



**HAL**  
open science

## Traces of An Early Learned Second Language in Discontinued Bilingualism

Jasmin Sadat, Rita Pureza, F. -Xavier Alario

► **To cite this version:**

Jasmin Sadat, Rita Pureza, F. -Xavier Alario. Traces of An Early Learned Second Language in Discontinued Bilingualism. *Language Learning*, 2016, 66 (2, SI), pp.210-233. 10.1111/lang.12199 . hal-01619552

**HAL Id: hal-01619552**

**<https://hal.science/hal-01619552>**

Submitted on 10 Apr 2019

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

1 Sadat, J., Pureza, R., & Alario, F. X. (2016). Traces of An Early Learned Second  
2 Language in Discontinued Bilingualism. *Language Learning*, 66(S2), 210-233.

3  
4 DOI : [10.1111/lang.12199](https://doi.org/10.1111/lang.12199)

5  
6  
7  
8 **Traces of an early learnt second language**  
9 **in discontinued bilingualism**

10 Jasmin Sadat <sup>a, c</sup>, Rita Pureza <sup>b</sup>, & F.-Xavier Alario <sup>c</sup>

11  
12  
13 <sup>a</sup> Aix-Marseille Université, CNRS, LPL UMR 7309, Aix-en-Provence, France

14 <sup>b</sup> University of Minho, School of Psychology, Human Cognition Lab, Minho, Portugal

15 <sup>c</sup> Aix-Marseille Université, CNRS, LPC UMR 7290, Marseille, France

16  
17  
18  
19  
20 Running head: SECOND LANGUAGE TRACES IN DISCONTINUED BILINGUALISM

21 Keywords: fluency; word retrieval; bilingualism; unlearning; cognates

1

2

Authors' note

3 Acknowledgements

4 This research was supported by the European Research Council (FP7/2007-2013 Grant  
5 number 263575), the Brain and Language Research Institute (A\*MIDEX grant ANR-  
6 11-IDEX-0001-02, LABEX grant ANR-11-LABX-0036), and the Fédération de  
7 Recherche 3C (Aix-Marseille Université).

8

9 Address correspondence to:

10 F.-Xavier Alario,

11 Laboratoire de Psychologie Cognitive,

12 Aix-Marseille Université-CNRS UMR 7290,

13 3, Place Victor Hugo

14 13331 Marseille, France.

15 Email: francois-xavier.alario@univ-amu.fr

16

1

2

Abstract

3

4 Can an early learnt second language influence speech production after living many  
5 years in an exclusively monolingual environment? To address this issue, we  
6 investigated the consequences of discontinued early bilingualism in heritage speakers  
7 who moved abroad and switched language dominance from the second to the primary  
8 learnt language. We used two fluency tasks to compare European Portuguese  
9 monolinguals with early European Portuguese-French bilinguals who no longer use  
10 French. The occurrence of cognate words in retrieval performance was used as an index  
11 for the influence of the early learnt second language (French). Results showed that  
12 bilinguals used more cognates than non-cognates relative to monolinguals. Also,  
13 monolinguals and bilinguals produced the same number of responses in the fluency  
14 tasks, and the produced words were of similar frequency. Our findings highlight that  
15 early learning of a second language, even when discontinued, plays a lasting role for  
16 word selection.

17

18

1

2

## Traces of an early learnt second language in discontinued bilingualism

3

4

5        Although much research has focused on the influence of a primary language on  
6 second language production (e.g., Flege, Munro, MacKay, 1996; Hermans, Bongaerts,  
7 de Bot, & Schreuder, 1998), only few studies have looked at the linguistic remains from  
8 an early learnt second language that is not used anymore. This is usually the case for  
9 bilingual ‘returnees’, that is, early bilinguals who continuously used a second language  
10 during many years before moving abroad to an exclusively monolingual environment  
11 (e.g., of their first learnt language: Kanno, 2000). While it is established that linguistic  
12 knowledge of an unpracticed second language undergoes attrition (e.g., Cook, 2007;  
13 Schmid & de Bot, 2004), it is still possible that traces of such early bilingualism endure  
14 and influence speech, even after many years of living in a different language  
15 environment. The goal of the present study is to explore the remains and influences of  
16 such an early second language experience on word production performance. To do so,  
17 we assessed the use of cognates in word retrieval performance of early bilinguals who  
18 no longer use their second language.

19        Cognates are translations that share meaning and are similar in form  
20 (phonologically and/or orthographically; e.g., *girafa* [giraffe], in European Portuguese  
21 and English); they contrast with non-cognates that only share meaning (e.g., *pássaro*  
22 [bird]). It has been shown that cognates are more ‘resistant’ to language attrition, while  
23 non-cognates tend to be lost both in language attrition and language death (see Schmid  
24 & de Bot, 2004). More importantly for the present study, processing benefits for  
25 cognate retrieval have been shown in the two languages of a bilingual. Previous studies  
26 comparing bilingual to monolingual performance reported production benefits for  
27 cognates when compared to non-cognates (e.g., Costa, Caramazza, Sebastián-Gallés,  
28 2000; Costa, Santesteban, & Caño, 2005; Ivanova & Costa, 2008; Gollan & Acenas,  
29 2004; for a reconsideration of ‘benefits’ see Sadat, Martin, Magnuson, Alario, & Costa,  
30 in press), highlighting the special role of cognates in bilinguals. Cognate effects in word  
31 production of bilinguals suggest that the words of the two languages spread activation to  
32 their common phonological representations. The most prominent explanation regarding

1 the origin of such a cognate effect hinges on the interactive nature of lexical processing  
2 (e.g., Costa et al., 2005). Phonemes that are common across the two languages of a  
3 bilingual would feed back their activation to the word level, and thus facilitate retrieval  
4 of cognates compared to non-cognates (but see also Sánchez-Casas & García-Albea,  
5 2005, or Van Hell & De Groot, 1998, for alternative explanations at the morphological  
6 and conceptual level respectively). Irrespective of the precise origin of the effect, the  
7 fact that cognate status is a feature of bilinguals' linguistic knowledge (but not  
8 monolinguals') and that its manipulation affects performance, makes it a sensible  
9 measure of other-language activation during speech production of bilinguals.

10 The group of bilingual speakers in the present study consisted of early bilingual  
11 heritage speakers of European Portuguese that were born and raised in France, but were,  
12 at the time of testing, living in an almost exclusively monolingual environment of their  
13 first learnt language (European Portuguese). European Portuguese has again become  
14 their dominant and now only language, as the use of their second language (French)  
15 declined drastically since they moved to their parents' country of origin. Since cognate  
16 words are more resistant to language disuse (in the non-used language), we expect them  
17 to serve as a refined index of second language influence on the used language. Thus an  
18 increased use of cognates *in the used language* by this type of bilinguals, compared to  
19 monolinguals, would indicate that there are still remaining traces of their early language  
20 experience that surface in their speech.

21 To evaluate word retrieval abilities, we implemented a standard cognitive task  
22 that is commonly used in clinical and laboratory contexts to measure word retrieval  
23 performance (e.g., Benton, 1968; Benton & Hamsher, 1976; Lezak, 1995). In such  
24 fluency tasks, participants are asked to name a maximal number of exemplars given a  
25 single category cue, i.e., semantic (e.g., animals) or letter (e.g., words starting with the  
26 letter F) during a fixed amount of time (usually one minute; Roberts & Le Dorze, 1997).  
27 A common assumption regarding word retrieval dynamics in this task is that the  
28 category name will activate multiple candidates and the participant must choose one  
29 name at a time, selecting from among the activated alternatives (Sandoval, Gollan,  
30 Ferreira, & Salmon, 2010).

