Perro or *txakur*? Bilingual language choice during production is influenced by personal preferences and external primes

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Abstract

Bilinguals living in a bilingual society continuously need to choose one of their languages to communicate a message. Sometimes, the circumstances (e.g., the presence of a monolingual) dictate language choice. When surrounded by other bilinguals, however, the bilinguals themselves can often decide which language to use. While much previous research has assessed language production when language selection is predetermined, we assessed how bilinguals choose the naming language themselves. We focused on the role of personal language preferences and examined to what extent personal preferences might be affected by external, suggestive language primes. Spanish-Basque bilinguals were asked to name pictures in their language of choice. Pictures were either presented on their own or were preceded by a linguistic or non-linguistic prime. In a separate session, participants were asked which language they preferred for each picture. Language choice during voluntary picture naming was related to personal language preferences. A bilingual was more likely to name a picture in the language they preferred for that specific picture. Furthermore, bilinguals were more likely to choose the language matching the preceding linguistic or non-linguistic prime. Effects of primes and preferences were additive and the influence of language preference on choice was equally strong in the primed and no-prime tasks. In addition to modulating language choice, following preferences and primes was also associated with faster responses. Together, these findings show that initial stages of language production and language choice are not just modulated by external primes but also by a bilingual's individual preferences.

Keywords: bilingualism; language choice; voluntary language switching; language preferences; language primes

1. Introduction

Both monolinguals and bilinguals constantly need to choose which words to use. Do we describe a dog by just saying 'dog' or do we refer to the specific breed ('poodle')? Bilinguals have an additional challenge: In addition to choosing the specific word form, they need to decide which language to produce it in. In some instances, the language is determined by the circumstances. For example, a Spanish-English bilingual who is surrounded by Spanish monolinguals will need to use Spanish. In other environments, such as bilingual societies, a bilingual can choose more freely which language to use. For example, when Spanish-Basque bilinguals are speaking with other Spanish-Basque bilinguals, they can often freely choose which language to use and can switch between languages when convenient. Bilinguals may have their own, individual preferences regarding language choice. These language preferences might be specific to the words a bilingual wants to produce or the message they want to convey rather than a global, topic-independent preference. While much research has been done on bilingual language production requiring use of a contextually determined language, we know very little about how and why bilinguals choose a specific language in contexts allowing free language choice. In this study we examined how individual language preferences can modulate bilingual language choice. Furthermore, in daily-life circumstances, even when both languages can be used freely, external cues might prime a specific language (e.g., the overall context might be more closely associated with one of the languages). We therefore also examined how language preference guides language choice in the presence of language primes and how preference and external primes interact (i.e., whether preference and primes have an independent influence on language choice or whether one overrules the other).

1.1. Bilingual language production

In monolingual production, several processes have been proposed that allow speakers to go from initial planning phases to articulation. In Levelt, Roelofs, and Meyer’s model (1999), language production processes start with a conceptualisation phase in which lexical concepts are activated (e.g., the concept of a dog). Next, in the lexical stratum, the corresponding lemma (i.e., the word for 'dog') with its syntactic features is selected. Lastly, in the form stratum, the word's morphological and phonological features are activated, followed by the phonetic encoding and articulatory execution. The process of language production thus starts with the initial concept and decision *which* word to produce. For monolinguals, there is a wide range of word options that can be selected, depending on the specific meaning one intends to communicate. For bilinguals, an additional level of complexity is formed by the selection of the language used to convey the message. In one prominent theory of bilingual language production (Inhibitory Control Model, Green, 1998), bilingual language use is regulated by an external supervisory attentional system (SAS) and language task schemas. The decision which language to use is transmitted by the SAS to the language task schemas, which in turn regulate the lexico-semantic system. This system activates words corresponding with the language task schema while inhibiting words from the other language. The exact mechanisms, however, to select the lemma and whether this requires inhibition and the presence of a language-external SAS is debated (cf. e.g., Multilink, Dijkstra et al., 2019).

While many studies and models have focussed on the processes following the initial phase of language selection, relatively little is known about the mechanisms underlying language choice. Language choice can be stimulus-driven (bottom-up), for example by linguistic or non-linguistic cues present in the context, but can also be led top-down by the speaker’s intentions or preference for one language ((Extended) Control Process Model, Green, 2018; Green & Wei, 2014). The vast majority of psycholinguistic research on language production, however, focuses on language selection driven by cues in the context (e.g., the face of a specific interlocutor) or by the input itself (e.g., words to be read in a specific language). Indeed, most previous research on bilingual language switching has used external cues (e.g., country flags or words in a specific language) to instruct the bilingual which language to use and when to switch (e.g., Costa & Santesteban, 2004; Meuter & Allport, 1999).

In daily life, the decision which language to use is indeed sometimes determined by the circumstances, for instance when bilinguals need to switch between two monolinguals speaking two different languages. However, for bilinguals living in a bilingual society, language choice is not always strictly determined. In these environments, bilinguals can switch freely between languages and change their language choice throughout the course of a conversation (e.g., Fricke & Kootstra, 2016; cf. de Bruin, Samuel, & Duñabeitia, 2018; Gollan & Ferreira, 2009, for experimental paradigms eliciting voluntary language switches). In these switching environments, bilinguals might take a more opportunistic approach using the words that come first, regardless of the language (Green & Abutalebi, 2013). Here we examined two factors that can drive language choice in these free choice contexts: external primes and personal preferences.

1.2. External primes

In the same way that external primes can restrict language choice in some circumstances, they can guide language choice in other contexts. We will use the phrase 'external primes' to refer to a range of linguistic and non-linguistic primes that are part of the context a target production (e.g., the production of the word 'dog') is embedded in. For example, both the topic of the conversation (e.g., whether a situation is a typical American or French scenario) and the interlocutor (e.g., whether an interlocutor is fluent in two languages or only has minimal knowledge of the second language) can affect language choice (Grosjean, 2008). Similarly, Telugu-English bilinguals were found to use and switch to English more often in the presence of a cartoon figure with a high proficiency in English than in the presence of a cartoon with a lower proficiency in English (Kapiley & Mishra, 2019). Even task-irrelevant cues that had artificially been associated with a language during a short training phase can modulate language choice. Bhatia, Prasad, Sake, and Mishra (2017) first asked Hindi-English bilinguals to complete a cued switching task in which colour patches were associated with a specific language. Next, the participants were asked to name pictures in their language of choice. Prior to each picture, a cartoon figure was presented that waved at one of the colour patches. While participants were instructed that the colour patch did not matter, they named the pictures more often in the language matching the colour patch. In some of the tasks, participants were also more likely to switch to the language associated with the colour (i.e., there was a larger percentage of switch trials when language choice matched the colour patch than when language choice did not match the colour patch). Only language choice was affected by the cues; reaction times (RTs) were comparable for cue-congruent and cue-incongruent responses.

Others, however, have shown that primes can also affect speed of language production or processing. Woumans and colleagues (2015) studied how faces associated with a specific language affected bilingual language production. After participants were familiarised with faces using a specific language, they were asked to generate verbs in response to nouns produced by these familiar faces. Bilinguals were faster to produce words in the congruent language (i.e., when the familiar face used the language used during the familiarisation) than in the incongruent language (i.e., when the familiar face used a language not previously used during familiarisation), at least in the first part of the experiment. Similarly, other studies have found that bilinguals respond faster when the image of a face or cultural cue matched the target language (e.g., seeing an Asian face when using Chinese, Li, Yang, Scherf, & Li, 2013; Roychoudhuri, Prasad, & Mishra, 2016; Zhang, Morris, Cheng, & Yap, 2013). Furthermore, interlocutor identity does not only affect language production but can also affect how words are perceived in a language previously associated with a specific interlocutor (Martin, Molnar, & Carreiras, 2016; Molnar, Ibáñez-Molina, & Carreiras, 2015).

In addition to these non-linguistic primes, the actual language used in a conversation affects language choice. Corpus-based analyses have shown that switches are modulated by the language of the preceding utterance (Fricke & Kootstra, 2016). For example, in a default-English conversation, bilinguals were more likely to switch within an utterance when the preceding utterance was produced in Spanish. This pattern was strongest when there was no change in speaker (i.e., when the preceding sentence was uttered by the speaker themselves rather than by an interlocutor). In addition, not following the previously used language might come with a cost. To address whether bilinguals take more time when switching languages than when they continue to use the same language, studies typically compare response times when participants switch languages versus response times when participants do not switch languages within dual-language environments. For example, when using picture-naming studies, switch trials (using a different language to name a picture than the language used for the previous picture) and non-switch trials (using the same language as for the previous picture) can be compared. Experimental work on language switching (e.g., de Bruin et al., 2018; Gollan & Ferreira, 2009) has shown a switching cost with slower responses on switch than non-switch trials even when switching happens voluntarily. This cost has also been found in code-switching studies using corpora (e.g., Fricke, Kroll, & Dussias, 2016). Furthermore, while bilinguals switch languages, they do not switch languages constantly and often prefer to continue using the preceding language. This suggests that the preceding language context can have a strong effect on language choice.

