	Classroom	clorckheam	教室	勾室
EnglishTopic	Classmate	drastnent	同学	窝学
EnglishTopic	Roommate	reannent	室友	室填
EnglishTopic	Teacher	tielder	老师	枝师
EnglishTopic	Instructor	inchroctor	辅导员	厚导员
EnglishTopic	Assistant	attontant	助教	助努
EnglishTopic	Football	loodbads	足球	足壳
EnglishTopic	Basketball	batvonpell	篮球	篮晚
EnglishTopic	Sport	snurs	运动	运忽
MandarinTopic	Adoption	asoxtion	收养	收碧
MandarinTopic	Orphan	urswan	孤儿	孤另
MandarinTopic	Father	tascer	父亲	父贯
MandarinTopic	Brother	crither	兄弟	兄彤
MandarinTopic	Sister	douter	姐妹	固妹
MandarinTopic	Kitten	kollen	小猫	晓猫
MandarinTopic	Puppy	vopty	小狗	晓狗
MandarinTopic	Decorations	digocations	装饰品	装饰滔
MandarinTopic	Vase	vost	花瓶	花逆
MandarinTopic	Toy	tra	玩具	徒具
MandarinTopic	Playground	planploust	操场	喂场
MandarinTopic	Doll	vils	洋娃娃	迈娃娃
MandarinTopic	Kindergarten	windergannin	幼儿园	幼儿曼
MandarinTopic	Swings	blongs	秋千	秋克
MandarinTopic	Playhouse	plaghound	剧场	剧斯
MandarinTopic	Piano	reino	钢琴	受琴
MandarinTopic	Violin	vionad	小提琴	小提泰
MandarinTopic	Cello	tenlo	大提琴	大恰琴
MandarinTopic	Sofa	sogo	沙发	沙久
MandarinTopic	Kitchen	jaipsen	厨房	厨着
MandarinTopic	Tableware	fawrepare	餐具	餐各
MandarinTopic	Balcony	bercoty	阳台	促台
MandarinTopic	Photo	twolo	照片	照欠
MandarinTopic	Doorbell	roorbews	门铃	门淡

Notes

1 The ZIPF score is a standardised measure that is independent of the size of the database, thus allowing for closer comparisons between different databases that might differ in the number of words included (cf. Van Heuven et al. 2014, for more details on how to compute ZIPF scores).

2 We also analysed switching (difference between switch and non-switch trials) and mixing (difference between non-switch and single-language) effects. Here, we only included the twelve words per condition that were preceded by another word (and not the trials preceded by pseudoword). There were no interactions between trial type and condition, suggesting that topic did not influence switching/mixing effects.

3 Individual language-use percentages per participant and item (rather than per item across participants) also showed a significant interaction between %language use and language.

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