31  
32 <Insert Table 1 about here>  
33

1 Previous research has shown that this type of task can reveal differences in the  
2 linguistic behavior of mono- and bilinguals (see Table 1 for an overview of results from  
3 verbal fluency studies in bilinguals). The most common explanations for poorer  
4 performance of bilinguals as compared to monolinguals in linguistic fluency are linked  
5 to the consequences of using two languages on a daily basis. First, it is possible that  
6 bilinguals need to apply language control mechanisms during speech production to  
7 avoid interference between languages (Green, 1998), since word representations of the  
8 two languages are co-activated. This additional processing would slow down lexical  
9 access and retrieval in bilinguals compared to monolinguals, hence resulting in fewer  
10 verbal fluency responses within the allotted time. An alternative explanation relates  
11 linguistic costs to the fact that bilinguals produce speech in each of their languages  
12 overall less often than monolinguals who always speak one language only. Accordingly,  
13 a bilingual cost would result from weaker links between the semantic and phonological  
14 representations, underlying poorer word retrieval abilities in bilinguals compared to  
15 monolinguals (Gollan et al., 2008). Finally, a more recent proposal for the worse  
16 performance of bilinguals in language production relates to processing costs at post-  
17 lexical stages (Hanulová et al., 2011; Sadat, Martin, Alario, & Costa, 2012; Sadat et al.,  
18 2015). It states that processes such as phonological encoding, syllabification, and  
19 articulation may be more effortful if there are incompatibilities between the constraints  
20 of each language which in turn leads to costs in the speech of bilinguals relative to  
21 monolinguals.

22 In that theoretical context, we note some inconsistencies in the results of  
23 previous studies on the bilingual cost in the verbal fluency task (Table 1). For example,  
24 Rosselli et al. (2000) found that bilingual speakers differed from monolinguals on the  
25 number of exemplars produced in semantic categories, but not in letter categories.  
26 Gollan and colleagues (2002) replicated Rosselli et al.'s results with bilinguals  
27 producing fewer correct exemplars in semantic categories, but they also observed  
28 differences between speaker groups in letter categories. Although these previous studies  
29 generated mixed results (e.g., Bialystok et al., 2008b), fluency tasks still represent a  
30 common research tool used to detecting differences in linguistic processing between  
31 monolinguals and bilinguals (e.g., Blumenfeld et al., 2016). More importantly, the  
32 question of whether there is a bilingual cost in verbal fluency or not is less important for  
33 the purpose of the present study. The aim of the current study does not concern the  
34 number of words produced, but rather which type of words are produced, and whether

1 or not they are cognates. The rate of cognate production is our proxy for testing the  
2 possible remains of an early learnt second language in the speech production of  
3 bilinguals who no longer use their second language, compared to monolinguals for  
4 whom no cognates exist.

5         Given that the precise mechanisms and processes underlying the bilingual cost in  
6 verbal performance are still unclear, it is also debated how word retrieval in semantic or  
7 letter fluency tasks could be more reliably influenced by bilingualism (e.g., Sandoval et  
8 al., 2010). Regarding letter fluency tasks, researchers argued that phonemic generation  
9 is not a common strategy for word retrieval, and therefore should be more demanding in  
10 terms of executive control and attention than other kinds of speech elicitation tasks.  
11 Thus recent studies suggested that bilinguals would be able to compensate their  
12 linguistic deficit with an advantage in executive processing, and thus differences  
13 between the two groups of speakers should be equalized for letter fluency (e.g.,  
14 Bialystok & Craik, 2010; Friesen, Luo, Luk, & Bialystok, 2015).

15         However, several previous studies also suggested that performance differences  
16 across semantic and letter categories may be driven by particular language properties.  
17 For example, Kempler, Teng, Dick, Taussig, and Davis (1998) showed that variation in  
18 verbal fluency performance across languages depended on the language of  
19 administration. In their study, Vietnamese participants produced more animal names  
20 than Spanish participants, possibly because animal names are typically monosyllabic in  
21 Vietnamese unlike multisyllabic Spanish names (but see Pekkala, Goral, Hyun, Obler,  
22 Erkinjuntti, & Albert, 2009). Another observation also indicates that the relation  
23 between the words in the two languages impacts bilingual performance. Although some  
24 verbal fluency studies reported poorer performance of bilinguals than monolinguals,  
25 other studies showed that bilinguals produced a higher proportion of cognate words than  
26 monolinguals (Blumenfeld et al., 2016; Sandoval et al., 2010).<sup>1</sup>

27         Thus a possible explanation for previously reported performance differences  
28 between mono- and bilingual fluency could be that bilinguals produce more words of a  
29 certain type (e.g., cognates) in letter than in semantic categories because of the inherent  
30 linguistic properties of the tested categories (see also Michael & Gollan, 2005). That is,  
31 bilinguals and monolinguals may not differ in the overall number of exemplars  
32 produced in letter categories because bilinguals are able to choose from a higher  
33 proportion of cognates in these categories. In contrast, in semantic categories the  
34 number of cognates may be more limited than in letter categories, and therefore



1 bilinguals would produce less cognate exemplars simply because these words are not  
2 available. Thus, we hypothesize that the number of cognates that can be produced in  
3 each category as well as the restrictions set by the fluency task (in terms of time or type  
4 of category) is an important factor to be controlled for in this context.

5 An additional word property that previous studies suggested to explain the  
6 poorer bilingual performance in fluency tasks relates to the actual frequency values of  
7 the generated responses (Gollan, Montoya, Cera, & Sandoval, 2008). Although Rosselli  
8 et al. (2000) showed that monolinguals outperformed bilinguals on semantic categories,  
9 some categories still allowed for a better performance in one of the bilingual's  
10 languages depending on the frequency of the exemplars. Thus, if bilingual participants  
11 were more used to naming animals in language A than B, performance regarding animal  
12 retrieval in language A was better than in language B. It seems reasonable that  
13 bilinguals retrieve and name words that they usually produce in one language faster than  
14 words that they are not used to producing in that language (Gollan et al., 2008). For this  
15 reason, we will also assess and compare the frequency values of the responses generated  
16 by mono- and bilinguals in the two experiments of the current study.

17 In sum, the aim of the present study was to test for the influence of an early  
18 learnt second language in bilinguals' word retrieval by assessing cognate production.  
19 We will do so by using a fluency task, which has previously been shown to reveal  
20 bilingualism effects in active bilinguals, while controlling for important distributional  
21 properties of the words.

### 22 23 Experiment 1: Typed fluency task

24 To control for the distributional properties of the candidate words, we estimated  
25 a priori the maximum number of cognates that could be generated in the respective  
26 semantic categories. This allowed controlling the proportion of cognate vs. non-cognate  
27 candidates per category. In Experiment 1, a standard fluency task was administered that  
28 contained semantic and letter categories with an increased response time window of five  
29 minutes. The increased response time will allow for a more exhaustive assessment of  
30 the word retrieval performance of mono- and bilinguals over time. Such extended  
31 response windows are common in studies that thoroughly investigate the dynamics  
32 underlying semantic retrieval of words from human memory (e.g., Hills, Jones, & Todd,  
33 2012). In addition, responses were typed on a keyboard rather than spoken to ease  
34 coding and post-processing.

1

2

## Method

3 *Participants*

4         The bilingual group consisted of 24 European Portuguese-French bilinguals,  
5 born in France and descendents of emigrant European Portuguese parents (17 women, 7  
6 men). They all filled out a shortened online version of the Language History  
7 Questionnaire (Li, Sepanski, & Zhao, 2006) to provide language usage characteristics  
8 (see Table 2 for a summary). All bilinguals stated that European Portuguese was their  
9 native language (as well as French in some cases), and that they acquired both  
10 languages starting from birth. They indicated that French was their dominant language  
11 while living in France, although nowadays European Portuguese has become their  
12 dominant language. These participants were balanced bilinguals in their early childhood  
13 who went back to Portugal during their youth, and at present live in an almost exclusive  
14 monolingual environment. Participants consistently reported that while living in France,  
15 they spent most of their time in French monolingual contexts except at home. When  
16 they moved back to Portugal, there was a complete language dominance switch to  
17 European Portuguese. Bilinguals confirmed that French is used only in few particular  
18 situations (e.g., talking on the phone with family and friends; watching French movies).  
19 For the control group, 24 European Portuguese native monolingual speakers were tested  
20 (17 women, 7 men;  $M = 23.58$  years old,  $SD = 4.36$ ). Monolinguals had a medium level  
21 of English from formal high school education (similar to bilinguals), but no knowledge  
22 of French.

