Agència
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Memòria justificativa de recerca de les convocatòries BCC, BE, BP, CTP-AIRE, DEBEQ, FI, INEFC, NANOS i PIV

La memòria justificativa consta de les dues parts que venen a continuació:
1.- Dades bàsiques i resums
2.- Memòria del treball (informe científic)

Tots els camps són obligatoris

1.- Dades bàsiques i resums

Nom de la convocatòria

FI

Llegenda per a les convocatòries:

BCC	Convocatòria de beques per a joves membres de comunitats catalanes a l'exterior
BDH	Beques i ajuts postdoctorals del Programa DGR-Henkel KGaA
BE	Beques per a estades per a la recerca fora de Catalunya
BP	Convocatòria d'ajuts postdoctorals dins del programa Beatriu de Pinós
CTP-AIRE	Ajuts per accions de cooperació en el marc de la comunitat de treball dels Pirineus. Ajuts de mobilitat de personal investigador.
DEBEQ (Modalitat A3)	Beques de Cooperació Internacional i Desenvolupament
FI	Beques predoctorals per a la formació de personal investigador
INEFC	Beques predoctorals i de col·laboració, dins de l'àmbit de l'educació física i l'esport i les ciències aplicades a l'esport
PIV	Beques de recerca per a professors i investigadors visitants a Catalunya

Títol del projecte: ha de sintetitzar la temàtica científica del vostre document.
Effects of Bilingualism on Multi-Word Production

Dades de l'investigador o beneficiari

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Paraules clau: cal que esmenteu cinc conceptes que defineixin el contingut de la vostra memòria.
Speech Production; Bilingualism; Noun-Phrases;Articulatory Durations; Lexical Variables

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Nom i cognoms i signatura
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Visttiplau del/de la responsable de la
sol·licitud

Generalitat de Catalunya
Departament d'Innovació,
Universitats i Empresa

Resum del projecte: cal adjuntar dos resums del document, l'un en anglès i l'altre en la llengua del document, on s'esmenti la durada de l'acció

Resum en la llengua del projecte (màxim 300 paraules)

Resum en anglès (màxim 300 paraules)
It has been shown that bilinguals are disadvantaged on some language production tasks when compared to monolinguals. The present study investigated the effects of bilingualism on lexical retrieval in single and multi-word utterances. To this purpose, we tested three groups of 35 participants each (Spanish monolinguals, highly proficient Spanish-Catalan and Catalan-Spanish bilinguals) in two sets of picture naming experiments. In the first one, participants were asked to name black-and-white object drawings by single words. In the second one, participants had to name colored pictures with determiner adjectival noun phrases (NP) like "the red car". In both sets of experiments, bilinguals were slower than monolinguals, even when naming in their dominant language. We also examined the articulatory durations of both single word and NP productions for this bilingual disadvantage. Furthermore, response onset times and durations of all groups in both experiments were affected by lexical variables of the picture names. These results are consistent with previous studies (Ivanova & Costa, 2008, Gollan et al., 2005) showing a bilingual disadvantage in single word production and extend these findings to multiword-utterances and response durations. They also support the claim that articulatory processes are influenced by lexical variables.

Resum en anglès (màxim 300 paraules) – continuació -.

2.- Memòria del treball (informe científic sense limitació de paraules). Pot incloure altres fitxers de qualsevol mena, no més grans de 10 MB cadascun d'ells.

Effects of Bilingualism on Multi-Word Production

Introduction

Exploring the collateral effects of bilingualism is an important issue of present research. Apart from advantages associated with early bilingualism in tasks of executive control (Bialystok, 1999; Bialystok, Craik, Klein, & Viswanathan, 2004; Costa, Hernandez, & Sebastian-Galles, 2008), recent studies show a bilingual processing costs relative to monolinguals in linguistic performance: monolinguals outperform bilinguals on the Boston Naming Test (Kohnert, Hernandez, & Bates, 1998) and uni-modal bilinguals encounter more TOTs than monolinguals (Gollan & Acenas, 2004; Gollan & Brown, 2006; Pyers, Gollan, & Emmorey, 2009). Moreover, bilingualism is associated with reduced category fluency and bilinguals are generally slower and less accurate in naming pictures than monolinguals (Gollan, Montoya, Fennema-Notestine, & Morris, 2005), even when the task is performed in their first and dominant language (Ivanova & Costa, 2008).

Additionally to these findings coming mostly from accuracy and reaction time studies, there is evidence that bilingualism exerts an influence onto articulatory durations during naming. In a recent study by (Flege & Hojen, 2004) articulatory durations of phrases that differed in syntactic complexity were compared between monolingual English speakers and late Spanish-English bilinguals. They found that in a naming condition where the instructions for the participants emphasized speed of response, bilinguals' articulatory durations were significantly longer in noun phrase production than for monolinguals.