Together these studies show that different types of primes, both linguistic and non-linguistic, can affect bilingual language production/processing, both by guiding language choice and by speeding up or slowing down responses.

1.3. Individual preferences

In addition to external primes that can be found in the context, bilingual language production can be affected by factors related to the individual bilingual. Language switching is related to a range of socio-pragmatic purposes (cf. Myers-Scotton, 1993). For example, bilinguals might switch to a specific language for 'strategic' communicative purposes, for instance to change the topic or to emphasise or clarify their message (e.g., Reyes, 2004). Furthermore, although language switching does not need to indicate language incompetence (e.g., Yow, Tan, & Flynn, 2018), bilinguals might use words that are more easily retrieved in a specific language (e.g., de Bruin et al., 2018).

Most previous work looking at individual differences between bilinguals in relation to bilingual language control and switching has focused on variables such as proficiency and language use. These variables are often defined globally, for example by establishing a bilingual's first (L1) and second language (L2). Proficiency in each of the languages has been associated with language choice. For example, unbalanced bilinguals use their L2 to name easier items while leaving their L1 for more difficult-to-name items (Gollan & Ferreira, 2009).

However, a bilingual's proficiency and use are not always stable across domains. Instead, they can vary depending on the topic and language mode (e.g., Grosjean, 2016). That is, bilinguals might use one language more often in some situations (e.g., at work) but might use another language more often in other circumstances (e.g., at home). Language use and choice might thus differ not only between bilinguals but also *within* bilinguals. Looking at lexical access and language choice, de Bruin et al. (2018) found that language choice was related to the speed of lexical access at a participant-item level. Overall RTs in a specific language were not related with language choice: Bilinguals who were faster overall when using Basque were not more likely to use Basque for all words. Instead, the relationship between lexical access and language choice depended on the actual picture that had to be named. The same bilingual could be relatively fast at naming the picture of a horse in Basque (and would name that picture more often in Basque) but could be faster when using Spanish to name a table and would indeed use Spanish more often for that picture (while the opposite could be true for another bilingual). This highlights the need to assess in more detail how differences *within* a bilingual can affect language choice. An open question is to what extent language choice is related to a bilingual's own preferences. Bilinguals might prefer to use one language for certain topics/words but another language for other topics/words. To what extent do these within-bilingual preferences modulate both language choice and the speed of lexical access?

1.4. Current study

The current study therefore aimed to examine different factors that might contribute to free language choice in bilinguals. We focused on the role of individual language preferences and their potential interplay with external language primes.

We asked bilinguals to name pictures in their language of choice. In a separate preceding session, we asked them to indicate their preferred language for each picture. If bilingual language choice is (at least partly) governed by within-bilingual differences in language preference, the same bilingual should use different languages for different pictures, depending on their preferences. This would offer support for the idea that language use and preferences not only differ between bilinguals, but also within bilinguals depending on the topic of conversation (Grosjean, 2016). In addition to assessing language choice, we assessed response times (RTs) as a measure of speed of lexical retrieval. If preference guides language choice at a conceptual level without influencing the speed of lexical retrieval, RTs should not be modulated by language preference. However, if words matching a bilingual's language preference are more easily available, RTs should be faster when a bilingual produces a word in the preferred language than when they use the non-preferred language.

In daily life, bilinguals will not always follow their own preferences but they will also be affected by primes present in their surroundings. Non-linguistic primes have been the focus of most experimental work assessing effects of primes on either language choice (e.g., Bhatia et al., 2017) or lexical access (e.g., Woumans et al., 2015). Corpus analyses have furthermore suggested that language produced by the speaker themselves might have a particularly strong influence on language choice/switching (Fricke & Kootstra, 2016). Based on these studies, we aimed to examine if and how linguistic primes (i.e., asking participants to read a short Spanish or Basque sentence before naming a picture) and non-linguistic primes (i.e., seeing the Spanish or Basque flag before naming the picture) affect language choice. Importantly, both linguistic and non-linguistic primes were task-irrelevant but had strong existing associations with one of the languages (i.e., our participants did not have to be familiarised with these primes to form a language-specific association). They are furthermore types of primes that our participants experience in daily life. For example, participants are used to seeing visual symbols (e.g., the Basque flag) in their daily lives. In addition, linguistic primes (e.g., overhearing someone else's conversation or seeing a written sentence in a specific language) also occur frequently. We used two linguistic and two non-linguistic prime types per language. To increase similarity between linguistic and non-linguistic prime types, both types of primes required participants to process visual information (a flag versus a short sentence). To increase the need for linguistic processing in the linguistic-prime condition, we also asked participants to read the sentence out loud. Given that own language production has been found to have a strong influence on language choice (e.g., Fricke & Kootstra, 2016) and considering that linguistic primes included the additional component of language production, we expected effects on language choice to be stronger for linguistic than non-linguistic primes.

If bilingual language choice is affected by suggestive external primes, bilinguals should be more likely to use a specific language when it matches the language indicated by the prime. Some previous studies have suggested that primes can affect language choice but not speed of lexical retrieval (e.g., Bhatia et al., 2017) while other work has shown that primes can modulate lexical access (e.g., Woumans et al., 2015) when language selection is predetermined (i.e., when bilinguals *have* to use a specific language). If primes do not just influence language choice but can also modulate the speed of naming, picture naming should be faster when bilinguals use the language matching the prime than when they use the mismatching language. We were especially interested in the potential interplay between language preferences and external primes. If language preference influences language choice regardless of the surrounding context, effects of language preference should be equally strong in tasks with and without primes and should persist even in the presence of linguistic and non-linguistic language primes. In line with this, if both primes and preferences influence language choice independently, participants should be most likely to use a language if it matches the prime as well as their own preference. However, if external language primes overrule individual preferences, effects of language preference should be smaller or non-existing in primed contexts compared to contexts without external primes.

2. Methods

2.1. Participants

The final dataset contained sixty-two Spanish-Basque bilinguals (48 female, *M*age = 25.5, *SD*age = 4.8). All participants had normal or corrected-to-normal vision and no known neurological, reading, or hearing impairments. The first session of the experiment was completed by 95 participants. In this session, participants were asked to indicate their naming preference for a list of pictures, including the sixteen target pictures used in session 2. Thirteen participants were not invited for the second part, because they indicated a Basque preference for all target pictures (*N* = 5), a Spanish preference for all targets (*N* = 7), or no language preference for any of the targets (*N* = 1). Of the 82 participants that were invited for the second part, 67 took part. Two participants were subsequently removed due to not switching languages during the experimental tasks; two participants were invited for the second part despite not having a Spanish preference for any of the items and were subsequently removed;

and one participant had to be removed due to computer failure, leading to a final sample of sixty-two participants. The participants provided written informed consent. The study was approved by the BCBL Ethics Review Board and complied with the guidelines of the Helsinki Declaration.

In the first session, participants were also asked about their language use and switching habits. All participants reported having at least some contexts in which they switch languages in daily life (e.g., with friends, family, or at work). Seven participants indicated that they do not have any non-switching contexts in daily life; most other participants mainly indicated speaking to someone who does not speak Basque as the most typical non-switching context. Participants also completed the Bilingual Switching Questionnaire (Rodriguez-Fornells, Kramer, Lorenzo-Seva, Festman, & Münte, 2012). Participants reported frequent switching into Spanish (scale 3-15: $M = 9.1$, $SD = 2.1$) as well as Basque (scale 3-15: $M = 8.3$, $SD = 2.0$). In terms of education, the majority of participants (52) completed their primary and secondary education in Basque; the other ten participants completed their education in Basque and Spanish.

When they signed up for the participant database, all participants completed a set of objective and subjective language measures that form part of the BEST, including a picture naming task, lexical decision task (LexTALE), and an interview (De Bruin, Carreiras, & Duñabeitia, 2017). In the picture naming task, they were asked to name 65 non-cognate pictures in Basque and Spanish. In the LexTALE, participants performed a lexical decision task in Spanish and Basque. In the five-minute interview, a native speaker assessed the participants' language proficiency and fluency in Spanish and Basque by asking questions ranging in difficulty. In addition to these measures, participants were asked to self-rate their proficiency on a scale from 0 to 10 as well as their exposure to and spoken use of each language on a scale from 0 to 100%. The results from these measures are provided in Table 1.

Table 1. Summary of the objective and subjective measures of language proficiency, language exposure, and language use for Spanish (left) and Basque (right).

	Spanish			**Basque**		
	Mean	SD	Range	Mean	SD	Range
Age of Acquisition	0.6	1.7	0-8[1]	1.0	1.2	0-3
Picture naming (0-65)	64.6	0.7	62-65	58.2	6.6	41-65
LexTale						
(0-100%)	93.8	5.5	78-100	89.7	7.5	64-99
Interview (1-5)	5.0	0.0	5-5	4.6	0.6	3-5
Self-rated proficiency						
(0-10)						
Speaking	9.3	0.8	7-10	8.6	1.1	6-10
Understanding	9.4	0.8	7-10	9.2	1.0	7-10
Writing	9.0	1.1	6-10	8.5	1.4	6-10
Reading[2]	9.3	0.8	7-10	9.1	1.2	5-10
General[3]	9.1	0.9	7-10	8.4	1.1	6-10
%exposure						
(0-100)	54.0	10.6	30-70	34.8	10.7	10-60
%speaking						
(0-100)	56.9	12.6	30-80	33.9	11.5	10-60

[1]One participant listed Spanish AoA to be 8 years old; however, this was their first language of acquisition, so this is likely to be an error.
[2]Data missing from one participant.
[3]Data missing from two participants.