23

24

&lt;Insert Table 2 about here&gt;

25

26 *Materials*

27         The typed fluency task in Experiment 1 consisted of three semantic categories  
28 and three letter categories. In order to estimate the number of European Portuguese-  
29 French cognate words that could be produced across semantic categories, we used a  
30 French database (Basety, Léger, Boumlak, & Tijus, 2008) from which nine out of  
31 twenty-one categories were translated to European Portuguese, excluding compound  
32 words (no similar database was available for European Portuguese; however; given a  
33 certain degree of cultural and environmental similarities between France and Portugal,  
34 we reasoned that mention in the French database was a good approximation of mention

1 in a putative Portuguese database). For each exemplar in Basety, the appropriate  
2 translation in European Portuguese was taken from ‘The Free Dictionary’  
3 (<http://www.thefreedictionary.com/>) and ‘Infopedia’ (<http://www.infopedia.pt/>).  
4 Phonetic transcription was transferred from Lexique 3.71 (New, Pallier, Ferrand, &  
5 Matos, 2001) and revised by a phonetic expert. A word was considered to be a cognate  
6 if it had less than 0.25 Levenshtein’s distance values, i.e., if it needed less than three  
7 substitutions to edit one string into its equivalent translation (considering insertions and  
8 deletions, e.g., Dijkstra, Miwa, Brummelhuis, Sappelli, & Baayen, 2010).

9 The proportions of cognate (vs. non-cognate) words obtained for each semantic  
10 category were: animals – 32%; fruits – 35%; musical instruments – 55%; vegetables –  
11 26%; furniture – 37%; tools – 19%; professions – 15%; vehicles – 38%; and clothing –  
12 41%. The chosen semantic categories were ‘fruits’, ‘furniture’ and ‘clothing’, because  
13 they had a good mix of cognates and non-cognates as well as a good pool of exemplars  
14 possible to name in the time range of the task. Given that there is not much (if any)  
15 literature for the letter fluency task in European Portuguese, we decided to choose three  
16 letters that were not to be used in Experiment 2 (see below) to avoid perseverations.  
17 Portuguese lexical frequency values for the responses were extracted from the program  
18 Procura-PALavras (P-PAL; Soares et al., 2014) and are reported in log frequency per  
19 million words.

### 20 21 *Procedure*

22 Participants were asked to type as many exemplars as possible for the semantic  
23 categories ‘fruits’, ‘furniture’ and ‘clothing’, and the letter categories ‘D’, ‘O’, and ‘V’.  
24 In most fluency tasks, participants are given 60 seconds to give as many responses as  
25 possible. However, in the present study participants were given five minutes for each  
26 semantic or letter category in order to increase the time period of possible answers for  
27 potential differences between groups to unfold over time, and to understand if the  
28 pattern of responses was maintained during a more extended time period. The  
29 presentation of the categories was alternated between semantic and letter fluency  
30 according to a Latin square design (12 lists – two participants per list). The software  
31 DMDX was used for the presentation of the categories and data recording (Forster &  
32 Forster, 2003).

33 To ease response coding, participants typed their responses on a standard  
34 computer keyboard rather than speaking out loud. This procedure is expected to lead to

1 slightly slower responses than with oral production. However, given the extended  
2 response window, this modification was not crucial to our purposes, and typed  
3 responses afforded considerably simpler post-processing and coding than spoken  
4 responses.

## 6 Results

7 In the semantic categories, exemplars belonging to a super-ordinate category  
8 (e.g., *clothes*) were considered correct answers except if subcategory exemplars were  
9 presented as well (e.g., *jacket, skirt*, etc.). If this happened, each subcategory exemplar  
10 was considered correct and not the super-ordinate exemplar. Responses were coded by  
11 the experimenter and considered errors when they were perseverations (repetition of the  
12 same word), intrusions (words that did not belong to the category), and non-words (e.g.,  
13 incorrectly typed words); these were excluded from the analyses and not treated any  
14 further. Moreover, all proper name responses (mostly cognates by nature) were  
15 excluded (5.35%) since the production of this type of words does not need to be driven  
16 by traces of the second language, and their inclusion would artificially increase the  
17 count of cognates. Each exemplar was considered to be a cognate or non-cognate  
18 according to the criteria explained in the Materials section.

19  
20 <Insert Figure 1 about here>

21  
22 There was an average of 79 responses across categories (letter:  $M = 80$ ,  $SD = 21$ ;  
23 semantic:  $M = 77$ ,  $SD = 17$ ), with a maximum of 126 and a minimum of 42 answers.  
24 Overall, monolinguals and bilinguals produced a similar number of responses in the  
25 time given (see Figure 1 for an overview; monolinguals: 3761 responses; bilinguals:  
26 3779 responses;  $\chi^2(1, N=7540) = 0.04$ ,  $p = 0.84$ ).

27 Responses that were cognates (monolinguals: 1733 trials; bilinguals: 1844 trials)  
28 were contrasted with non-cognate responses (monolinguals: 2028 trials; bilinguals:  
29 1935 trials) to estimate whether the probability of producing a cognate response was  
30 modulated by the experimental factors. A logistic mixed-effects model included  
31 predictors for speaker group (bilinguals vs. monolinguals), task (semantic vs. letter  
32 category), order (i.e., the order of production of each exemplar during the time available  
33 to respond), and by-participant and by-category random intercepts (i.e., letter category  
34 'D', 'V', 'O', and semantic category 'fruits', 'clothing', 'furniture'). We included all

1 predictors, tested for possible interactions, and retained only those contributing  
2 significantly to the model using a backward elimination procedure.<sup>2</sup>

3 The probability of producing a cognate was significantly higher for bilinguals  
4 than monolinguals (see Figure 2). The effect of task was significant, such that the  
5 probability of producing a cognate was higher in the letter than semantic category task.  
6 The overall effect of order was also significant, such that the probability of producing a  
7 cognate increased with increasing retrieval order. The interactions between speaker  
8 group and the other predictors were not significant. Statistical values for the significant  
9 predictors of cognate production probability are reported in Table 3.

10  
11 <Insert Table 3 about here>

12  
13 <Insert Figure 2 about here>

14  
15 It is possible that the individual language usage characteristics of the bilinguals  
16 (taken from the Language History Questionnaire; see Table 2) could have influenced the  
17 present cognate effect. If these ratings would be predictive of the usage of cognate  
18 words, one could argue that cognate retrieval should vary depending on the individual  
19 amount of French usage. For example, participants who at present do not have any  
20 French exposure at all could show a smaller cognate effect in the present task than  
21 participants who still have little exposure. To test this hypothesis, we added these  
22 variables as predictors in the previous logistic mixed-effects model. In particular, we  
23 looked at the effect of number of hours and percentage of time speaking in French and  
24 in European Portuguese, the participants' age, the years spent in France and in Portugal,  
25 and the context of learning their second language French (at home, at school, or both).  
26 None of these variables were significant in predicting cognate production probability.  
27 Such absence of effect could well be due to our questionnaires not being detailed  
28 enough to obtain fine-grained measures for these variables. It remains to be established  
29 whether and how such variables might influence variability of the cognate effect at an  
30 individual level.

31 Finally, we also looked at the frequency values of the produced words to  
32 examine whether mono- and bilinguals differed in the types of words they produced.  
33 We classified all responses into three categories: (1) words that were produced by both  
34 mono- and bilinguals, (2) words that were produced by bilinguals only, and (3) words

1 that were produced by monolinguals only. Mean frequency values of the produced  
2 words were virtually the same between the subset of words unique to monolinguals ( $M$   
3 = 0.62,  $SD = 0.17$ ) and the one unique to bilinguals ( $M = 0.65$ ,  $SD = 0.12$ ;  $t[46] = 0.65$ ,  
4  $p = 0.52$ ). Across all participants, the produced cognates ( $M = 0.79$ ,  $SD = 0.67$ ) were of  
5 lower mean frequency than the non-cognates ( $M = 0.83$ ,  $SD = 0.73$ ;  $t[94] = -2.36$ ,  $p =$   
6  $0.02$ ).

## 8 Experiment 2: Mixed task

9 In Experiment 2, we used a constrained fluency task (mixed task) in which  
10 participants were asked to give a single response that belonged to a particular semantic  
11 category, and started with a specific first letter (e.g., ANIMALS: B). These category  
12 pairs were selected considering combinations that could produce both cognate and non-  
13 cognate exemplars to an equal extent, using the available semantic database. Previous  
14 studies showed that bilinguals usually produced a higher proportion of cognates in letter  
15 categories than in semantic categories (Blumenfeld et al., 2016; Sandoval et al., 2010).  
16 In a mixed task like Experiment 2 that is more constrained than the standard fluency  
17 task, we predict that, given the equal probability of producing a cognate and a non-  
18 cognate, bilinguals would be more likely to select a cognate word from among all  
19 possible candidates.