Explanations for the bilingual advantages in cognitive control as well as their linguistic disadvantages are based on the fact that bilinguals need to keep apart two representational systems and use each of them properly when they are speaking in one of their languages.
One way to explain the disadvantage associated with bilingualism is tight to competition. Concepts automatically activate lexical representations in both languages (Colomé, 2001; Costa, Caramazza, & Sebastian-Galles, 2000) and thus items from the language-not-in use can interfere during lexical selection (Green, 1998). Thus this between language interference causes a slow-down in bilingual language production relative to monolinguals.
Alternatively, the bilingual disadvantage in linguistic processing has been explained in the framework of frequency-of-use (Gollan, Montoya, Cera, & Sandoval, 2008). Given that bilinguals overall use their dominant language less often than monolinguals, frequency-of-use values for items in the bilingual lexicon are generally lower than the corresponding values in monolinguals. Bilingualism thus affects language production as a result of less practiced use in each of the languages and so worse naming performance for bilingual speakers is observed when compared to monolinguals.

The objective of the current investigation is not to resolve the debate about the origin of the bilingual disadvantage, but rather to provide further evidence of its extent into more natural language production. It is important to establish the consequences of bilingualism in multi-word production and on various dimensions of linguistic performance. To this end, we assessed the performance of three groups of speakers (Spanish monolinguals, Spanish-Catalan bilinguals, and Catalan-Spanish bilinguals) in two different picture naming experiments (Bare naming and Noun phrase production). First of all, we wanted to replicate previous results reporting a disadvantage for bilinguals relative to monolinguals in single word production. Secondly, we aimed at investigating articulatory durations of the utterances and see if a bilingual cost would be present in speech execution, even when bilinguals were using their first and dominant language. And finally, we wanted to generalize our findings to multi-word

utterances and look if the linguistic cost associated with bilingualism would still be present in the naming latencies and articulations during noun-phrase production.

As a further point, we wanted to investigate the influence of two lexical variables - Frequency and cognate status - onto articulatory durations. Since the first studies by (Oldfield & Wingfield, 1965) it is known that low frequency words are named slower than high frequency words. When going to a bilingual context, it is also known that cognate words are named faster than non-cognate words (Costa et al., 2000). Thus both of these variables exert important influences onto bilingual language production, but, however, their impact on articulatory durations is less defined. Recent literature suggests that durations are sensitive to linguistic variables like for example word-specific frequency. Gahl (2008) investigated durations of English low and high frequency homophones (e.g., "thyme" versus "time") in a natural speech corpus and found that word-specific frequency predicted the homophone's articulatory duration. Thus we included pictures with high and low frequency names and pictures with cognate and non-cognate names in our study.

Experiment 1a (Bare Nouns)

Method

Participants

Three groups of participants were recruited: 30 monolinguals, 27 Spanish-Catalan bilinguals and 27 Catalan-Spanish bilinguals. Participants were psychology students at the University of Murcia, Spain (monolingual group) or at the University of Barcelona, Spain (two bilingual groups). All monolinguals grew up in Spanish speaking families and used Spanish only for daily communication. All bilinguals were highly proficient in Catalan and Spanish and had acquired their L1 (either Spanish or Catalan) from birth before being exposed to their L2. None of the participants was fluent in any other language. Participants in the three groups did not differ in age or educational background. All participants had normal or corrected-to-normal vision.

Materials

The stimuli were 40 pictures of common objects, selected from Snodgrass & Vanderwart (1980) and the International Picture Naming Project (Szekely et al., 2004). Two groups of 20 pictures were created: Twenty pictures had high frequency names (HF; M = 59.4 occurrences per million, SD = 62.8; range: 15.4 – 278.0; Spanish frequency database "BuscaPalabras" (Davis & Perea, 2005)) and 20 had low frequency names (LF; M = 4.0 occurrences per million, SD = 3.5; range: 0.4 – 14.8; $t(19.12) = 3.94$, $p = .001$). There were 10 cognates (C) and 10 non-cognates (NC) in each frequency group, which were matched for grammatical gender (5 feminine and 5 masculine nouns). Cognates and non-cognates did not differ in frequency in either group (all ps > .23). Picture names were also matched for phoneme length across sets (all ps > .08). A summary of these properties is

provided in Table 1. Pictures had black outlines and white surfaces, were 300 pixels wide x 300 pixels high and were presented on a white rectangle.

Group of picture names	Occurrences per million (*M*)	Occurrences per million (*SD*)	Range	Phoneme length (*M*)	Phoneme length (*SD*)
HF-C	67.3	76.0	18.4 – 278	6.0	1.3
HF-NC	51.6	49.2	15.4 – 172	5.0	1.7
LF-C	5.00	4.50	0.40 – 14.8	6.2	1.1
LF-NC	3.00	2.20	0.70 – 6.30	5.3	2.1

Table 1

Design

The presentation of the pictures in each list was pseudo-randomized with the following restrictions: (a) the 160 pictures were presented in four successive sets of 40, each picture being presented only once per set; (b) picture names in two successive trials were neither semantically nor phonologically related. Participants within each group were randomly assigned to different lists, created following a Latin Square design.