2.2. Materials

Sixteen images were selected from the MultiPic database (Duñabeitia et al., 2018). These images reflected easy-to-name objects or animals, had a high naming agreement in Spanish (*M*

= 94.0%, *SD* = 9.6), and had been named consistently in Basque by four Basque native-speakers in a previous norming. The Spanish and Basque names were non-cognates and were matched on frequency, number of syllables, and number of phonemes (see Appendix A). The use of a small number of individual items that are repeated frequently across conditions is in line with cued language-switching studies (e.g., Costa & Santesteban, 2004; Costa, Santesteban, & Ivanova, 2006; Meuter & Allport, 1999) and allowed us to only select words that bilinguals frequently use in daily life. We selected stimuli belonging to four semantic categories to examine potential cumulative semantic interference effects; this research question is beyond the scope of the current manuscript and effects of semantic category are not analysed. In the non-linguistic prime task, two versions of the Spanish and Basque flags were used to precede the pictures. In the linguistic prime task, the Spanish and Basque equivalents of the sentences 'This is what I see on the screen …' and 'On the screen I see this …' preceded the pictures. Each participant saw each version of the prime equally often.

2.3. Task

The three main tasks were voluntary picture naming tasks in which the participants were presented with a picture on the screen that they could name in their language of choice. Participants were encouraged to use the word that came to mind first, regardless of the language. They were also told that they could use both languages and could switch whenever they wanted. Participants completed three naming tasks. In the no-prime task, pictures were presented one by one on the screen without any other information. In the linguistic prime task, each picture was preceded by a Spanish or Basque sentence. The participant was instructed to read the sentence out loud prior to pressing the space bar to see the picture. In the non-linguistic prime task, participants saw a country flag (Spanish or Basque) for one second prior to seeing the picture (which was also accompanied by the flag). In both the linguistic and non-linguistic prime tasks, participants were instructed that they could ignore the sentence or flag when naming the picture. The instructions emphasised that they could name the picture in their language of choice, regardless of the information preceding the picture.

The no-prime task consisted of 128 trials. Each primed task consisted of 256 trials; half of the trials were preceded by a Basque prime while the other half was preceded by a Spanish prime. Half of the trials presented a different prime than the previous trial (prime switch, e.g., Basque prime on previous trial and Spanish prime on current trial) while the other half presented the same prime as the previous trial (prime repetition, e.g., Basque prime on previous and on current trial). Each picture was preceded an equal number of times by a Basque or Spanish prime in each task. Each picture was also presented an equal number of times as a prime switch or repeat trial for each language prime. Each participant saw the same stimulus list in each task to ensure that the preceding stimuli were always the same regardless of the task (i.e., to avoid the language preference for the previous trial differing between tasks).

Each trial started with a fixation cross presented for 500 ms, followed by the picture staying on the screen for 2500 ms regardless when the response was given (similar to the procedure used in other voluntary switching studies with this population, e.g., de Bruin et al., 2018). In the linguistic prime task, the picture was preceded by a sentence that stayed on the screen until the participant read it aloud and pressed the space bar to see the picture. In the non-linguistic prime task, the picture was preceded by a country flag that stayed on the screen for one second (our pilot study suggested that this interval was sufficient for participants to process the prime while being comparable to the interval in the linguistic prime task). In all conditions, naming times were measured relative to the onset of picture presentation.

2.4. Procedure

The study consisted of two sessions. Instructions were provided on the screen in Basque and Spanish and the experiment was led by a bilingual experiment leader, speaking to the participants naturally in both languages. In the first session, participants were asked to complete a survey. This survey included 46 non-cognate pictures (16 target pictures, which were chosen before the preference ratings) for which the participants were asked to indicate their language preference (Basque/Spanish) and the strength of their language preference ('no preference at all'; 'very weak'; 'weak'; 'medium'; 'strong'; 'very strong'). Participants were simply shown the picture and were asked to indicate in which language they preferred to name the object shown in the picture, following these instructions (in Spanish and Basque): "In the next part you are going to see some images. Indicate which language you prefer to use to name each image (Basque or Spanish). Also indicate your level of preference for using this language". With each presented image, participants were reminded of the two questions (preferred language and strength of preference). By asking this question about individual pictures/objects (rather than more globally in the form of e.g., "which language do you prefer to speak"), we gave participants a concrete framework to base their decision on. By using concrete, highly frequent, and neutral pictures, we avoided participants preferring a language based on emotional or strategic (e.g., political) associations. Furthermore, by assessing item-specific preferences, we avoided drawing global comparisons between bilinguals, which could be more strongly influenced by participants interpreting "preference" in different ways. Thirty additional pictures were added to the 16 target pictures so that participants did not know which pictures were used in the subsequent experiment and consequently could not memorise the indicated language preference for those specific pictures.

A subset of participants (see 'participants' section) completed a second session in which they were asked to name pictures. This session started with a brief familiarisation phase in which participants saw each target picture with the corresponding Basque and Spanish name. Next, they completed a single-language task in which they were asked to name each picture once in Basque and once in Spanish in separate language blocks. The order of languages was counterbalanced. These single-language blocks were included to have a measure of response speed when pictures were named the first time in each language.

This was followed by the three voluntary picture naming tasks of main interest. The order of tasks was counterbalanced so that half of the participants started with the no-prime task, followed by the non-linguistic prime, and the linguistic prime task. The other half of the participants started with the linguistic prime task, followed by the non-linguistic prime task, and the no-prime task. This way, half of the participants started with the no-prime task and half with the primed task. The linguistic and non-linguistic primes were always completed consecutively to avoid participants switching between no-prime and prime tasks. With this counterbalancing scheme, half of the participants completed the linguistic prime task prior to the non-linguistic prime task while the other half completed the two primed tasks in the reversed order. Initial analyses including task order showed no effects of the task participants started with.

The tasks were presented using Psychopy 1.83.04 (Peirce, 2007). Stimuli were 200x200 pixels and were presented using a white background on a Viewsonic E90f monitor, with 90Hz refresh rate, and a screen resolution of 1024x768. Responses were recorded through a Sennheiser PC 151 headset with microphone.

2.5. Data analysis

The data and analysis script are available at: https://osf.io/b7xkh/

Basque-Spanish native speakers scored the participants' responses during the picture-naming tasks. They scored response language as well as accuracy (no or late response; wrong word; words combining the two languages; correct response). Trial type (i.e., language switch or non-switch) was coded afterwards. All responses were recorded and response times were determined using CheckVocal (Protopapas, 2007). For all analyses, incorrect responses as well as responses that could not be classified as switch or non-switch trials (i.e., first trial after a break and trials preceded by a mistake) were removed. In addition, we only included items in the analysis for which participants had a preference. That is, we removed the specific items for which a particular participant indicated having 'no preference' in the survey. Of the 16 pictures, on average 1.5 pictures did not have a Basque/Spanish preference for a given participant (*SD* = 2.8) and were removed from all further analyses (97 pictures across the 62 participants).

All data were analysed with mixed-effect models in R (version 3.6.0) using the lme4 package version 1.1-21 (Bates, Maechler, Bolker, & Walker, 2014) using either generalized linear mixed-effect models (for binary variables such as language choice or trial type) or linear mixed-effect models (for RT analyses). All data-analyses started with a maximal structure (cf. Barr, Levy, Scheepers, & Tily, 2013) including all fixed effects of interest, random intercepts for participants and items and slopes for all within-participant or within-item predictors. When models did not converge, we removed correlations between the random slopes and intercepts. If this was not sufficient, we first removed by-item slopes that explained least variance, followed by removal of by-participant slopes. All models converged following this procedure; the models' random-effects structures can be found on https://osf.io/b7xkh/.

Continuous fixed effects were centred and scaled and the two-level categorical predictors were coded as -0.5 and 0.5. The models were checked for collinearity between predictors through VIF.mer (Frank, 2011) and all VIFs were below 2.5. *T* or *z* values > 2 were interpret as reflecting significant findings.

2.5.1. Language choice

We first examined if and how preferences and primes affect language choice. In these analyses, language choice (Basque coded as 0; Spanish coded as 1) was the dependent variable (DV). The first analysis focused on the no-prime task and had one predictor: language preference. From the survey, we derived the language preference for each participant-item combination. This language preference was entered as a predictor with Basque preference coded as -0.5 and Spanish preference as 0.5. In the second analysis we examined the role of language preference and language primes in the two primed tasks. In addition to language preference, this analysis (with language choice as the DV) included language prime (Basque: -0.5; Spanish: 0.5) and type of prime (non-linguistic: -0.5; linguistic: 0.5). Lastly, we compared the primed and no-prime tasks to see whether the effects of language preference differed depending on the presence or absence of language primes. This analysis included language preference and task (no-prime: -0.5; primed: 0.5) as predictors.

