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Are similar control processes implemented during single and dual language production? Evidence from switching between speech registers and languages

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Abstract

To investigate whether similar control processes are used during single and dual language production, we compared register switching (formal and informal speech in the same language) vs. language switching (French and English). The results across two experiments showed a positive correlation of overall register- and language-switch costs and similar formal French switch costs across the two switching tasks. However, whereas increasing the cue-to-stimulus interval resulted in a reduction of language-switch costs, register-switch costs were unaffected by the interval manipulation. This difference in switch-cost pattern indicates that control processes are not entirely identical during single and dual language production.

Introduction

An important bilingual process is that of language control, which reduces non-target language interference and ensures selection of target-language words. Many studies have investigated to what degree such control is similar to non-linguistic executive control (e.g., Branzi, Calabria, Boscarino & Costa, 2016; Declerck, Grainger, Koch & Philipp, 2017b; Jylkkä, Lehtonen, Lindholm, Kuusakoski & Laine, 2018; Stasenko, Matt & Gollan, 2017). These studies typically compare the costs of switching between two languages with the cost of switching between two non-linguistic tasks. These language- and task-switching costs are assumed to reflect inhibitory suppression of the non-target language or task on the previous trial persisting into the current trial (e.g., Meuter & Allport, 1999; Green, 1998; for a review, see Declerck & Philipp, 2015a). Because the literature on domain-general bilingual language control has led to conflicting results across and even within studies, we wanted to take a step back and see if control processes are even shared within the same domain (i.e., language processing). To this end, we compared performance of French–English bilinguals on a language switching task (i.e., switching between their two languages), as a way to measure control processes in a dual language context, and a newly developed register-switching task (i.e., switching between formal and informal language within the same language), as a way to measure control processes in a single language context.

A multitude of studies have shown that control processes, measured with the switching task, are implemented during both single (e.g., Finkbeiner, Almeida, Janssen & Caramazza, 2006; Sikora & Roelofs, 2018; Yeung & Monsell, 2003) and dual (e.g., Bonfieni, Branigan, Pickering & Sorace, 2019; Costa, Santesteban & Ivanova, 2006; Meuter & Allport, 1999) language production. However, few studies have directly compared control processes in a single and dual language context (Abutalebi, Annoni, Zimine, Pegna, Seghier, Lee-Jahnke, Lazeyras, Cappa & Khateb, 2008; Declerck et al., 2017b; for comparisons of different types of bilingual language control, see also Dias, Villameriel, Giezen, Costello & Carreiras, 2017; Kirk, Kempe, Scott-Brown, Philipp & Declerck, 2018). Declerck et al. (2017b) compared the costs of switching between naming pictures in each of two languages (French–English) versus the costs of switching between picture and category naming within the same language, while the language-switching task and within-language switching task were otherwise methodologically identical. The switch costs in the language-switching task positively correlated with the switch costs in the within-language switching task, and there was no statistical difference between the reaction time (RT) switch costs in the two switching tasks. Yet, in error rates, the cost of switching between languages was larger than the cost of within-language switching between picture naming and category naming.

Along the same lines, Abutalebi et al. (2008) conducted an fMRI study in which language switching (German-French) was compared to switching between two linguistic tasks in the same language (picture and verb naming in German). Their results, which focused on German picture naming, showed no difference in the behavioral data. However, there was a larger involvement of the left caudate and left anterior cingulate cortex in language switching.

Taken together, these studies show that, within the same domain, control processes overlap to a certain degree, but might not overlap entirely. In the current study, we further investigated whether similar control processes are implemented during single and dual language processing. To this end, we designed a novel within-language switching task, namely a switching task between two different speech registers.

Speech registers are different varieties of language used in different social circumstances and entail using different vocabulary subsets, among other differences (e.g., differences in linguistic complexity, connotation, and specificity). We employed the two most frequently used speech registers: the formal and the informal register. The formal register is typically used in a professional setting and is characterized by a less personal use of language, whereas the informal register is typically used with people that the speaker is close with (i.e., friends and family) and is characterized by a more colloquial use of language. Control processes of these speech registers are assumed to be necessary because a speaker would not want to use the wrong speech register in a certain context (e.g., informal register in a job interview).

Next to naming pictures with formal (e.g., "garçon" [French for boy]) or informal names (e.g., "gamin" [French for kid]), the French–English bilinguals in our study also had to name pictures in formal French (e.g., "garçon") or English (e.g., "boy") in the language-switching task. If similar control processes are implemented during single and dual language production, then there should be a significant positive correlation between the switch costs across the two switching tasks. Additionally, since formal French is used in both switching tasks, and thus are directly comparable, similar switch costs for formal French across the two switching tasks would indicate that similar control processes are used in the single and dual language contexts.

Finally, in Experiment 2, we also examined whether a similar switch cost pattern can be obtained across the two switching tasks by manipulating the Cue-to-Stimulus Interval (CSI), which entails a manipulation of the time between the presentation of the cue and the stimulus. Several prior studies have shown that increasing the CSI results in smaller language-switch costs (e.g., Costa & Santesteban, 2004; Fink & Goldrick, 2015; Ma, Li & Guo, 2016). This effect is one of the most investigated manipulations in the language-switching literature and has been interpreted as a measure of active preparation of control processes (e.g., Ma et al., 2016). If similar control processes are used during single and dual language contexts, the register- and language-switch costs should be similarly sensitive to a CSI manipulation.