Procedure

Stimulus presentation and a software voice-key were controlled via DMDX (Forster & Forster, 2003). Sensitivity of the voice-key was adjusted for each participant, tested in a sound-proof room. Each trial started with a fixation cross displayed in the centre of a computer screen for 500 ms. After a 300 ms blank screen, the picture of the object to name was displayed. The picture remained on the screen until the voice key detected the response or after 2000 ms if no overt response was recorded. The following trial started 1500 ms after the participant's response.

The experiment was divided in two phases: familiarization and testing. In the first phase, participants were familiarised with the experimental material and the task. They were asked to name the 40 pictures using bare nouns. If participants gave another picture name than the intended one, they were corrected by the experimenter at the end of the familiarization phase. In the testing phase, 160 pictures were presented. Each of the 40 pictures was repeated 4 times. All participants were instructed to name the pictures as fast and as accurately as possible, by using bare nouns. Participants' responses were all automatically recorded by DMDX (Forster & Forster, 2003) and errors were noted down online by the experimenter. In total, the experiment lasted about 30 minutes.

Data analyses

All vocal response onsets were visually double-checked offline, and corrected if necessary using "CheckVocal" (Protopapas, 2007). Trials with malfunctioning of the voice key, incorrect responses, or influent speech

(stuttering, utterance repairs, etc.) were classified as errors and excluded from analyses (Monolinguals: 1.8 %; L1: 1.8 %; L2: 2.5 %)). In order to obtain articulatory durations, naming offset was determined and checked using "CheckVocal" (Protopapas, 2007). Trials excluded from latency analyses were also excluded from duration analyses. Additionally, voice recordings exceeding the recording time-window were excluded from analyses (Monolinguals: 0.6 %; L1: 0.6 %; L2: 0.8 %).

Response onsets, durations and error rates were analysed using Analyses of Variance (ANOVAs) with participants and items as random factors. "Group" was a between-participant and within-item factor (monolingual versus L1 bilingual versus L2 bilingual). "Noun frequency" (referred later as Frequency; high versus low) and "noun cognate status" (referred later as Cognate; cognate versus non-cognate) were within-participant and between-item factors. In what follows, "frequency effect" refers to the difference in performance between responses to low and high frequent nouns. Regarding the cognate manipulation, any difference observed between responses non-cognate and cognate nouns in monolingual speakers will serve as baseline against which to compare the results of the bilingual groups. This is because the systematic difference in cognate status between the picture names for bilinguals is not present in monolinguals. Thus "cognate effect" in L1 and L2 bilingual speakers is defined as the interaction between cognate status and participant group.

Results

Naming latencies

The results of the ANOVAs performed on the naming latencies are reported on Table 2. The ANOVAs revealed a significant main effect of Group. Post-hoc analysis (LSD) revealed that onset latencies were significantly faster for monolinguals than L1 bilinguals (p = .024) and L2 bilinguals (p = .002; monolinguals: M = 672 ms, SD = 94; L1 bilinguals: M = 725 ms, SD = 96; L2 bilinguals: M = 745 ms, SD = 109). Naming latencies did not significantly differ between L1 and L2 bilinguals (p = .420). The main effect of Frequency was also significant, with faster responses for high (M = 678 ms, SD = 87) than low frequency words (M = 747 ms, SD = 111). The Group x Frequency two-way interaction did not reach significance.

Response onsets for non-cognates (M = 731 ms, SD = 113) were significantly slower than for cognates (M = 694 ms, SD = 94). Group and Cognate factors interacted marginally in F_1 analysis, indicating that the magnitude of that difference varied across groups (monolinguals: M = 30 ms, SD = 33; L1 bilinguals: M = 33 ms, SD = 27; L2 bilinguals: M = 47 ms, SD = 28). 2 x 2 ANOVAs on three restricted data sets (Cognate versus Non-Cognate Status and either Monolingual versus L1 bilingual or Monolingual versus L2 bilingual or L1 versus L2 bilingual) showed that the Group x Cognate interaction (i.e. "cognate effect") was significant when comparing monolinguals with L2 bilinguals and marginally significant when comparing L1 bilinguals with L2 bilinguals.