2.5.2. Language switches

In the next set of analyses, we examined whether bilinguals were more likely to switch languages when there was a switch in language preference (i.e., when the language preference for the current picture differed from the preference for the previous picture) or when there was a switch in language prime (i.e., when the language prime for the current trial differed from the previous trial). This analysis was purely included to see whether there was any relationship between preference/prime switches and language switches when participants followed their preference/prime, as bilinguals would be expected to have to switch more often to be able to use the preferred/primed language if that preference/prime differed from the previous item. We therefore only included trials in which language choice matched the preference/prime. We compared how many trials were language-choice switches when the preference/prime switched compared to the preceding trial versus when there was no switch in preference/prime. To facilitate the design and interpretation of this analysis, we assessed preference and prime switches separately: one analysis included the no-prime task and looked at language preference switches while the second analysis included the primed tasks and only considered language prime switches (regardless of the preference). Language switch was used as the dependent variable. The first analysis included the no-prime task and the predictors language choice (Basque = -0.5; Spanish = 0.5) and language preference switch (non-switch = -0.5; switch = 0.5). The second analysis included the primed tasks and the predictors language choice, language prime switch (non-switch = -0.5; switch = 0.5), and type of prime (non-linguistic: -0.5; linguistic: 0.5).

2.5.3. Reaction times

Lastly, we examined how language preference and primes related to reaction times (using log-transformed RTs as the DV). We used these RT analyses to examine A) whether following preferences/primes influenced overall RTs; B) whether following preferences/primes influenced switching costs. If following your preference/prime facilitates language production, we expect an effect of following preference/prime on overall RTs. If following your preference/prime also facilitates language switching, we expect a smaller switching costs when the preference/prime is followed. In all tasks, RTs were measured relative to picture presentation. In the linguistic prime task, participants had to press the space bar after producing the linguistic prime. The picture was presented as soon as they pressed the space bar. Eight participants pressed the space bar before they finished producing the prime. While we could still determine the picture naming time relative to picture presentation, this measure was less reliable because picture naming times were likely to be delayed due to ongoing sentence reading. We therefore excluded these participants from RT analyses.

The analysis focusing on preference in the no-prime tasks included the predictors language choice, language preference match (i.e., whether the language choice matched the preference; match: -0.5, mismatch: 0.5) and trial type (i.e., whether the language choice on the current trial differed from the previous trial, similar to how language switches are defined in other language-switching studies, non-switch: -0.5; switch: 0.5). The analysis focusing on the primed task included language prime match (i.e., whether the language choice matched the language prime; match: -0.5, mismatch: 0.5), language preference match, language choice, and trial type.

Analyses were based on individual trials but by-participant means are provided in the text and figures. For the RTs, the reported averages are based on raw values even though the analyses were performed on log RTs.

3. Results

As a descriptive measure, we first calculated the percentage of Basque preferences indicated in the survey as well as the percentage of Basque responses in the picture-naming task by participant and by item. The participants, on average, had a preference towards Basque in both the survey (*M* = 66.2%, *SD* = 22.1, range = 6.3 – 93.8) and in the experimental tasks (*M* = 61.7% of correct answers named in Basque, *SD* = 12.4, range = 14.4 – 90.7*)*. Similarly, the items showed a Basque preference in the survey (*M* = 66.8%, *SD* = 16.6, range = 42.4 – 87.3) and in the experimental tasks (*M* = 62.4% of correct answers named in Basque, *SD* = 9.9, range = 35.2 – 73.4). Importantly for the current study, none of the participants had the same language preference for all items and none of the items were preferred to be named in a specific language by all participants.

Accuracy was close to ceiling in all tasks and not analysed further (no-prime *M* = 99.1%, *SD* = 1.4; non-linguistic prime *M* = 99.1%, *SD* = 1.2; linguistic prime *M* = 99.2%, *SD* = 1.2).

3.1. Language choice

3.1.1. No-prime task: role of language preference

We first examined the no-prime task in which participants were simply asked to name pictures in their language of choice. We examined whether there was a relationship between language preference and language choice. The negative intercept confirmed that Basque was chosen more often than Spanish (β = -0.442, *SE* = 0.145, *z* = -3.041, see Figure 1). However, language choice was influenced by language preference (β = 0.741, *SE* = 0.210, *z* = 3.529, see Figure 1).

Basque was used relatively less often when participants had a Spanish preference for an item (*M*Basque choice = 49.7%; *SD* = 23.7%) than when they had a Basque preference (*M*Basque choice = 66.9%; *SD* = 15.6%).

In this study, we were particularly interested in assessing whether language preferences for specific words affect language choice, over and above potential effects of overall language proficiency/use. To assess whether the findings reported are present when considering language proficiency and use, we reran the analyses including Basque proficiency (as measured on the 65-item vocabulary test) and use (defined as self-rated percentage speaking time in daily life). Basque rather than Spanish proficiency was included because performance in the Spanish proficiency test was at ceiling. No effects of Basque proficiency were observed. Basque use was related with overall language choice ($\beta = -0.281$, $SE = 0.109$, $z = -2.587$), reflecting that participants with higher Basque language use in daily life also used Basque more often in our task. Importantly, the main effect of language preference was observed when taking overall proficiency and use into account ($\beta = 0.766$, $SE = 0.220$, $z = 3.482$), showing that these preferences at the individual participant-item level go beyond overall proficiency and use.

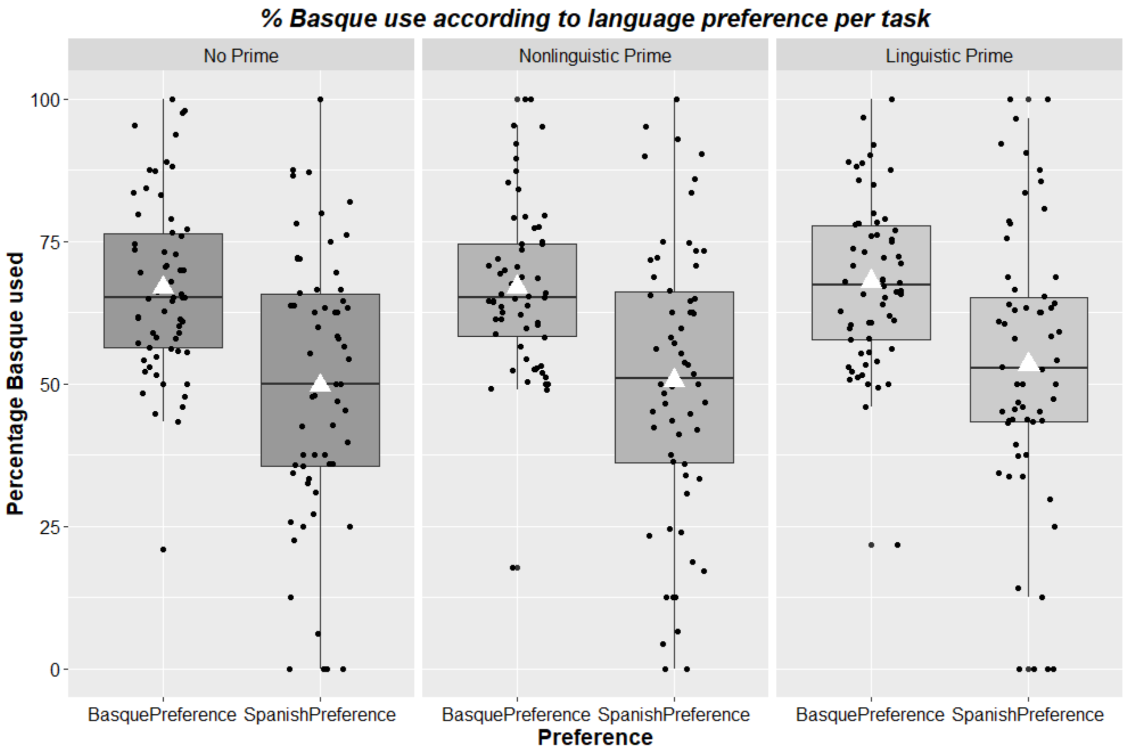

Figure 1. *Percentage of Basque used per task (no prime, non-linguistic prime, linguistic prime) and for trials with a Basque preference (left boxplot in each panel) or Spanish preference (right boxplot in each panel). Each black dot represents the mean for an individual participant; the white triangle represents the mean across participants.*

3.1.2. Primed tasks: role of language preference and primes

Next, we analysed the primed tasks to examine whether A) there was an effect of linguistic and non-linguistic primes on language choice, and B) whether and how language preferences influenced choice in the presence of primes.

In the presence of primes, participants still followed their language preference (β = 0.759, *SE* = 0.215, *z* = 3.530, see Figure 1). There was also an effect of prime (β = 0.874, *SE* = 0.151, *z* = 5.783): Participants were more likely to use Basque for items preceded by a Basque prime (*M*Basque choice= 69.6%, *SD* = 15.1) than for items preceded by a Spanish prime (*M*Basque choice = 54.1%, *SD* = 17.7). Language preference and prime did not interact (β = -0.119, *SE* = 0.077, *z* = -1.541), showing that the two are additive with participants most likely to use Basque for items with a Basque preference preceded by a Basque prime and relatively most likely to use Spanish for items with a Spanish preference preceded by a Spanish prime (see Figure 2).