## 21 Method

### 22 *Participants*

23 Participants in Experiment 2 were the same as in Experiment 1, with 24  
24 European Portuguese-French bilinguals and 24 European Portuguese native  
25 monolinguals.

### 27 *Materials*

28 The mixed task consisted of individual trials for a semantic category together  
29 with a first letter (e.g., 'ANIMAL: B'). For the nine semantic category translated to  
30 European Portuguese, we looked at the number of exemplars that could be elicited for  
31 each letter. Given that age of acquisition is one of the most influential predictors of  
32 lexical availability (Hernandez-Muñoz, Izura, & Ellis, 2006), the potential responses to  
33 letter category pairs were controlled for frequency and age of acquisition in European  
34 Portuguese (i.e., very typical exemplars were excluded, like 'ANIMAL: C' – *cão* [dog];

1 Marques, Fonseca, Morais, & Pinto, 2007; Soares et al., 2010). Each combination of a  
2 semantic category and letter had roughly similar probabilities of generating cognates or  
3 non-cognates (e.g., for the semantic category ‘animals’ starting with the letter ‘A’, there  
4 were eight possible cognate candidates and eight possible non-cognate candidates). A  
5 total of thirty trials were created with six semantic categories and a maximum of seven  
6 and a minimum of three letters per category. The selected categories were ‘animals’  
7 (32% of cognates on average), ‘musical instruments’ (55% of cognates on average),  
8 ‘vegetables’ (26% of cognates on average), ‘tools’ (19% of cognates on average),  
9 ‘professions’ (15% of cognates on average), and ‘vehicles’ (38% of cognates on  
10 average). In Table 4, all the retained combinations of category and letter in the mixed  
11 task are presented. Frequency values for the responses were extracted from the program  
12 Procura-PALavras (P-PAL; Soares et al., 2014) and are reported in log frequency per  
13 million words.

14  
15 <Insert Table 4 about here>

### 16 17 *Procedure*

18 Each pair (category and letter) was presented for 30 seconds or until the  
19 participant finished typing their answer. The Mix program (van Casteren & Davis,  
20 2006) was used to randomizing the order of presentation, with a minimal distance of  
21 two between the same category or the same letter, creating a different order for each  
22 participant (both bilinguals and monolinguals). The software DMDX was used for the  
23 presentation of the categories and data recording (Forster & Forster, 2003).

24 Participants were asked to type the first exemplar that came to their minds  
25 matching the required semantic and letter category. They were asked to answer as fast  
26 as possible while trying to avoid mistakes. For all participants, Experiment 2 was  
27 administered after a short break following Experiment 1.

### 28 29 *Results*

30 As in Experiment 1, we used a logistic mixed-effects model to explore the  
31 probability of cognate production in the mixed task. Responses that were cognates  
32 (monolinguals: 277 trials; bilinguals: 302 trials) were contrasted with non-cognate  
33 responses (monolinguals: 274 trials; bilinguals: 245 trials) to accurately predict the  
34 probability of producing a cognate response. The model included the predictors speaker

1 group (bilinguals vs. monolinguals), trial order (i.e., the order of occurrence of a  
2 specific category), the interaction between these two, and by-participant and by-  
3 category random intercepts (e.g., animal starting with letter ‘m’).

4 Results showed that the probability of producing a cognate was significantly  
5 higher for bilinguals than monolinguals ( $\beta = -0.77$ ,  $SE = 0.27$ ,  $z[1092] = -2.87$ ,  $p =$   
6  $0.004$ ; see Figure 3). The effect of trial order was not significant. However, the  
7 interaction between speaker group and trial order was significant, such that with  
8 increasing trial order the probability of producing a cognate was lower for bilinguals  
9 than for monolinguals ( $\beta = 0.04$ ,  $SE = 0.02$ ,  $z[1092] = 2.17$ ,  $p = 0.030$ ).

10  
11 <Insert Figure 3 about here>  
12

13 Importantly, the effects reported for Experiment 2 confirm the pattern of results  
14 obtained in Experiment 1 and show more precisely that early bilinguals retrieve more  
15 cognates than non-cognates during word production than monolinguals. As in  
16 Experiment 1, the bilinguals’ language history characteristics were not significant in  
17 predicting cognate production probability. Finally, we also looked at the frequency  
18 values of the words produced to examine whether mono- and bilinguals differed in the  
19 types of words they produced. We classified all responses into three categories: (1)  
20 words that were produced by both mono- and bilinguals, (2) words that were produced  
21 by bilinguals only, and (3) words that were produced by monolinguals only. Mean  
22 frequency values of the produced words were similar between the subset of words  
23 unique to monolinguals ( $M = 0.53$ ,  $SD = 0.22$ ) and the one unique to bilinguals ( $M =$   
24  $0.49$ ,  $SD = 0.28$ ;  $t[45] = -0.58$ ,  $p = 0.57$ ). Across all participants, the produced cognates  
25 ( $M = 0.61$ ,  $SD = 0.40$ ) were of similar mean frequency than the non-cognates ( $M = 0.59$ ,  
26  $SD = 0.43$ ;  $t[94] = 1.06$ ,  $p = 0.29$ ).

## 27 28 General Discussion

29 In the present study, we explored the influence of an early learnt second  
30 language on word retrieval in bilinguals who no longer use their second language. We  
31 used two modified fluency tasks and compared bilinguals’ (typed) word production to  
32 that of monolinguals by investigating the use of cognate words. In Experiment 1,  
33 participants were asked to respond to three semantic and three letter categories. Two



1 methodological changes were adopted to ease the interpretation of fluency performance:  
2 the response time window of the task was increased, leaving participants five minutes  
3 instead of the standard time of 60 seconds to consider retrieval performance more  
4 exhaustively. We also conducted an a priori estimation of the proportion of cognate  
5 words in each of the semantic categories, thus controlling for a factor that could have  
6 been responsible for previously reported poorer performance of bilinguals. In  
7 Experiment 2, a restricted fluency task, participants were asked to retrieve a single  
8 exemplar of a semantic category starting with a given letter. In this task again, responses  
9 in each category pair could generate either a cognate or a non-cognate response at equal  
10 rates.

11 In the extended fluency task (Experiment 1), monolinguals and bilinguals  
12 produced the same number of responses during the time given. Contrary to previous  
13 studies (e.g., Gollan et al., 2002; Sandoval et al., 2010), bilinguals did not present a  
14 retrieval cost in the fluency task compared to monolinguals. Moreover, in the current  
15 study there was no performance difference across semantic and letter categories for  
16 these two groups of speakers (e.g., Rosseli et al., 2002; see Table 1 for a summary of  
17 previous evidence). In addition, the present data does not suggest any differences  
18 between mono- and bilinguals in terms of frequency values for the retrieved words.  
19 Previous studies suspected that bilinguals would show a bias towards using higher  
20 frequency words when asked to generate responses in their first and second language  
21 (Gollan et al., 2002). The fact that we did not observe any differences in the frequency  
22 values of the generated words may be due to the fact that our bilingual participants were  
23 ‘virtually’ monolingual, and that they were using their first language. The bilinguals of  
24 our study had been living in an exclusively monolingual context for many years and  
25 their use of a second language had been drastically reduced. It seems likely that after so  
26 many years of no longer using a second language, the bilinguals’ word use would  
27 resemble those of a monolingual in terms of frequency measures. Moreover, the  
28 explanation of using words of lower frequency in the speech production of bilinguals  
29 seems difficult to transfer to verbal fluency performance in a bilingual’s first language.

30 However, the key difference we observed between mono- and bilinguals'  
31 performance was a higher number of cognates produced by bilinguals in both letter and  
32 semantic categories. The fact that we found a larger number of cognate words used in  
33 the present type of bilinguals shows that early language learning impacts current word

1 selection, even though the early learnt language has been discontinued for many years  
2 and speakers had been living in an exclusively monolingual language environment.

3 The present results also showed that the probability of producing a cognate was  
4 overall higher in the letter than in the semantic categories. One possible explanation for  
5 this observation is that letter categories are overall larger than semantic categories  
6 thereby allowing for a larger number of selectable cognate words (Blumenfeld et al.,  
7 2016; Michael & Gollan, 2005). In previous studies on verbal fluency with bilinguals  
8 there was no information on the distribution of available cognates per fluency  
9 categories. Therefore, it is possible that the differences between letter and semantic  
10 categories may have been caused by the number of cognates that the participants could  
11 (or could not) produce. The present study made an important step forward in tackling  
12 this problem by taking into account an a priori estimation of cognate and non-cognate  
13 distribution per category.