Naming latencies

3 x 2 x 2 ANOVA	2 x 2 ANOVA		dfn	dfd	F	MSE	*p*	η_p^2
Group		F_1	2	81	5.34	162343	.007	.12
		F_2	1.3	47	110	820	< .001	.75
Frequency		F_1	1	81	179	2207	< .001	.69
		F_2	1	36	15.4	9357	< .001	.30
Group x Frequency		F_1	2	81	1.55	2207	.218	.04
		F_2	1.3	47	1.97	820	.164	.05
Cognate		F_1	1	81	126	893	< .001	.61
		F_2	1	36	4.33	9357	.045	.11
Group x Cognate		F_1	2	81	2.46	893	.092	.06
		F_2	1.3	47	1.34	820	.263	.04
	Group (Mono vs. L2)	F_1	1	55	3.75	485	.058	.06
	x Cognate	F_2	1	38	1.56	787	.219	.04
	Group (L1 vs. L2)	F_1	1	52	3.34	384	.073	.06
	x Cognate	F_2	1	38	4.27	205	.046	.10

Table 2.

Naming durations

The results of the ANOVAs performed on the naming durations are reported on Table 3. The ANOVAs revealed a significant main effect of Group in F_2 analysis. Post-hoc analysis (LSD) did not reveal any significant differences between durations in the three groups (monolinguals: *M* = 400 ms, *SD* = 56; L1 bilinguals: *M* = 411 ms, *SD* = 53; L2 bilinguals: *M* = 424 ms, *SD* = 69). There was a significant main effect of Frequency in F_1 analysis: durations were shorter for high (*M* = 402 ms, *SD* = 59) than low frequency words (*M* = 420 ms, *SD* = 60). The Group x Frequency interaction did not reach significance.

The difference in response durations between non-cognates (*M* = 404 ms, *SD* = 58) and cognates (*M* = 419 ms, *SD* = 62) was significant in F_1 analysis. The Group x Cognate two-way interaction (i.e. "cognate effect") was significant, indicating that the magnitude of that difference varied across groups (monolinguals: *M* = -13 ms, *SD* = 10; L1 bilinguals: *M* = -11 ms, *SD* = 9; L2 bilinguals: *M* = -20 ms, *SD* = 8). 2 x 2 ANOVAs on three restricted data sets (Cognate versus Non-Cognate Status and either Monolingual versus L1 bilingual or Monolingual versus L2 bilingual or L1 versus L2 bilingual) showed that the two-way interaction Group x Cognate was significant when comparing monolinguals with L2 bilinguals and when comparing L1 with L2 bilinguals.

Naming durations

3 x 2 x 2 ANOVA	2 x 2 ANOVA		dfn	dfd	F	MSE	*p*	η_p^2
Group		F_1	2	81	1.18	13915	.312	.03
		F_2	2	72	78.1	70	< .001	.69

Frequency		F_1	1	81	428	62	< .001	.84
		F_2	1	36	0.61	15117	.439	.02
Group x Frequency		F_1	2	81	2.48	62	.090	.06
		F_2	2	72	0.43	70	.655	.01
Cognate		F_1	1	81	215	84	< .001	.73
		F_2	1	36	0.43	15117	.516	.01
Group x Cognate		F_1	2	81	7.50	84	.001	.16
		F_2	2	72	3.78	70	.032	.10
	Group (Mono vs. L2)	F_1	1	55	8.76	41	.005	.14
	x Cognate	F_2	1	38	3.18	91	.082	.08
	Group (L1 vs. L2)	F_1	1	52	16.0	38	< .001	.24
	x Cognate	F_2	1	38	6.34	76	.016	.14

Table 2.

Naming errors

The ANOVAs performed on error rates revealed no significant effect of Group (F_1[2, 81] = 1.02, MSE = 3, p = .364, η_p^2 = .03; F_2[1.71, 61.72] = 1.23, MSE = 3, p = .296, η_p^2 = .03). The main effect of Frequency was significant (F_1[1, 81] = 28.29, MSE = 2, p < .001, η_p^2 = .26; F_2[1, 36] = 10.22, MSE = 14, p = .003, η_p^2 = .22), showing that error rates were higher for low (M = 2.9 %, SD = 4.4) than high frequency words (M = 1.0 %, SD = 2.0). No Group x Frequency interaction was observed (F_1[2, 81] = .93, MSE = 2, p = .398, η_p^2 = .02; F_2[1.71, 61.72] = 1.48, MSE = 3, p = .236, η_p^2 = .04).

The difference in errors between responses to non-cognates (M = 2.6 %, SD = 4.3) and cognates (M = 1.4 %, SD = 2.4) reached significance (F_1[1, 81] = 11.46, MSE = 2, p = .001, η_p^2 = .12; F_2[1, 36] = 4.23, MSE = 14, p = .047, η_p^2 = .11). Cognate did not interact with Group (F_1[2, 81] = 1.47, MSE = 2, p = .237, η_p^2 = .04; F_2[1.71, 61.72] = 2.18, MSE = 3, p = .128, η_p^2 = .06).