There were no differences between the linguistic and non-linguistic primes. They had a similar effect on language choice (prime type: β = -0.098, *SE* = 0.075, *z* = -1.308; type of prime x language of prime: β = 0.176, *SE* = 0.268, *z* = 0.658). There was also no interaction between type of prime and language preference (β = -0.056, *SE* = 0.105, *z* = -0.536), nor a three-way interaction (β = -0.188, *SE* = 0.139, *z* = -1.350). This suggests that linguistic and non-linguistic primes had comparable effects on the language that was produced immediately after the prime (see Figure 2).

Similar to the no-prime analyses, we included Basque proficiency and use in the model. No effects of Basque proficiency were found. Again, Basque use was related to overall language choice (β = -0.256, *SE* = 0.117, *z* = -2.198), reflecting that participants with a higher Basque use used Basque more often. This pattern was weaker in the linguistic prime task (β = 0.218, *SE* = 0.077, *z* = 2.822), suggesting that the linguistic cues might have encouraged Basque use in bilinguals who use Basque less often in daily life. Importantly, effects of language preference (β = 0.766, *SE* = 0.208, *z* = 3.682) and prime (β = 0.881, *SE* = 0.150, *z* = 5.853) remained present when proficiency and use were included.

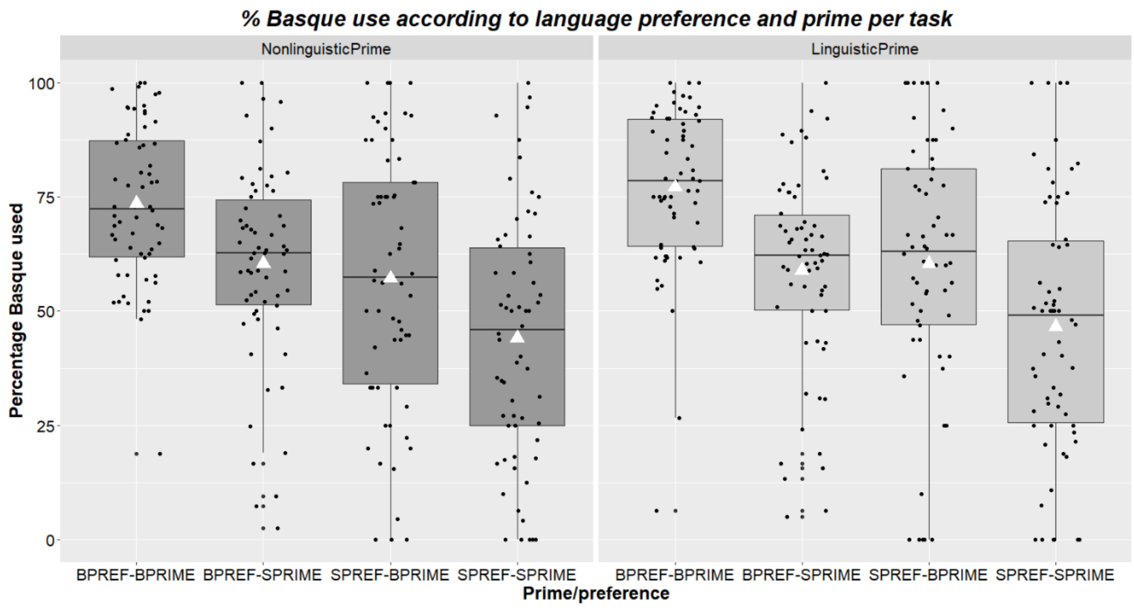

Figure 2. *Percentage of Basque used per task (non-linguistic prime on the left, linguistic prime on the right). Within each panel, the four box plots show from left to right: Basque preference & Basque prime (match) – Basque preference & Spanish prime (mismatch) – Spanish preference & Basque prime (mismatch) – Spanish preference & Spanish prime (match). Each black dot represents the mean for an individual participant; the white triangle represents the mean across participants.*

3.1.3. No-prime versus primed tasks

The previous analysis showed that the effect of language preference remained present even when primes were included and that the effects of primes and preferences were additive. To examine whether effects of language preference were smaller in a context including primes, we compared the no-prime to the primed tasks. There was an overall effect of language preference on language choice (β = 0.695, *SE* = 0.227, *z* = 3.065) that did not interact with task (β = -0.082, *SE* = 0.102, *z* = -0.810), confirming that the influence of language preference was similar in contexts with and without primes.

3.2. Language switching

3.2.1. No-prime task: language preference switches

Next, we examined whether preferences and primes can influence a bilingual's language switches. For language switches, it is not the preference as such that might matter. If the current preference is Basque and Basque was also the preference on the previous trial, there is no need to switch. We therefore focused on language preference as compared to the previous trial. In order to follow their language preference, bilinguals would be expected to switch more often if language preference differs from the previous trial. For this analysis we only included trials on which participants followed their preference (i.e., trials with a Basque preference named in Basque; trials with a Spanish preference named in Spanish) to assess whether a larger number of trials were language switches when preference switched.

Participants were more likely to switch languages when there was a switch in language preference ($\beta = 0.651$, $SE = 0.179$, $z = 3.644$) and this pattern did not differ for the two languages (see Table 2; $\beta = 0.238$, $SE = 0.222$, $z = 1.075$). Participants thus switched languages more often if the preference differed from the previous trial than when preference stayed the same. This is not surprising given that participants would need to switch languages in order to be able to follow their preference. Overall, of the trials produced in Spanish, a larger percentage was a switch trial ($M = 57.0\%$, $SD = 16.0$) than in Basque ($M = 36.1\%$, $SD = 12.2$; $\beta = 0.657$, $SE = 0.169$, $z = 3.886$). While the number of switch trials was comparable in Spanish and Basque, participants produced far more Basque non-switch trials than Spanish non-switch trials, reflecting their tendency to use Basque as the base language.

Table 2. Mean percentage of language switches (number of switch trials divided by the total number of trials) by language choice (Basque/Spanish, only including trials in which language preference was followed) and by preference switch (e.g., previous trial: Basque preference, current trial: Spanish preference) or repeat (e.g., previous trial: Basque preference, current trial: Basque preference) trials. Standard deviations are given within parentheses. In the analysis we only included the no-prime task when assessing language-preference switches. For completeness, however, the table shows the means separately for the no-prime, non-linguistic prime, and linguistic prime tasks.

LANGUAGE CHOICE	**BASQUE**		**SPANISH**	
	Switch to Basque preference	Repetition Basque preference	Switch to Spanish preference	Repetition Spanish preference
%LANGUAGE SWITCH				
No prime	42.9 (25.1)	30.5 (18.4)	61.9 (25.0)	42.8 (33.7)
Non-linguistic Prime	44.5 (25.8)	33.0 (17.6)	59.6 (24.3)	42.2 (27.3)
Linguistic Prime	42.0 (24.0)	31.7 (16.3)	63.7 (19.5)	54.4 (28.1)

3.2.2. Primed tasks: language prime switches

Similarly, we then assessed whether participants switched more often when following a prime that differed from the previous trial. When producing a word in the same language as the prime, participants indeed more often switched when the prime differed from the previous trial, to allow them to use the language matching the prime (see Table 3; $\beta = 0.990$, $SE = 0.156$, $z = 6.336$). Similar to the no-primed task, there was a higher percentage of Spanish than Basque switches ($\beta = 1.118$, $SE = 0.138$, $z = 8.117$), but the effects of prime switches on language switches were similar for the two languages ($\beta = 0.171$, $SE = 0.096$, $z = 1.784$). There were no effects of or interactions with type of prime (all zs < 1.4).

Table 3. Mean percentage of language switches (number of switch trials divided by the total number of trials) by language choice (Basque/Spanish, only including trials that followed the language prime) and by prime switch (e.g., previous trial: Basque prime, current trial: Spanish prime) or repeat (e.g., previous trial: Basque prime, current trial: Basque prime) trials. Standard deviations are given within parentheses. The results are given separately for the non-linguistic and linguistic primes.

LANGUAGE CHOICE	**BASQUE**		**SPANISH**	
	Switch to Basque prime	Repetition Basque prime	Switch to Spanish prime	Repetition Spanish prime
%LANGUAGE SWITCH				
Non-linguistic Prime	44.3 (21.9)	30.2 (16.5)	67.8 (20.2)	51.8 (22.5)
Linguistic Prime	46.2 (21.4)	27.1 (18.3)	71.7 (19.1)	48.9 (24.2)

3.3. Reaction times analysis

Prior to the RT analysis, outliers (RTs more than 2.5 *SD* above or below the mean, calculated on the log RTs per participant, task, language, and trial type; 2.0% of correct trials) were removed. Two analyses were run: one assessing effects of language preference in the no-prime task and one assessing effects of preference and prime in the primed tasks. To facilitate comprehension, we discuss these analyses in two parts. We first discuss effects of preference and primes on overall RTs. This answers the question whether following your preference/prime is associated with faster responses. Next, we focus on the potential interaction between following preference/primes and trial type. An interaction with trial type would indicate that following preferences/primes is associated with smaller switching costs.