14 One novel feature of Experiment 1 is that the response time-window was longer  
15 than that used in most previous studies (five vs. one minute). To compare our results  
16 with previous fluency studies, we applied the same analysis as above to a subset of the  
17 fluency data of Experiment 1 comprising the first minute only (see also Sandoval et al.,  
18 2010 for investigating different time bins during the first minute of a fluency trial). For  
19 this subset of the first minute, the difference in the number of responses between  
20 monolinguals and bilinguals was marginally significant, with monolinguals producing  
21 slightly more responses than bilinguals (monolinguals: 1553 responses [semantic: 881;  
22 letter: 672]; bilinguals: 1449 responses [semantic: 805; letter: 644];  $\chi^2$  (1, N=3002)  
23 =3.60,  $p=0.06$ ). However, the difference between mono- and bilinguals in the  
24 probability of producing cognates was not significant. All other effects were the same as  
25 in the main analysis presented above (e.g., a higher probability of producing a cognate  
26 in the letter than semantic category task for both speaker groups). This means that when  
27 only considering the first minute our results are in line with some of the previous verbal  
28 fluency studies reporting slightly reduced word retrieval for bilinguals than  
29 monolinguals (see Table 1). Our results show, however, that when participants are given  
30 enough time, differences in the number of retrieved responses across speakers are not  
31 maintained, and differences in the type of responses (i.e., cognates) become obvious. It  
32 is difficult to hypothesize how word retrieval dynamics depend on such temporal  
33 constraints and how this would apply to explanations of a bilingual cost (e.g., see  
34 Sandoval et al., 2010), especially in this particular population of early bilinguals who no

1 longer use their second language. However, irrespective of these different theories, our  
2 results show that in bilinguals who have not used a second language for an extended  
3 time, the occurrence of cognate words in verbal fluency tasks is sensitive to the  
4 extension of the response time window. Future studies on fluency performance of  
5 bilinguals should consider using the methodological modifications we adopted to  
6 broaden the sensitivity of the fluency task.

7       Importantly, bilinguals also produced more cognate words than monolinguals in  
8 the mixed experiment (Experiment 2) in which participants were required to respond  
9 with a single exemplar only. The mixed task was more controlled compared to standard  
10 fluency tasks in terms of possible response candidates. Thus the results of Experiment 2  
11 replicate and extend the pattern of increased cognate production for bilinguals obtained  
12 in Experiment 1.

13       It seems reasonable to assume that the current results depend on the many  
14 factors defining different bilingual populations. For example, recent studies testing  
15 mono- and bilingual speakers on verbal fluency tasks showed that proficiency is a major  
16 determinant for cognate use in bilinguals (e.g., Bluemenfeld et al., 2016; Kormi-Nouri  
17 et al., 2012). However, explanations in the present study for why bilinguals would use  
18 more cognates in speech production than monolinguals evolve less around proficiency  
19 or early age of acquisition, since all bilinguals had acquired their second language from  
20 very early on and with a high degree of proficiency. Instead, unlike previous studies, the  
21 present study allows distinguishing effects of high proficiency and early age of  
22 acquisition from effects of high frequency of use. Thus, our results point to the lasting  
23 impact of second language phonology on first language production, even in cases when  
24 usage is drastically reduced. In this context it is also important to mention another factor  
25 that seems to be influential for cognate production in bilinguals. The amount of cognate  
26 use may depend on the phonological similarity of the bilingual's two languages,  
27 meaning that for more similar languages, bilinguals would be more likely to engage in  
28 cognate production. The present study tested bilinguals of two Romance languages,  
29 European Portuguese and French. To get an idea of the role of language similarity for  
30 cognate production, we identified the percentage of unique responses in our two  
31 experiments, and assessed the percentage of cognates and non-cognates between, on the  
32 one hand, European Portuguese and French, and on the other hand, European  
33 Portuguese and a more distant language such as English. The proportion of cognate  
34 responses for European Portuguese and French was similar in Experiment 1 (57%) and

1 2 (56%). In comparison, the proportion of cognate responses between European  
2 Portuguese and English was lower (Experiment 1: 30%; Experiment 2: 38%). Thus it  
3 may be possible that the closer linguistic similarity of European Portuguese and French  
4 aided detecting the use of cognates in this particular type of bilinguals. Future studies  
5 need to further determine the role of language similarity for cognate production in  
6 bilinguals.

7 In a verbal fluency task which resembles an associative search tasks, inter-  
8 language form similarity could help in cueing the phonological encoding of target  
9 words that fit the selection criteria (see e.g., Sadat, Martin, Costa, & Alario, 2014, for a  
10 review on how phonological similarity influences speech production in different  
11 contexts). When compared to monolingual performance, the absence of inter-language  
12 form similarity will thus lead to a cost in bilingual lexical access. This may for example  
13 induce a higher number of unresolved tip-of-the-tongue states in the case of non-  
14 cognates for bilinguals compared to monolinguals, as well as a bilingual cost in naming  
15 performance in the case of non-cognates (Sadat et al., 2015). Overall, the current results  
16 highlight that phonological similarity across languages plays an important and lasting  
17 role for bilingual lexical access, even after many years of living in another language  
18 environment.

19 It is also worth mentioning that the population of bilinguals in the current study  
20 contrasts with participants of previous studies that explored the long-term consequences  
21 of language learning during an early critical period (e.g., Pallier et al., 2003;  
22 Ventureyra, Pallier, & Yoo, 2004). In that research, participants were early adoptees for  
23 which their first learnt language had undergone complete attrition (but see Pierce, Klein,  
24 Chen, Delcenserie, & Genesee, 2014). For example, Pallier and colleagues tested if  
25 there would be any unconscious influences from an early learnt language on their  
26 participants' speech perception or in their neural language circuitry, but did not observe  
27 any remaining language sensitivity. Thus it is clear that an early exposure of a second  
28 language is simply not enough to ensure remaining elements in later speech production.  
29 In contrast, the bilinguals of the current study had been raised and lived for many years  
30 as highly proficient bilinguals before entering into an exclusive monolingual  
31 environment.

32 In sum, the present study establishes the long lasting impact of previously  
33 having learnt and mastered another language on the speech production of early  
34 bilinguals who no longer use their second language. Altogether, a bilingual's word

- 1 retrieval in their first language is influenced by an early learnt second language, even
- 2 after many years of disuse.
- 3
- 4

Footnotes

1  
2  
3  
4  
5  
6  
7  
8  
9  
10

1. The difference in cognate production between monolinguals and bilinguals in Sandoval et al. (2010) was only apparent in the proportions, not in the absolute number of produced cognates (due to unequal numbers of total responses between monolinguals and bilinguals).
2. Including maximal individual by-random slopes into the logistic model did not improve the model's fit and thus we retained the model with simple by-participant and by-item intercept random slopes.

## References

- 1  
2  
3 Benton, A.L. (1968). Differential behavioral effects of frontal lobe disease.  
4 *Neuropsychologia*, 6, 53–60. doi:10.1016/0028-3932(68)90038-9
- 5 Benton, A.L., Hamsher, K. (1976): *Multilingual Aphasia Examination*. Iowa City, Iowa:  
6 AJA Associates.
- 7 Bialystok, E., & Craik, F. I. (2010). Cognitive and linguistic processing in the bilingual  
8 mind. *Current Directions in Psychological Science*, 19 (1), 19-23.  
9 doi:10.1177/0963721409358571
- 10 Bialystok, E., Craik, F. I., & Luk, G. (2008b). Lexical access in bilinguals: Effects of  
11 vocabulary size and executive control. *Journal of Neurolinguistics*, 21(6), 522-  
12 538. doi:10.1016/j.jneuroling.2007.07.001
- 13 Bialystok, E., Craik, F.I., & Luk, G. (2008a). Cognitive control and lexical access in  
14 younger and older bilinguals. *Journal of Experimental Psychology: Learning,*  
15 *memory, and cognition*, 34(4), 859-873. doi:10.1037/0278-7393.34.4.859
- 16 Blumenfeld, H. K., Bobb, S. C., & Marian, V. (2016). The role of language proficiency,  
17 cognate status and word frequency in the assessment of Spanish–English  
18 bilinguals’ verbal fluency. *International Journal of Speech-Language Pathology*,  
19 18(2), 1-12. doi:10.3109/17549507.2015.1081288
- 20 Bolla, K. I., Gray, S., Resnick, S. M., Galante, R., & Kawas, C. (1998). Category and  
21 letter fluency in highly educated older adults. *The Clinical*  
22 *Neuropsychologist*, 12(3), 330-338. doi:10.1076/clin.12.3.330.1986
- 23 Capitani, E., Laiacona, M., & Barbarotto, R. (1999). Gender affects word retrieval of  
24 certain categories in semantic fluency tasks. *Cortex*, 35(2), 273-278.  
25 doi:10.1016/S0010-9452(08)70800-1
- 26 Cook, V. (2007). The nature of the L2 user. *EUROSLA Yearbook*, 7(1), 205-220.
- 27 Costa, A., Caramazza, A., & Sebastian-Galles, N. (2000). The cognate facilitation  
28 effect: Implications for models of lexical access. *Journal of Experimental*  
29 *Psychology: Learning, Memory, and Cognition*, 26(5), 1283-1296.  
30 doi:10.1037//0278-7393.26.5.1283
- 31 Costa, A., Santesteban, M., & Caño, A. (2005). On the facilitatory effects of cognate  
32 words in bilingual speech production. *Brain and Language*, 94, 94-103.  
33 doi:doi:10.1016/j.bandl.2004.12.002