Summary of findings

Monolinguals showed significantly faster naming latencies than bilinguals in single word production, even when bilinguals were using their first and dominant language. Articulatory durations for monolinguals were shorter than for bilinguals, although this difference was only significant in the analysis by items. Across participant groups naming latencies were faster and articulatory durations were shorter for high frequency nouns than for low frequency nouns. Finally, L1 and L2 bilinguals produced marginally shorter naming latencies, but longer durations for cognate compared to non-cognate nouns.

Experiment 1b (Noun-Phrases)

Method

Participants

Three groups of participants were recruited: 35 monolinguals, 35 Spanish-Catalan bilinguals and 35 Catalan-Spanish bilinguals. Participants had similar characteristics as in Experiment 1a (see Table 4).

	Spanish monolinguals	Spanish-Catalan bilinguals	Catalan-Spanish bilinguals
Age	20.7 (2.5)	21.4 (2.7)	20.5 (2.0)
% Daily use of Spanish	99.9 (0.4)	78.4 (14.7)	24.5 (14.4)
Age exposed to Spanish	0 (0)	0 (0)	3.5 (2.5)
Age speaking Spanish	1.4 (0.6)	1.1 (0.2)	5.0 (2.4)
Age exposed to Catalan	_	4.8 (4.8)	0.2 (0.7)
Age speaking Catalan	_	5.6 (4.6)	1.4 (0.7)
Age exposed to other language	7.2 (2.9)	6.9 (2.6)	7.0 (2.0)
Spanish proficiency	4.0 (0.1)	4.0 (0.0)	3.9 (0.2)
Catalan proficiency	_	3.7 (0.4)	4.0 (0.0)
Other language proficiency	2.0 (0.9)	2.4 (0.8)	2.4 (0.7)

Table 3.

Materials

The stimuli were the same as in Experiment 1a, except that the previously used black-and-white drawings were presented in four different colours: two colours with high frequency names ("green", 69.5 occurrences per million and "red", 63.8 occurrences per million) and two colours with low frequency names ("purple", 2.9 occurrences per million and "yellow", 25.0 occurrences per million). The four colour names were matched for cognate status (2 cognates: green and purple; 2 non-cognates: yellow and red) and phoneme length (LF colours: 7 and 4 phonemes; HF colours: 4 and 5 phonemes). The properties of the adjectives were counterbalanced to preserve the symmetry in the materials properties. Such counterbalancing is not intended as an experimental manipulation, as it only concerns four different words. Therefore the corresponding contrasts will not be analysed. All pictures represented objects encountered in each colour in everyday life: no picture with natural specific colour, like animals or fruits was used. The pictures had black outlines and coloured surfaces, were 300 pixels wide x 300 pixels high and were presented on a white rectangle. Eight pictures with characteristics similar to the experimental items were used as practice trials.

Design

The design was identical to Experiment 1a, with the additional constraint during exprimental list construction that the same colour did not appear in two successive trials. The response deadline was extended to 3000 ms.

Procedure

The procedure mirrored the one in Experiment 1a, except that after familiarization, participants were asked to name the coloured versions of the eight practice pictures by uttering adjectival noun phrases (e.g. "el coche rojo", "the red car" in Spanish). In the testing phase, each of the 40 pictures appeared once in each of the four colours. All participants were instructed to name the pictures as fast and as accurately as possible, by using adjectival noun phrases. In total, the experiment lasted about 40 minutes.

Data analyses

As in Experiment 1a, all vocal response onsets were visually double-checked offline, and corrected if necessary using "CheckVocal" (Protopapas, 2007). Since onset times were crucial in the present experiment, 20 % of the monolingual and L1 recordings were independently checked by a naive ratter. The two sets of checked onset latencies were highly correlated (monolingual group: $r(1025] = .999$, $p < .001$; L1 bilinguals: $r(1048] = .998$, $p < .001$). The average of the absolute difference between the two checked latency sets was 3.42 ms (*SD* = 7.72) in monolinguals and 4.57 ms (*SD* = 6.42) in the L1 bilingual group. Since the inter-ratter variability was very low, the onset latencies of the entire sample checked by one ratter were deemed reliable and used for analyses.
Trials with malfunctioning of the voice key, incorrect responses, or influent speech (stuttering, utterance repairs, etc.) were classified as errors and excluded from analyses (Monolinguals: 4.8 %; L1: 4.1 %; L2: 6.2 %). Trials excluded from latency analyses were also excluded from duration analyses. Additionally, voice recordings exceeding the recording time-window were excluded from analyses (Monolinguals: 0.04 %; L1: 0.00 %; L2: 0.11 %).
Response onsets, durations and error rates were analysed as in Experiment 1a.