3.3.1. No-prime task: following language preference and overall RTs

The first analysis focused on the relationship between language preference (matching or mismatching the language choice) and RTs in the no-prime task. The full results are presented in Table 4. RTs were significantly shorter when responses were made in Basque (*M* = 782.6, *SD*

= 99.1) than in Spanish (*M* = 878.5, *SD* = 139.4). Of main interest for the current study was the question whether responses were faster when participants used their preferred language. This was indeed the case. Both Spanish and Basque responses were faster when participants used the language matching their preference as compared to when the used language did not match their own preference (see Figure 3 and Table 5).

Table 4. Results of the RT analysis focusing on language preference in the no-prime task. For each predictor, the estimate, standard error, and t value are given with an asterisk indicating a significant effect. Language preference match trials were coded as -0.5; mismatch trials as 0.5 ('Language preference match'). Non-switch trials were coded as -0.5; switch trials as 0.5 ('Trial type'). Basque trials were coded as -0.5; Spanish trials as 0.5 ('Language choice').

Predictor	Estimate	SE	T value
Intercept	**6.699**	**0.022**	**305.410***
Language preference match	**0.076**	**0.008**	**9.024***
Trial type	**0.022**	**0.007**	**2.937***
Language choice	**0.073**	**0.011**	**6.700***
Language preference match x Trial type	0.002	0.012	0.184
Language preference match x Language choice	-0.019	0.015	-1.220
Trial type x Language choice	-0.019	0.013	-1.496
Language preference match x Trial type x Language choice	0.022	0.024	0.901

Table 5. Mean RTs by language choice (Basque/Spanish) and by language preference match/mismatch (i.e., whether the participant used the language matching their preference for this particular item). Standard deviations are given within parentheses. The results are given separately for the no-prime, non-linguistic prime, and linguistic prime tasks. Considering that language preference was not controlled experimentally, participants differed greatly in the number of trials per condition (including some participants with no trials in specific conditions). We therefore present both the by-participant and the by-item means.

LANGUAGE CHOICE	**BASQUE**		**SPANISH**	
	Match preference	Mismatch preference	Match preference	Mismatch preference
No Prime				
By participant	762.8 (102.7)	852.1 (133.4)	876.3 (168.8)	914.4 (159.5)
By item	778.7 (45.6)	798.1 (61.4)	813.7 (86.8)	923.8 (62.9)
Non-linguistic Prime				
By participant	797.8 (113.6)	876.2 (123.9)	894.4 (151.7)	922.6 (132.4)
By item	810.1 (42.3)	829.7 (59.9)	848.9 (82.6)	945.4 (56.5)
Linguistic Prime				
By participant	808.1 (111.2)	884.7 (120.3)	902.1 (165.2)	951.8 (142.5)
By item	822.1 (40.4)	830.9 (65.1)	847.5 (73.2)	967.9 (65.8)

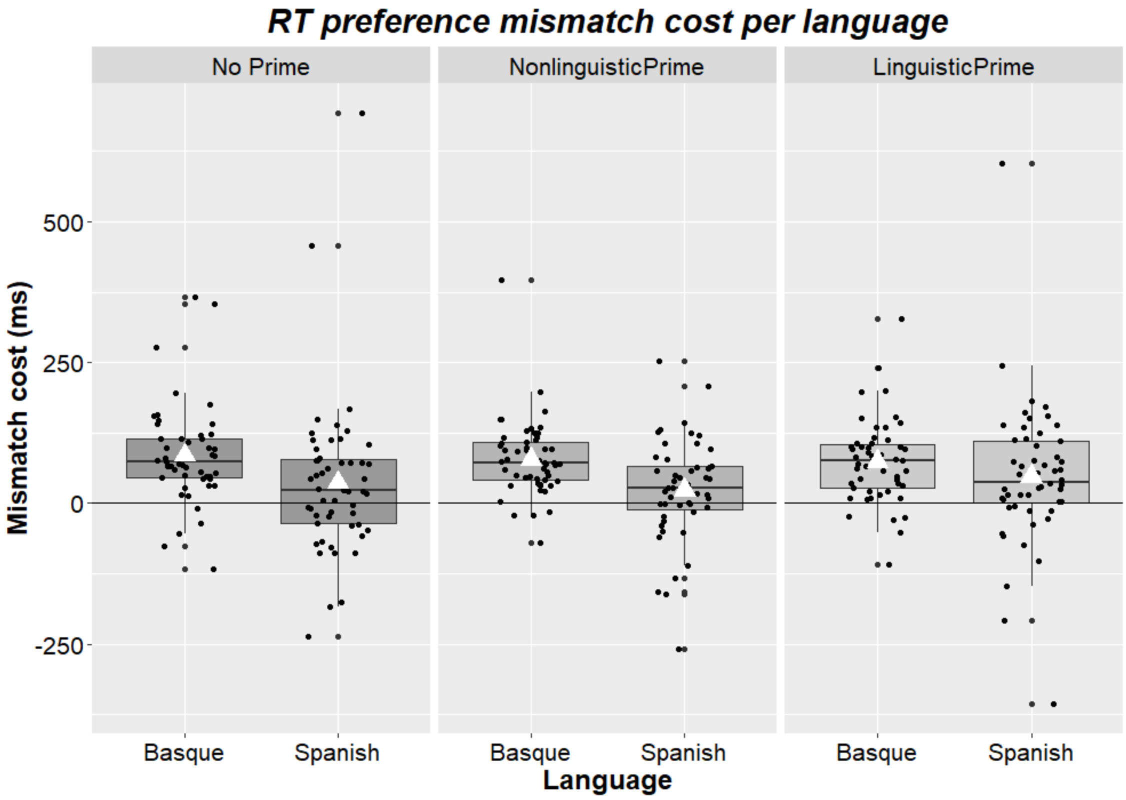

Figure 3. *RT preference mismatch cost (RT difference between trials in which the language choice mismatched the participants' preference and trials with a match between language choice and language preference). The results are shown per task (no prime, non-linguistic prime, linguistic prime) and for trials produced in Spanish and Basque. Each black dot represents the mean for an individual participant; the white triangle represents the mean across participants. Given that the plot shows the mismatch cost (i.e., the difference between match and mismatch trials), for each language and task the plot only includes participants who produced both preference match and mismatch trials.*

3.3.2. Primed tasks: following language primes and overall RTs

The next analysis focused on the primed contexts. We assessed whether overall RTs were affected by following language primes or not. We first included type of prime (non-linguistic or linguistic) as an additional predictor. In line with the language choice analyses, there were no effects of or interactions with type of prime (all *t*s < 1.7). To simplify the models, we therefore ran the reported analyses without type of prime. The full statistics are provided in Table 6.

Similar to the previous analyses, there was a main effect of language (reflecting faster Basque than Spanish responses). Of main interest here was the question whether RTs were affected by the preceding linguistic or non-linguistic prime. As can be seen in Figure 4 and Table 7, this was indeed the case. Participants named the picture faster when they used the language matching the preceding prime than when they used a mismatching language. Effects of prime and preference were additive such that participants were fastest when they used the language that matched both the prime and their own preference. Similar to the language choice analyses, effects of language preference were observed even in the primed contexts. A direct comparison of the effects of following preference on overall RTs between the primed and no-prime tasks confirmed that the effect of preference was equally strong in contexts with and without primes (β = -0.001, *SE* = 0.007, *z* = -0.188, see Figure 3).

Table 6. *Results of the RT analysis focusing on language primes and preferences in the primed tasks. For each predictor, the estimate, standard error, and t value are given with an asterisk*

indicating a significant effect. Language preference match trials were coded as -0.5; mismatch trials as 0.5 ('Language preference match'). The same coding was used for language prime match/mismatch trials. Non-switch trials were coded as -0.5; switch trials as 0.5 ('Trial type'). Basque trials were coded as -0.5; Spanish trials as 0.5 ('Language choice').

Predictor	Estimate	SE	T value
Intercept	**6.743**	**0.021**	**326.816***
Language preference match	**0.076**	**0.005**	**14.216***
Language prime match	**0.055**	**0.004**	**13.586***
Trial type	**0.016**	**0.004**	**3.626***
Language choice	**0.070**	**0.008**	**8.474***
Language preference match x Language prime match	0.005	0.005	0.829
Language preference match x Trial type	0.004	0.006	0.717
Language prime match x Trial type	-0.003	0.006	-0.554
Language preference match x Language choice	0.004	0.013	0.303
Language prime match x Language choice	0.006	0.006	1.092
Trial type x Language choice	-0.008	0.007	-1.116
Language preference match x Language prime match x Trial type	0.011	0.012	0.959
Language preference match x Language prime match x Language choice	0.011	0.012	0.856
Language preference match x Trial type x Language choice	0.002	0.015	0.121
Language prime match x Trial type x Language choice	-0.018	0.012	-1.470
Language preference match x Language prime match x Trial type x Language choice	-0.020	0.024	-0.815

Table 7. Mean RTs by language choice (Basque/Spanish) and by language prime match/mismatch (i.e., whether the participant used the language matching the prime). Standard deviations are given within parentheses. The results are given separately for the non-

linguistic prime and linguistic prime tasks. Given that language primes were controlled experimentally, the number of trials per condition was more evenly distributed and we only present by-participant means.