- 1 Crossley, M., D'Arcy, C., & Rawson, N. S. (1997). Letter and category fluency in  
2 community-dwelling Canadian seniors: A comparison of normal participants to  
3 those with dementia of the Alzheimer or vascular type. *Journal of Clinical and*  
4 *Experimental Neuropsychology*, *19*(1), 52-62. doi:10.1080/01688639708403836
- 5 Dijkstra, T., Miwa, K., Brummelhuis, B., Sappelli, M., & Baayen, H. (2010). How  
6 cross-language similarity and task demands affect cognate recognition. *Journal*  
7 *of Memory and Language*, *62*(3), 284-301. doi:10.1016/j.jml.2009.12.003
- 8 Flege, J. E., Munro, M. J., & MacKay, I. R. (1996). Factors affecting the production of  
9 word-initial consonants in a second language. In R. Bayley & D.R. Preston (Eds)  
10 *Second language acquisition and linguistic variation* (vol. 10, pp 47-73), John  
11 Benjamins.
- 12 Forster, K. I., & Forster, J. C. (2003). DMDX: A Windows display program with  
13 millisecond accuracy. *Behavior Research Methods, Instruments, & Computers*,  
14 *35*(1), 116-124. doi:10.3758/BF03195503
- 15 Friesen, D. C., Luo, L., Luk, G., & Bialystok, E. (2015). Proficiency and control in  
16 verbal fluency performance across the lifespan for monolinguals and bilinguals.  
17 *Language, Cognition and Neuroscience*, *30*(3), 238-250.  
18 doi:10.1080/23273798.2014.918630
- 19 Gollan, T. H., & Acenas, L. R. (2004). What is a TOT? Cognate and translation effects  
20 on tip-of-the-tongue states in Spanish-English and Tagalog-English bilinguals.  
21 *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *30*(1),  
22 246-269. doi:10.1037/0278-7393.30.1.246
- 23 Gollan, T. H., Montoya, R. I. & Werner, G. A. (2002). Semantic and letter fluency in  
24 Spanish-English bilinguals. *Neuropsychology*, *16*, 562-576. doi:10.1037//0894-  
25 4105.16.4.562
- 26 Gollan, T. H., Montoya, R. I., Cera, C. M. & Sandoval, T. C. (2008). More use almost  
27 always means a smaller frequency effect: Aging, bilingualism, and the weaker  
28 links hypothesis. *Journal of Memory and Language*, *58*, 787-814.  
29 doi:10.1016/j.jml.2007.07.001
- 30 Gollan, T. H., Montoya, R., Fennema-Notestine, C., & Morris, S. (2005). Bilingualism  
31 affects picture naming but not picture classification. *Memory and Cognition*,  
32 *33*(7), 1220-1234. doi: 10.3758/BF03193224
- 33 Hermans, D., Bongaerts, T., De Bot, K., & Schreuder, R. (1998). Producing words in a  
34 foreign language: Can speakers prevent interference from their first language?



- 1           *Bilingualism: Language and Cognition*, 1(3), 213-229. doi:  
2           10.1017/S1366728998000364
- 3 Hills, T. T., Jones, M. N., & Todd, P. M. (2012). Optimal foraging in semantic memory.  
4           *Psychological Review*, 119(2), 431-440. doi: 10.1037/a0027373
- 5 Ivanova, I., & Costa, A. (2008). Does bilingualism hamper lexical access in speech  
6           production? *Acta Psychologica*, 127, 277-288. doi: 10.1016/j.actpsy.2007.06.003
- 7 Kanno, Y. (2000). Bilingualism and identity: The stories of Japanese returnees.  
8           *International Journal of Bilingual Education and Bilingualism*, 3(1), 1-18. doi:  
9           10.1080/13670050008667697
- 10 Kempler, D., Teng, E.L., Dick, M., Taussig, M., Davis, D.S. (1998). The effects of age,  
11           education, and ethnicity on verbal fluency. *Journal of the International*  
12           *Neuropsychological Society*, 4, 531–538. doi:N/A
- 13 Kormi-Nouri, R., Moradi, A. R., Moradi, S., Akbari-Zardkhaneh, S., & Zahedian, H.  
14           (2012). The effect of bilingualism on letter and category fluency tasks in primary  
15           school children: Advantage or disadvantage? *Bilingualism: Language and*  
16           *Cognition*, 15(2), 351-364. doi: 10.1017/S1366728910000192
- 17 Kozora, E., & Cullum, C. M. (1995). Generative naming in normal aging: Total output  
18           and qualitative changes using phonemic and semantic constraints. *The Clinical*  
19           *Neuropsychologist*, 9(4), 313-320. doi:10.1080/13854049508400495
- 20 Léger, L., Boumlak, H., & Tijus, C. (2008). BASETY: Extension et typicalité des  
21           exemplaires pour 21 catégories d'objets. *Canadian Journal of Experimental*  
22           *Psychology/Revue canadienne de psychologie expérimentale*, 62(4), 223-232.  
23           doi: 10.1037/a0012885
- 24 Lezak, M. D. (1995). *Neuropsychological assessment* (3rd ed.). New York: Oxford  
25           University Press.
- 26 Li, P., Sepanski, S., & Zhao, X. (2006). Language history questionnaire: A web-based  
27           interface for bilingual research. *Behavior Research Methods*, 38(2), 202-210.  
28           doi: 10.3758/BF03192770
- 29 Luo, L., Luk, G., & Bialystok, E. (2010). Effect of language proficiency and executive  
30           control on verbal fluency performance in bilinguals. *Cognition*, 114(1), 29-41.  
31           doi:10.1016/j.cognition.2009.08.014
- 32 Marques, J. F., Fonseca, F. L., Morais, S., & Pinto, I. A. (2007). Estimated age of  
33           acquisition norms for 834 Portuguese nouns and their relation with other