Results

Naming latencies

The results of the ANOVAs performed on the naming latencies are reported on Table 5. The ANOVAs revealed a significant main effect of Group. Post-hoc analysis (LSD) revealed that onset latencies were significantly faster for monolinguals than L1 bilinguals ($p = .023$), and significantly faster for L1 than L2 bilinguals ($p = .001$; monolinguals: *M* = 702 ms, *SD* = 95; L1 bilinguals: *M* = 756 ms, *SD* = 123; L2 bilinguals: *M* = 838 ms, *SD* = 127; see Figure 4). The main effect of Frequency was significant, with faster responses for noun phrases containing high (*M* = 723 ms, *SD* = 111) than low frequency nouns (*M* = 808 ms, *SD* = 131). The

Group x Frequency two-way interaction reached significance in F_1 analysis, showing that the size of the frequency effect varied across groups (monolinguals: *M* = 82 ms, *SD* = 38; L1 bilinguals: *M* = 72 ms, *SD* = 47; L2 bilinguals: *M* = 101 ms, *SD* = 47). Further 2 x 2 ANOVAs on three restricted data sets (Low versus High Frequency and either Monolingual versus L1 bilingual or Monolingual versus L2 bilingual or L1 versus L2 bilingual) showed that the Group x Frequency two-way interaction was only significant when L1 and L2 bilinguals were compared.

Responses to noun phrases containing non-cognate nouns (*M* = 794 ms, *SD* = 135) were significantly slower than to cognates (*M* = 737 ms, *SD* = 114). Group and Cognate factors interacted significantly in F_1 analysis, indicating that the magnitude of that difference varied across groups (monolinguals: *M* = 45 ms, *SD* = 31; L1 bilinguals: *M* = 57 ms, *SD* = 39; L2 bilinguals: *M* = 68 ms, *SD* = 29). 2 x 2 ANOVAs on three restricted data sets (Cognate versus Non-Cognate Status and either Monolingual versus L1 bilingual or Monolingual versus L2 bilingual or L1 versus L2 bilingual) showed that the Group x Cognate interaction (i.e. "cognate effect") was significant when comparing monolinguals with L2 bilinguals.

Naming latencies

3 x 2 x 2 ANOVA	2 x 2 ANOVA		dfn	dfd	F	MSE	*p*	η_p^2
Group		F_1	2	102	17.2	38515	< .001	.25
		F_2	1.5	53.3	226	1132	< .001	.86
Frequency		F_1	1	102	395	1931	< .001	.80
		F_2	1	36	12.9	17798	.001	.26
Group x Frequency		F_1	2	102	3.86	1931	.024	.07
		F_2	1.5	53.3	2.29	1132	.125	.06
	Group (L1 vs. L2) x Frequency	F_1	1	68	6.62	1066	.012	.09
		F_2	1	38	4.99	734	.032	.12
Cognate		F_1	1	102	308	1099	< .001	.75
		F_2	1	36	5.76	17798	.022	.14
Group x Cognate		F_1	2	102	4.12	1099	.019	.08
		F_2	1.5	53.3	2.00	1132	.156	.05
	Group (Mono vs. L2) x Cognate	F_1	1	68	9.69	431	.003	.13
		F_2	1	38	2.61	1283	.115	.06

Naming durations

The results of the ANOVAs performed on the naming durations are reported on Table 6. The ANOVAs revealed a significant main effect of Group. Post-hoc analysis (LSD) revealed that monolinguals responded with shorter durations than L1 (*p* = .019) and L2 (*p* = .001) bilinguals (monolinguals: *M* = 805 ms, *SD* = 101; L1 bilinguals: *M* = 860 ms, *SD* = 89; L2 bilinguals: *M* = 881 ms, *SD* = 106; see Figure 5). Articulatory durations did

Table 4.

not significantly differ between L1 and L2 bilinguals (p = .377).[1] The main effect of Frequency was significant, with shorter durations for noun phrases containing high (M = 829 ms, SD = 99) than low frequency nouns (M = 868 ms, SD = 105). The Group x Frequency interaction did not reach significance.

The difference in response durations between noun phrases containing non-cognates (M = 844 ms, SD = 103) and cognates (M = 853 ms, SD = 104) was significant in F_1 analysis. The Group x Cognate two-way interaction (i.e. "cognate effect") was significant in F_1 analysis, indicating that the magnitude of that difference varied across groups (monolinguals: M = -14 ms, SD = 16; L1 bilinguals: M = -11 ms, SD = 14; L2 bilinguals: M = -4 ms, SD = 20). 2 x 2 ANOVAs on three restricted data sets (Cognate versus Non-Cognate Status and either Monolingual versus L1 bilingual or Monolingual versus L2 bilingual or L1 versus L2 bilingual) showed that the two-way interaction Group x Cognate was significant when comparing monolinguals with L2 bilinguals or L1 with L2 bilinguals.