LANGUAGE CHOICE	**BASQUE**		**SPANISH**	
	Match prime	Mismatch prime	Match prime	Mismatch prime
Non-linguistic Prime	798.3 (110.2)	837.5 (112.3)	887.7 (135.5)	935.9 (168.0)
Linguistic Prime	809.6 (112.3)	850.9 (116.0)	903.7 (153.7)	970.4 (173.5)

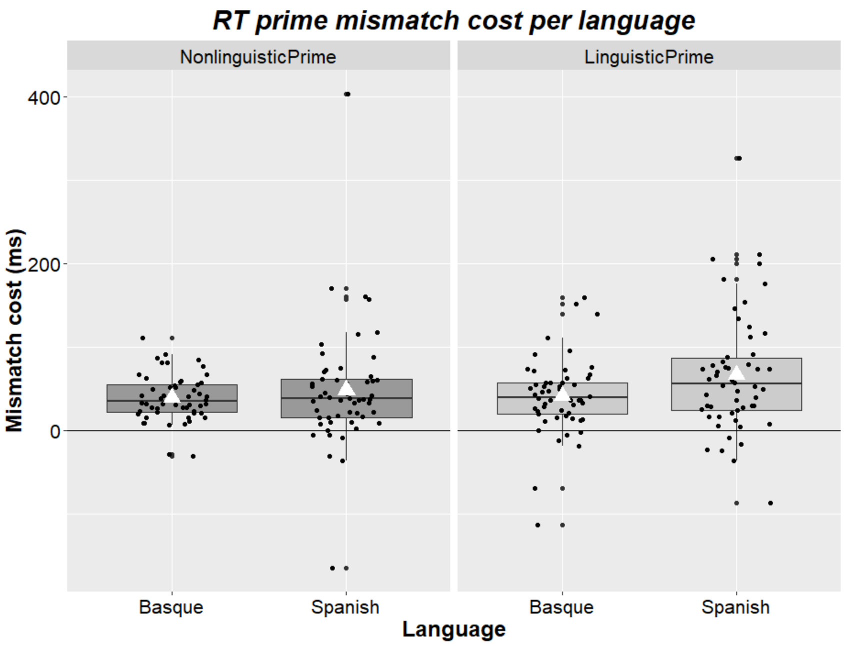

Figure 4. *RT prime mismatch cost (RT difference between trials in which the language choice mismatched the prime and trials with a match between language choice and language prime). The results are shown per task (non-linguistic prime, linguistic prime) and for trials produced in Spanish and Basque. Each black dot represents the mean for an individual participant; the white triangle represents the mean across participants.*

3.3.3. Following preferences/primes and RT switching costs

Next, we discuss effects of/interactions with trial type (a switch in language choice compared to the previous trial or not) to assess whether following preferences or primes affects language-switching costs. Both no-prime (Table 4) and primed (Table 6) analyses showed a significant effect of trial type, indicating a switching cost. In both analyses, following preference/primes affected overall RTs but not the switching cost. For the no-prime task, switching costs were comparable regardless of whether the language choice matched the participant's preference (match: by participant *M*cost = 40.6, *SD* = 70.4, by item: *M*cost = 31.2, *SD* = 21.7, mismatch: by participant *M*cost = 24.8, *SD* = 86.6, by item *M*cost = 42.8, *SD* =34.1). In other words, there was a similar switching cost when participants switched to a language matching their preference and when participants switched to a language that did not match their preference. Similarly, following primes affected overall RTs, but not the switching costs (match: *M*cost = 39.4, *SD* = 38.2, mismatch: *M*cost = 41.8, *SD* = 62.7). Participants thus had similar switching costs when they switched languages to follow the prime and when they switched languages but did not follow the prime.

4. Discussion

We examined language choice in Spanish-Basque bilinguals living in a bilingual society. These bilinguals were asked to name simple pictures in their language of choice. In some tasks, pictures were preceded by a linguistic prime (requiring production of a short sentence in Spanish or Basque) or by a non-linguistic prime (Spanish/Basque flag). In a separate session, we asked participants to indicate their language preference for the object depicted in each picture. Language choice in the picture-naming tasks was highly individual. It was related to both language preference and primes and these two effects were additive. Participants were most likely to use Basque to name a picture if their preference for that picture was Basque and if it had been preceded by a Basque prime; similarly, Spanish was most often used with a Spanish preference and prime. Participants were also faster at producing the picture names when they followed the language indicated by the primes and their own preferences. While participants were more likely to switch if there was a switch in preference or prime (compared to when the preference or prime was the same as on the previous trial), switching cost RTs were not affected by primes or preferences. Together, these results suggest that language choice and overall response speed are not only governed by external primes but also by a bilingual's individual language preference.

4.1. Language preference

The main focus of this study was to assess how language choice relates to different language preferences within bilinguals (i.e., language preferences depending on the object that had to be named). Participants' language choice was related to their language preference. They were relatively more likely to use Spanish when they had a Spanish preference for a specific item, and vice versa for Basque. Preference was not only related to language choice, but also to response speed. Participants were faster to name the picture when they used the language matching their preference.

Language preference was related to language choice even when overall language proficiency and use were taken into account. This highlights that language choice not only differs between bilinguals but also within bilinguals and can depend on the specific topic of communication (in this case, the specific picture that had to be named). These findings emphasise that bilingualism and language choice are context-dependent and highly individual. As outlined in Grosjean's Complementarity Principle Hypothesis (2016), bilingual language use might depend on the exact topic and context (e.g., bilinguals who use both languages on a daily basis might prefer to talk about topic A in language A and about topic B in language B). Our results show that language choice indeed goes beyond overall language use patterns and that it is affected by individual language preferences for specific words.

(Basque) language proficiency was not related to language choice, but Basque language use was. Participants who used Basque more often in daily life were more likely to choose Basque. These findings suggest that language use might be a better indicator of overall language choice than language proficiency. Even though most participants were either balanced in their daily-life Basque and Spanish language use or more Spanish-dominant, Basque was the preferred (and fastest) language in the voluntary picture-naming tasks (cf. de Bruin et al., 2018; Jevtović, Duñabeitia, & de Bruin, 2020, for similar findings). This could reflect several factors, including the fact that Basque was the language of schooling for most participants and the role of Basque as a minority language (i.e., Basque cannot always be used in daily life but when given a choice, Basque might still be the preferred language).

In this study, we focused on language preferences that bilinguals have for specific words. This study, and previous studies with this population (e.g., de Bruin et al., 2018), suggest that language preference depends on the combination of items and participants. As discussed above, it is not the case that individual participants always preferred the same language for all items. Instead, language preferences differed within bilinguals depending on the item. In addition, in this population it does not seem to be the case that certain word characteristics (e.g., word length, form, or frequency) are closely linked to language preference or language choice (cf. de Bruin et al., 2018, showing no relationship between relative word length or frequency and language choice). In this study we were not able to assess where these individual differences in preferences for these items might come from. Speculatively, it could be argued that language preference might be associated with how bilinguals acquired certain words and how often they use certain words in each language (also considering the association between preference/choice and speed of lexical processing). For example, a bilingual growing up with animals that are referred to in Basque might have a Basque preference for naming animal words. However, there are also many other external and internal factors that can drive language preference, including strategic and emotional reasons (cf. e.g., De Houwer, 2019; Myers-Scotton, 2003, for a discussion). These types of preferences might be more likely to emerge in studies that use pictures that are less neutral or lower in frequency than the ones used here. In addition, exploratory analyses on the current dataset (see supplementary materials) suggest that strength of language preference might also play a role. Bilinguals were somewhat more likely to follow their language preference if they had a strong preference for that specific item. In addition, participants were more likely to continue using the language they used the first time for a given picture. This influence of first naming language was observed in addition to an overall language preference effect. Future research will need to examine which other variables modulate voluntary language choice and lexical access.

4.2. Language primes

Both linguistic and non-linguistic primes affected language choice. Bilinguals were more likely to choose the language matching the country flag preceding the picture or matching the language of the sentence they produced themselves prior to naming the picture. This finding is in line with previous studies (e.g., Bhatia et al., 2017) showing that task-irrelevant cues can prime language choice. In contrast to Bhatia et al. (2017), primes not only affected language choice but also speed of naming. Participants were faster to name the pictures when they used the language matching the prime. This is in line with work instructing bilinguals to use a specific language matching or mismatching a contextual cue (e.g., Woumans et al., 2015).

The finding that participants were more likely to follow primes is perhaps not surprising and in line with previous research. The most important question in the current study was whether primes influenced the role of language preference. This was not the case. Effects of preference and primes were additive, meaning that participants were especially likely to use the language that matched both the prime and the preference. Similarly, participants were fastest to name the picture when they used the language that matched both their preference and the prime. Importantly, effects of language preference were just as strong in the no-prime task as in the tasks including primes, confirming the strong influence of preference on choice and RTs even in the presence of clearly visible primes. While these external primes had a strong influence on language choice, they did not overrule or diminish individual preferences. This suggests that even when bilinguals are in an environment favouring one language (and even though they are likely to follow that favoured language), language preference continues to guide language choice.