- 1 psycholinguistic variables. *Behavior Research Methods*, 39(3), 439-444. doi:  
2 10.3758/BF03193013
- 3 Michael, E.B., & Gollan, T.H. (2005). Being and becoming bilingual: Individual  
4 differences and consequences for language production. In J.F. Kroll & A.M.B.  
5 de Groot (Eds.) *Handbook of bilingualism: Psycholinguistic Approaches* (pp.  
6 389–407). New York: Oxford University Press.
- 7 Monsch, A. U., Bondi, M. W., Butters, N., Salmon, D. P., Katzman, R., & Thal, L. J.  
8 (1992). Comparisons of verbal fluency tasks in the detection of dementia of the  
9 Alzheimer type. *Archives of Neurology*, 49(12), 1253-1258. doi:  
10 10.1001/archneur.1992.00530360051017
- 11 New, B., Pallier, C., Ferrand, L., & Matos, R. (2001). Une base de données lexicales du  
12 français contemporain sur internet: LEXIQUE™ / A lexical database for  
13 contemporary French: LEXIQUE™. *L'Année Psychologique*, 101(3), 447-462.  
14 doi: 10.3406/psy.2001.1341
- 15 Pallier, C., Dehaene, S., Poline, J. B., LeBihan, D., Argenti, A. M., Dupoux, E., &  
16 Mehler, J. (2003). Brain imaging of language plasticity in adopted adults: Can a  
17 second language replace the first? *Cerebral Cortex*, 13(2), 155-161. doi:  
18 10.1093/cercor/13.2.155
- 19 Pekkala, S., Goral, M., Hyun, J., Obler, L. K., Erkinjuntti, T., & Albert, M. L. (2009).  
20 Semantic verbal fluency in two contrasting languages. *Clinical Linguistics &*  
21 *Phonetics*, 23(6), 431-445. doi: 10.1080/02699200902839800
- 22 Pierce, L. J., Klein, D., Chen, J. K., Delcenserie, A., & Genesee, F. (2014). Mapping the  
23 unconscious maintenance of a lost first language. *Proceedings of the National*  
24 *Academy of Sciences*, 111(48), 17314-17319. doi: 10.1073/pnas.1409411111
- 25 Portocarrero, J. S., Burrell, R. G. & Donovan, P. J. (2007). Vocabulary and verbal  
26 fluency of bilingual and monolingual college students. *Archives of Clinical*  
27 *Neuropsychology*, 22, 415–422. doi: 10.1016/j.acn.2007.01.015
- 28 Roberts, P. M., & Le Dorze, G. (1997). Semantic organization, strategy use, and  
29 productivity in bilingual semantic verbal fluency. *Brain and Language*, 59, 412–  
30 449. doi:10.1006/brln.1997.1753
- 31 Rosselli, M., Ardila, A., Salvatierra, J., Marquez, M., Matos, L., & Weekes, V. A.  
32 (2002). A cross-linguistic comparison of verbal fluency tests. *International*  
33 *Journal of Neuroscience*, 112, 759–776. doi: 10.1080/00207450290025752

- 1 Rosselli, M., Ardilla, A., Arujo, K., Weekes, V. A., Caracciolo, V., Padilla, M. &  
2 Ostrosky-Solis, F. (2000). Verbal fluency and repetition skills in healthy older  
3 Spanish English bilinguals. *Applied Neuropsychology*, 7, 17–24. doi:  
4 10.1207/S15324826AN0701\_3
- 5 Sadat, J., Martin, C., Alario, F.-X., & Costa, A. (2012). Characterizing the Bilingual  
6 Disadvantage in Noun Phrase Production. *Journal of Psycholinguistic Research*,  
7 41 (3), 159-179. doi:10.1007/s10936-011-9183-1.
- 8 Sadat, J., Martin, C., Alario, F.-X., & Costa, A. (in press). Breaking down the bilingual  
9 cost in speech production. *Cognitive Science*. doi : 10.1111/cogs.12315
- 10 Sadat, J., Martin, C., Costa, A., & Alario, F.-X. (2014). Reconciling Phonological  
11 Neighborhood Effects in Speech Production through Single Trial Analysis.  
12 *Cognitive Psychology*, 68, 33-58. doi:10.1016/j.cogpsych.2013.10.001
- 13 Sandoval, T. C., Gollan, T. H., Ferreira, V. S., & Salmon, D. P. (2010). What causes the  
14 bilingual disadvantage in verbal fluency? The dual-task analogy. *Bilingualism:*  
15 *Language and Cognition*, 13(2), 231-252. doi: 10.1017/S1366728909990514
- 16 Schmid, M. S., & De Bot, K. (2004). Language attrition. In A. Davies & C. Elder  
17 (Eds.), *The Handbook of Applied Linguistics* (pp. 210-234). Oxford: Blackwell  
18 Publishing.
- 19 Soares, A. P., Comesaña, M., Iriarte, A., Almeida, J. J., Simões, A., Costa, A., . . .  
20 Machado, J. (2010). P-PAL: Uma base lexical com índices psicolinguísticos do  
21 Português Europeu [P-PAL: A European Portuguese lexical database].  
22 *Linguamática*, 2, 67–72. doi:N/A
- 23 Taler, V., Johns, B. T., Young, K., Sheppard, C., & Jones, M. N. (2013). A  
24 computational analysis of semantic structure in bilingual verbal fluency  
25 performance. *Journal of Memory and Language*, 69, 607–618. doi:  
26 doi:10.1016/j.jml.2013.08.004
- 27 Tombaugh, T. N., Kozak, J., & Rees, L. (1999). Normative data stratified by age and  
28 education for two measures of verbal fluency: FAS and animal naming. *Archives*  
29 *of Clinical Neuropsychology*, 14(2), 167-177. doi:10.1016/S0887-  
30 6177(97)00095-4
- 31 Tomer, R., & Levin, B. E. (1993). Differential effects of aging on two verbal fluency  
32 tasks. *Perceptual and Motor Skills*, 76(2), 465-466. doi:  
33 10.2466/pms.1993.76.2.465

- 1 Van Casteren, M., & Davis, M. H. (2006). Mix, a program for  
2 pseudorandomization. *Behavior Research Methods*, *38*(4), 584-589. doi:  
3 10.3758/BF03193889
- 4 Vega-Mendoza, M., West, H., Sorace, A., & Bak, T. H. (2015). The impact of late, non-  
5 balanced bilingualism on cognitive performance. *Cognition*, *137*, 40-46.  
6 doi:10.1016/j.cognition.2014.12.008
- 7 Ventureyra, V. A., Pallier, C., & Yoo, H. Y. (2004). The loss of first language phonetic  
8 perception in adopted Koreans. *Journal of Neurolinguistics*, *17*(1), 79-91.  
9 doi:10.1016/S0911-6044(03)00053-8
- 10

- 1 Table 1 : Overview of verbal fluency studies comparing the number of exemplars  
 2 produced by monolingual and bilingual speakers (children, younger or older adults)

Task	Study	Observation
Semantic fluency		
	Bialystok et al. (2008b; Study 1 and 2)	monolinguals = bilinguals
	Blumenfeld et al. (2016)	monolinguals = bilinguals
	Current study	monolinguals = bilinguals
	Friesen et al. (2015)	monolinguals = bilinguals
	Luo et al. (2010)	monolinguals = bilinguals
	Rosseli et al. (2002)	monolinguals = bilinguals
	Taler et al. (2013)	monolinguals = bilinguals
	Vega-Mendoza et al. (2015)	monolinguals = bilinguals
	Bialystok et al. (2008a)	monolinguals > bilinguals
	Bialystok et al. (2008b; Study 2)	monolinguals > bilinguals
	Friesen et al. (2015)	monolinguals > bilinguals
	Gollan et al. (2002)	monolinguals > bilinguals
	Kormi-Nouri et al. (2012)	monolinguals > bilinguals
	Portocarrero et al. (2007)	monolinguals > bilinguals
	Rosseli et al. (2002)	monolinguals > bilinguals
	Rosseli et al. (2000)	monolinguals > bilinguals
	Sandoval et al. (2010)	monolinguals > bilinguals
Letter fluency		
	Bialystok et al. (2008b; Study 2)	monolinguals < bilinguals
	Friesen et al. (2015)	monolinguals < bilinguals
	Kormi-Nouri et al. (2003)	monolinguals < bilinguals
	Kormi-Nouri et al. (2012)	monolinguals < bilinguals
	Luo et al. (2010)	monolinguals < bilinguals
	Bialystok et al. (2008b; Study 2)	monolinguals = bilinguals
	Blumenfeld et al. (2016)	monolinguals = bilinguals
	Current study	monolinguals = bilinguals
	Friesen et al. (2015)	monolinguals = bilinguals
	Luo et al. (2010)	monolinguals = bilinguals
	Portocarrero et al. (2007)	monolinguals = bilinguals

Rosseli et al. (2000)	monolinguals = bilinguals
Rosseli et al. (2002)	monolinguals = bilinguals
Taler et al. 2013	monolinguals = bilinguals
Vega-Mendoza et al. (2015)	monolinguals = bilinguals
Bialystok et al. (2008a)	monolinguals > bilinguals
Bialystok et al. (2008b; Study 1)	monolinguals > bilinguals
Gollan et al. 2002	monolinguals > bilinguals
Sandoval et al. (2010)	monolinguals > bilinguals
Vega-Mendoza et al. (2015)	monolinguals > bilinguals

1 Table 2 : Means (M) and standard deviations (SD) for bilingual participants' self-report  
 2 ratings.  
 3

24 European Portuguese-French bilinguals		
	<i>M</i>	<i>SD</i>
Age	34.8	5.7
Percent daily use of European Portuguese	94.8	10.4
Percent daily use of French	26.7	26.0
Years in Portugal	21.7	4.7
Years in France	12.9	3.1
European Portuguese proficiency	7.0	0.0
French proficiency	6.9	0.4
English proficiency	3.9	1.8

4 Note: Language use scores represent the estimated percentage of daily use on a five  
 5 point scale (1%, 25%, 50%, 75%, 100%). Note that participants did not respect the  
 6 instructions that percentages should sum up to 100%. Proficiency ratings are on a 1–7  
 7 scale, where 1 indicates “very poor knowledge of the language” and 7 indicates “native

1 proficiency". Proficiency values represent the average of the participants' responses in  
2 four domains (speaking, writing, reading, and listening).