Naming durations

3 x 2 x 2 ANOVA	2 x 2 ANOVA		dfn	dfd	F	MSE	p	η_p^2
Group		F_1	2	102	5.76	37349	.004	.10
		F_2	2	72	583	101	< .001	.94
Frequency		F_1	1	102	521	308	< .001	.84
		F_2	1	36	6.15	6928	.018	.15
Group x Frequency		F_1	2	102	2.02	308	.138	.04
		F_2	2	72	1.44	101	.244	.04
Cognate		F_1	1	102	32.9	285	< .001	.24
		F_2	1	36	0.51	6928	.479	.01
Group x Cognate		F_1	2	102	3.37	285	.038	.06
		F_2	2	72	2.02	101	.140	.05
	Group (Mono vs. L2) x Cognate	F_1	1	68	5.58	162	.021	.08
		F_2	1	38	2.81	134	.102	.07
	Group (L1 vs. L2) x Cognate	F_1	1	68	4.13	145	.046	.06
		F_2	1	38	2.38	90	.132	.06

Table 5.

Naming errors

The ANOVAs performed on error rates revealed a significant effect of Group (F_1[2, 102] = 3.11, MSE = 8, p = .049, η_p^2 = .06; F_2[2, 72] = 7.34, MSE = 12, p = .001, η_p^2 = .17). Post-hoc analysis (LSD) revealed that bilinguals naming in L1 made significantly less errors than bilinguals naming in L2 (p = .017; monolinguals: M = 4.8 %, SD = 5.0; L1 bilinguals: M = 4.1 %, SD =5.3; L2 bilinguals: M = 6.2 %, SD = 6.3; see Figure 6). The main effect of Frequency was significant (F_1[1, 102] = 56.45, MSE = 4, p < .001, η_p^2 = .36; F_2[1, 36] = 12.84,

[1] Note that when entering participants and items as random variables in a Generalized Linear Mixed-Effects model, significant differences between all 3 groups are observed.

MSE = 58, p = .001, η_p^2 = .26), with higher error rates for noun phrases containing low (M = 6.8 %, SD = 6.6) than high frequency nouns (M = 3.2 %, SD = 3.5). No Group x Frequency interaction was observed (F_1 and F_2 < 1).

The difference in errors between responses to noun phrases containing non-cognates (M = 5.8 %, SD = 6.3) and cognates (M = 4.3 %, SD = 4.6) reached significance in F_1 analysis (F_1[1, 102] = 15.01, MSE = 2, p < .001, η_p^2 = .13; F_2[1, 36] = 2.19, MSE = 58, p = .147, η_p^2 = .06). Cognate did not interact with Group (F_1 and F_2 < 1).

Summary of findings

In the context of multi-word production, monolinguals showed significantly shorter naming latencies and articulatory durations than bilinguals. Such differences were observed even when bilinguals were using their first and dominant language. Across participant groups, naming latencies and articulatory durations were shorter when the noun phrases contained high compared to low frequency nouns. Finally, L1 and L2 bilinguals showed shorter naming latencies and durations for noun phrases containing cognate compared to non-cognate nouns.

General Discussion

The present study investigated if bilingual naming performance in multi-word utterances is less efficient than in monolingual speakers. To this end, naming latencies and durations of one mono- and two bilingual groups of speakers (L1 and L2 bilinguals) were assessed and compared in two picture naming experiments (single word and noun phrase production).

Overall, monolinguals had shorter naming latencies than bilinguals in both bare word and noun phrase naming. This result replicates previous findings of a bilingual latency disadvantage in bare naming studies (Gollan et al., 2005; Ivanova & Costa, 2008) and extends them to multi-word production. The present study shows that the linguistic cost associated with bilingualism is present even when speakers engage in more natural speech including grammatical processing and lexical retrieval of several words. Strikingly, this cost was also observed for bilinguals using their first and dominant language.

Interestingly, a comparison of the latency results of Experiments 1a and 1b reveals that the cost for L1 bilinguals in naming bare nouns was virtually of the same size as in naming noun phrases. In other words, the onset time difference between monolinguals and L1 bilinguals is not modulated by the number of words that are uttered. Keeping in mind the usual reservations about accepting the null hypothesis in mind, this observation could suggest that the bilinguals cost is not accumulated when multiple lexical items are accessed, but rather that the access to a whole planning unit is slowed down. Such conclusion should be considered cautiously however, given that different groups of speakers were involved across experiments, and that the adjectives were repeatedly accessed, on average once every fourth trial. Future studies should clarify the extent of the bilingual cost in multi-word retrieval.