While the primes were clearly present in the task context, it is unlikely that participants strategically followed the language indicated by the primes. First, participants were faster when they followed the prime language than when they did not. Following a rule that is not (always) compatible with your own choice is likely to lead to slower responses instead of faster responses (e.g., cued switching studies in which participants have to follow cues as a rule typically show slower response times than voluntary switching studies in which participants follow their own language choice, e.g., de Bruin et al., 2018). Furthermore, in the survey at the end of the experiment most participants reported that they were not influenced by the primes. For the non-linguistic primes, the majority of participants (42 out of 62) indicated not experiencing any or a weak influence of the primes. Twelve participants indicated a medium influence and only eight participants indicated a strong or very strong preference. Similarly, for the linguistic primes, over half of the participants (34) indicated no or a weak influence, 14 a medium influence, and 14 a strong or very strong influence. This suggests that most participants did not feel like they had to follow the primes.

We compared two types of primes: Linguistic (i.e., participants had to produce a sentence prior to naming the picture) and non-linguistic (country flag) primes. Previous experimental studies have mainly looked at non-linguistic primes (e.g., faces, flags, coloured frames). We expected effects of linguistic primes to be stronger than those of non-linguistic primes, especially considering that our linguistic primes required the participants to produce the language themselves (cf. Fricke & Kootstra, 2016). However, the type of prime (linguistic vs. non-linguistic) did not interact with the effect of the prime on the actual language choice when naming the following picture. Participants followed the language of the prime regardless of it being a linguistic or non-linguistic prime. One potential reason why linguistic primes were as strong as non-linguistic primes is that the same sentences (two per language) had to be used constantly. We opted for this sentence repetition to make the linguistic and non-linguistic prime conditions as similar as possible (i.e., two versions of a Spanish linguistic and non-linguistic prime and two versions of a Basque linguistic and non-linguistic prime). Using a more active task (e.g., describing a scene rather than reading a sentence) might boost effects of linguistic primes. Furthermore, it remains an open question whether a larger variability in linguistic primes could have a stronger effect on language choice. Different types of linguistic primes might also differ in their effects on naming language.

4.3. Theoretical implications

Models on language production typically include an initial conceptualisation/planning stage, in which the concept is activated. Models on bilingual production/processing include a language selection phase, for example in the form of a supervisory attentional system transmitting language selection to language schemas (Green, 1998). Most previous research has focused on scenarios in which the language choice is clearly identified by the environment, for example by using language cues requiring bilinguals to produce a certain language. However, language choice is not always determined by the surroundings. Models on bilingual language production therefore need to account for mechanisms underlying free language selection. In this study, we show that when bilinguals can freely choose a language, this level of language choice can be modulated by both individual preferences and external suggestive (but not restrictive) linguistic and non-linguistic primes. Influences of individual preferences remained when language primes were present in the context, highlighting the need to consider these individual preferences in models on bilingual language selection. Importantly, this study highlights differences in language preference not only between but also *within* bilinguals, with language preference depending on specific participant-item pairs. When individual differences are taken into account, they usually focus on overall participant characteristics such as language proficiency (e.g., Green, 1998). Here we show that language choice and lexical access are not only driven by overall proficiency or daily-life language use, but also depend on individual preferences for specific items/objects.

Language preference and primes not only affected language choice but also naming speed. These effects on RTs can stem from different levels. It is possible that they influence the speed of language decision/selection at the conceptualisation level. In the Inhibitory Control Model (Green, 1998), language decisions are governed by a language-external supervisory attentional system (SAS), which in turn forwards language decisions to the language task schemas and the lexico-semantic system. The decision which language to use might be sped up when the preferred/primed language is used. In addition (or alternatively), following preferences/primes might result in faster lexical retrieval.

Considering language preference, if concepts are more strongly associated with the language matching a bilingual's preference, the names in the corresponding language might be more easily retrievable than the name in the other language. Bilinguals are also likely to use their preferred language for a given object more often in daily life, which could further strengthen particular lemmas in the preferred language and lead to faster lexical access. In this case, faster retrieval of a specific lemma could feedback to the conceptual level and could guide language choice. Our data from the single-language condition suggest that language preference is indeed not just related to language-choice processes but also to speed of lexical retrieval. In the single-language conditions, participants were asked to name all pictures once in Basque and once in Spanish. RTs in these single-language conditions were faster when the assigned language matched the preference (M = 863ms) than when there was a mismatch (M = 916ms). This suggests that language preference is associated with speed of lexical retrieval even when language choice is predetermined.

Following primes also led to shorter RTs. This could be the result of faster decisions in the language decision process and/or faster lexical retrieval when following the primes. The external primes were presented prior to the picture, which could have led to higher activation of the language associated with the prime, subsequently leading to faster retrieval of words in that language. While following the prime might have sped up responses, *not* following the prime might have slowed down responses. In this sense, not following a prime might be similar to the effort associated with switching between two languages and could perhaps require inhibition of the language associated with the prime in order to 'switch' to the intended language (cf. Green, 1998).

Language preferences and primes affected language choice but only had a limited influence on language switching. When there was a switch in prime/preference as compared to the previous trial, participants were more likely to switch. In these cases, switching was often needed to be able to follow the preference or prime. However, contrary to the effects on overall RTs, switching costs were not affected by primes or preferences. Switching was equally effortful when participants switched languages to follow their prime/preference as when they switched but did not follow their prime/preference. The observed estimates for interactions between trial type and preference/prime match were close to zero and these null effects are unlikely to be the result of insufficient power. There are a few reasons why primes and preferences might not affect the switching cost. First, an overall switching cost was observed despite switching taking place voluntarily. This is in line with several previous voluntary switching studies (e.g., de Bruin et al., 2018; Gollan & Ferreira, 2009; Jevtović et al., 2020; but cf. e.g., Kleinman & Gollan, 2016, for types of voluntary switching that might not result in switching costs). The presence of a switching cost might suggest that switching requires reactive language control even when done voluntarily. This switching cost might stem from interference from the language that was used on the previous trial (Green, 1998). Even when switching freely, inhibition of the interfering non-target language might be needed (cf. de

Bruin et al., 2018). While using the language matching primes or preferences might lead to overall faster responses, it might not be sufficient to diminish the cost of switching from one target language to another language. An alternative, not mutually exclusive, interpretation is that following preferences/primes not only facilitates switching but also *staying* in a language. Most participants used a base language (often Basque). Following the Spanish preference/prime might not just have facilitated switching to Spanish (switch trials) but also staying in Spanish rather than returning to the base language (non-switch trials). This could explain the overall faster RTs on both switch and non-switch trials (although this explanation might only hold for the non-base language).

5. Conclusion

When bilinguals speak, they need to select one of their languages. In some circumstances, this language selection is determined by the context. However, bilinguals living in a bilingual society can often freely choose which language to use when they are surrounded by other bilinguals who speak the same languages. In this study, free language choice was found to be related to their personal preferences such that different languages were used depending on the object that needed to be named. In addition, language choice was modulated by linguistic and non-linguistic primes present in the context. However, effects of language preference were just as strong in contexts with primes as they were in contexts without primes. Following preferences and primes also led to faster responses, suggesting that preferences and primes not only affected language choices but also naming speed. Language preferences did not only differ between bilinguals but especially also within bilinguals depending on the object that had to be named. When not dictated by the circumstances, language selection is thus flexible and not just influenced by external primes but also by highly individual language preferences.

Acknowledgement

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska - Curie grant agreement No 743691. C.D. Martin was supported by the Spanish Ministry of Economy and Competitiveness (SEV-2015-490; PSI2017-82941-P), the Basque Government (PIBA18-29), and the European Research Council (ERC-2018-COG-092833). We would like to thank Itziar Basterra and Amets Esnal for their help with data collection

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Appendix A. Stimuli

Basque and Spanish words were matched on number of phonemes (Spanish: M = 5.4, SD = 1.0; Basque: M = 5.4, SD = 1.7; $t(15)$ = -.169, p = .868), number of syllables (Spanish: M = 2.5, SD = 0.5; Basque: M = 2.4, SD = 0.6; $t(15)$ = .368, p = .718), and log frequency (Spanish: M = 1.4, SD = 0.6; Basque: M = 1.4, SD = 0.5; $t(15)$ = -.013, p = .989). Word length and frequency were determined through E-Hitz for Basque (Perea et al., 2006) and B-Pal for Spanish (Davis & Perea, 2005).

Spanish	**Basque**	**English**
abrigo	beroki	coat
boca	aho	mouth
caballo	zaldi	horse
camisa	alkandora	shirt
cebolla	tipula	onion
ciervo	orein	deer
falda	gona	skirt
fresa	marrubi	strawberry
hombro	sorbalda	shoulder
mano	esku	hand
manzana	sagar	apple
oveja	ardi	sheep
perro	txakur	dog
queso	gazta	cheese
rodilla	belaun	knee
vestido	soineko	dress