3

4

5

6

7

1 Table 3:

2 Predictors of cognate production probability in the typed fluency task (Experiment 1).

Predictor	$\beta$	$SE \beta$	$z$ -value	$p$ -value
Intercept	0.72	0.12	6.20	<0.001
Bilinguals vs. monolinguals	-0.11	0.05	-2.39	0.017
Letter vs. semantic task	-0.72	0.15	-4.69	<0.001
Order	-0.01	<0.01	-5.37	<0.001

3 *Note:* SE = standard error. Cognate production probability was coded 0 for  
 4 cognates and 1 for non-cognates.

5



1 Table 4:

2 Category and letter combinations used in the mixed task (Experiment 2).

Letter	Animals	Musical Inst.	Vegetables	Tools	Professions	Vehicles
A	x				x	
B	x	x		x	x	x
C		x				
E	x				x	x
F		x			x	x
G					x	
I					x	
L				x		x
M	x			x		
N					x	
P			x			
R	x			x		
S		x	x			
T	x	x	x			x

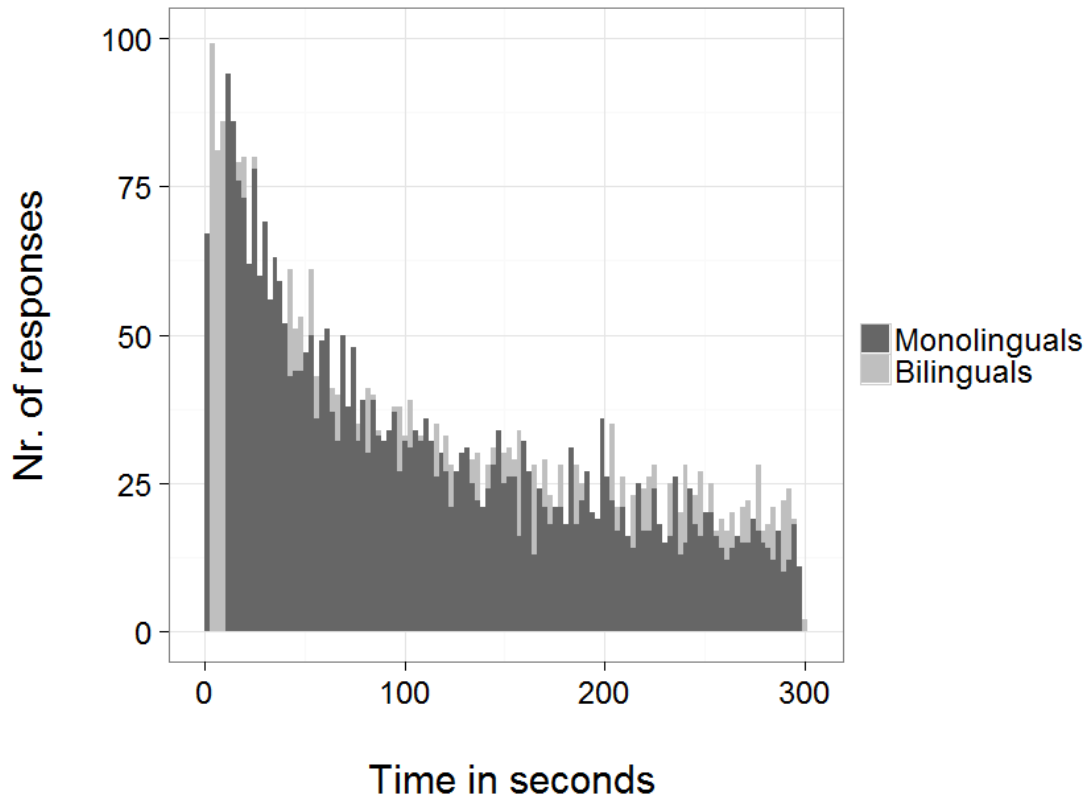
3

4

5

6 Figure 1: Distribution of responses across time for monolingual and bilingual

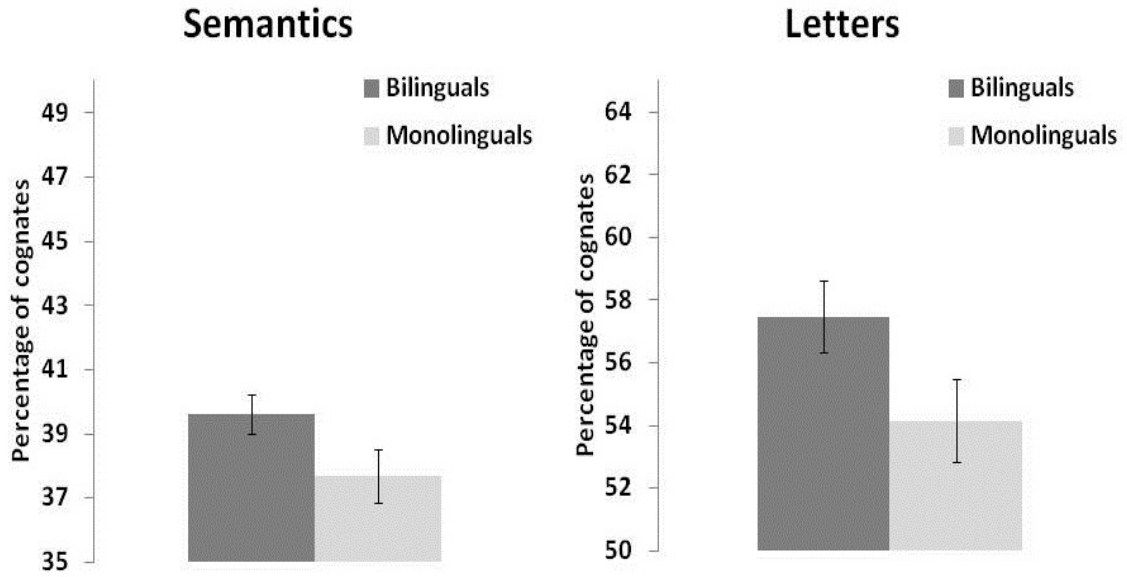
7 participants in the typed fluency task (Experiment 1).



1

1 Figure 2: Mean percentage of cognate production for mono- and bilinguals in the  
2 semantic and letter category task (Experiment 1). Error bars indicate the standard error  
3 of the mean.

4



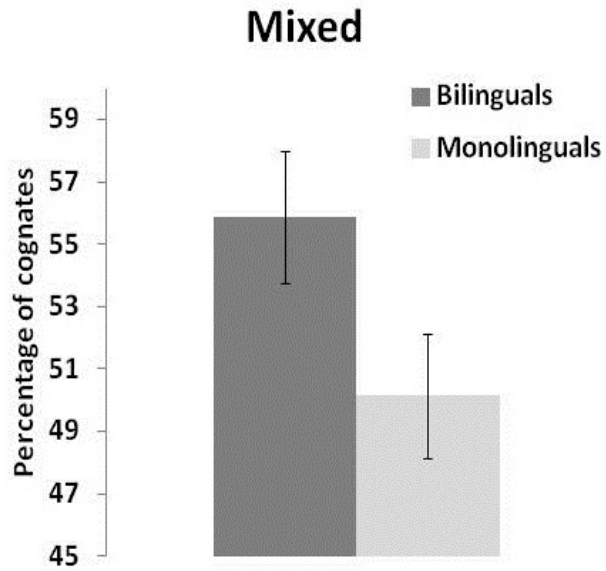
5

6

1 Figure 3: Mean percentage of cognate production for mono- and bilinguals in the mixed  
2 task (Experiment 2). Error bars indicate the standard error of the mean.

3

4



5

6

7