With regard to the articulatory durations in single and multi-word production, monolinguals showed shorter naming durations than both groups of bilinguals. However the results of the duration analyses in single word production were only significant by item and not by participant. Concerning noun phrase production, articulatory durations were significantly shorter for monolinguals than for L1 bilinguals. This finding adds information to the existing literature on non-native speaking rate effects in which longer durations are documented for non-native speakers (bilinguals speaking in L2) when compared to native speakers (monolinguals) in naming tasks that emphasize the speed of response (Flege & Hojen, 2004; Guion, Flege, Liu, & Yeni-Komshian, 2000; Mackay & Flege, 2004; Schmidt & Flege, 1995; Schmidt & Flege, 1996). The present study extends these observations by showing that longer naming durations can be observed even for early high proficient bilinguals that speak in their first learned and dominant language. Moreover, the bilingual articulatory disadvantage that emerges in noun phrase production compared to single word naming is in line with previous observations, showing that duration differences between mono- and bilinguals become more detectable with increasing complexity of the utterance (Flege & Hojen, 2004).

Altogether, then, the results of the present study generalize the observation of a bilingual disadvantage in speech production. Such disadvantage will now be discussed within two previously proposed accounts. We will then discuss the effects of the lexical manipulations (Frequency and Cognate status) within each group of speakers.

One explanation of the bilingual disadvantage in linguistic tasks is based on the principle of frequency-of-use: The more often words are retrieved during life, the faster and easier this task will be accomplished everyday. Since bilingual speakers naturally divide their frequency-of-use between two languages, the overall use of words in each of the languages is reduced in comparison to monolingual speakers. This account then can explain onset time differences between mono- and bilinguals, but is also applicable to such speaker group differences in articulatory durations. The interpretation of a frequency-of-use effect in onset times and articulatory routines is substantiated by the observation that lexical frequency of the words to produce showed a main effect on both kinds of measures (see further discussion below).

One further specification of the frequency-of-use hypothesis is based on the non-linearity of frequency effects. Given this non linearity, it is expected that low-frequency words should suffer more from a reduction in use than high frequency words. The bilingual disadvantage should thus be more pronounced with low than high frequency words (Gollan et al., 2008). This prediction does not find strong support in the current study, as the interaction between group of participants and noun frequency was not observed to be as salient as reported previously (Gollan et al., 2008). The only significant group x frequency interaction we observed was in the latency analysis of the noun phrases, indicating a significant difference in the size of the frequency effect between L1 and L2 bilinguals. Such result indeed supports the frequency-of-use hypothesis since L2 bilinguals should show larger frequency effects compared to L1 bilinguals due to reduced language use of the former.

Note however that this result is in line with the frequency-of-use explanation since L2 bilinguals should show larger frequency effects compared to L1 bilinguals due to reduced language use of the former.

An alternative account to explain a bilingual disadvantage in naming tasks is based on cross-language interference (Green, 1998). Words from the language not in use become activated and compete for lexical selection, even when bilinguals are using their dominant language. The conflict that arises, which is absent in monolinguals, would be responsible for the slow-down in bilingual naming latencies. The present results show such a bilingual disadvantage not only for naming latencies, but also for articulatory durations. Thus the question that arises is whether conflict at the level of selection can percolate down to affect processes of articulation. As

has been shown by (Kello, Plaut, & MacWhinney, 2000), under standard naming conditions articulatory durations usually do not show percolation effects from conflicts arising at earlier processing levels (see also Damian, 2003). Given that time pressure constraints in naming usually lead to a shifting of the stimulus effects from latencies onto articulatory durations (Kello, 2004), it remains unclear if conflict effects at lexical selection might have percolated under increased time pressure. In the present study, no deadline procedure was introduced to speed up participants' responses, but, however, the results showed that articulatory durations were sensitive to linguistic variables. Further experiments have to constrain the impact of time constraints on speech planning and execution processes.

Regarding the manipulations of frequency and cognate status in the present experiments, qualitatively similar effects could be observed in onset times as well as in durations. L1 and L2 bilinguals had faster onset times for cognate nouns when compared to non-cognates in single word and noun phrase production. However, the results of the present study did not show a systematic pattern for the role of cognate status on articulatory durations. L2 bilinguals showed marginally longer durations for cognate nouns compared to non-cognates in bare naming. On the contrary, in noun phrase production L2 bilinguals had significantly shorter naming durations for noun phrases containing cognates when compared to noun phrases containing non-cognate nouns. Given the small magnitude of the effect sizes and their diverging directions, the present results cannot clearly identify how cognate status can influence bilingual articulatory durations.

Finally, the present study shows that noun frequency status influences naming latencies as well as durations. High-frequency nouns had shorter latencies and durations than low-frequency nouns in the context of single or multi-word utterances. Thus, word-specific frequency affected not only naming latencies, but also articulatory processes in qualitatively the same way. This result replicates the well-documented frequency effect in naming latencies and is also in line with various studies showing shorter durations for high versus low frequency words (Gahl, 2008; Wright, 1979). Thus frequency can influence speech production beyond preparation processes extending into articulation. Altogether, the result show that variables important for lexical access affect stages before and after the initiation of speech and thus are in line with a cascaded articulation view in which early speech production processes can already affect articulation online.

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