Experiment 1

In Experiment 1, 24 French–English bilinguals performed a register-switching task and a language-switching task. This experiment had two goals. First, to examine whether switch costs would be observed when switching between speech registers (i.e., formal vs. informal French), as this had not yet been investigated. Second, we aimed to investigate whether there is an overlap in the control processes used when switching between speech registers and between languages.

Method

Participants

24 native French speakers, all students at Aix-Marseille University, that spoke English as their second language took part in the experiment (15 female, mean age = 23.7).[1] Prior to the experiment they were asked to fill in a language-history questionnaire and a French (Brysbaert, 2013) and English (Lemhöfer & Broersma, 2012) vocabulary test (see Table 1).

Stimuli

Similar to prior studies investigating language-switch costs (e.g., Costa & Satnesteban, 2004; Costa et al., 2006; Meuter & Allport, 1999) and switch costs across contexts (e.g., Declerck et al., 2017b; Stasenko et al., 2017), we used a relatively small number of stimuli, namely seven. The reason for using a relatively small number of stimuli is that we wanted the informal words to be known to most native French speakers, and none of the names could be cognates across languages or be related in form in French across the formal and informal counterparts (see Appendix for the stimulus list). These pictures had to be named throughout the experiment in formal (average frequency: 5.4 Zipf[2]; average number of syllables: 2.0; Ferrand, New, Brysbaert, Keuleers, Bonin, Méot, Augustinova & Pallier, 2010) or informal (average frequency: 4.2 Zipf; average number of syllables: 2.0) French in the register-switching task, and in (formal) French or English (average frequency: 5.1 Zipf; average number of syllables: 1.1; van Heuven, Mandera, Keuleers & Brysbaert, 2014) in the language-switching task (for an overview of the stimuli, see Appendix).[3]

The target speech register in the register-switching task was cued by a red or yellow frame around the stimuli for formal or informal French, respectively. The target language in the language-switching task was cued by a green or blue frame around the stimuli for French or English, respectively. The experiment was presented with E-prime and errors were coded online by the experimenter.

Procedure

The register- and language-switching task both consisted of a practice block of seven trials, followed by two experimental blocks of 112 trials each, with an equal number of trials for each speech register/language and an equal number of switch and repetition

[1]24 participants were examined, similar to other studies in which we investigated linguistic switch costs (e.g., Declerck et al., 2017a; Declerck et al., 2017b). To be sure that this results in enough power, a power analysis was conducted for data with random participants and items (Green & MacLeod, 2016) on a data set with a similar group of 60 French–English bilinguals. More specifically, 200 (Monte Carlo) simulations, as suggested by Brysbaert and Stevens (2018), were run using the simr package in R to see if language-switch costs could be observed with 24 participants and seven stimuli. This resulted in a 95% chance to observe language-switch costs with this sample size. We kept 24 participants to have an optimal chance of observing language- and register-switch costs.

[2]For information on Zipf, see van Heuven et al. (2014).

[3]It could be argued that there are slightly different meanings between formal-informal word pairs. However, the same could be said for specific word pairs across languages (i.e., translation-equivalent words). For example, the French word "cheveux", which means hair. Though its meaning is more specific than the English translation-equivalent, as it only relates to hair on the top of the head of a human.

Table 1. Overview of demographic information (SD in brackets).

	Experiment 1		Experiment 2	
	French	English	French	English
Age-of-acquisition	0.1 (0.6)	9.1 (1.9)	0.9 (3.4)	9.9 (2.2)
Currently used	79.6 (17.3)	20.4 (17.3)	70.8 (10.0)	29.2 (10.0)
Speaking	6.5 (0.6)	4.5 (0.8)	6.7 (0.4)	4.3 (0.9)
Reading	6.7 (0.6)	5.0 (1.1)	6.6 (0.5)	4.8 (1.1)
LexTALE	89.2 (6.5)	74.5 (9.6)	89.2 (3.8)	68.3 (9.3)

The information consists of the average age of acquisition of each language, the average percentage of time the participants currently spoke each language, the average self-rated scores for speaking and reading both languages (1 being very bad and 7 being very good), and the results for the French and English vocabulary test (LexTALE).

trials for each speech register/language in each block. The order of switching task (i.e., register and language switching) was counterbalanced across participants.

In each block, every trial started with the simultaneous presentation of cue and stimulus. Both remained on the screen until a response was registered. Finally, a pause of 600 ms would occur immediately after speech onset, which was followed by the next trial.

Analysis

The first trial of each block and the error trials (i.e., responses in the wrong language and semantically incorrect responses) were excluded from RT analyses, as were trials following an error trial and voice key malfunctions (noted by the experimenter, a trained research assistant, in real time). Furthermore, RTs larger or smaller than two standard deviations from the mean (per participant and per switching task) were discarded as outliers. Taking these four criteria into account, a total of 11.6% of the register switching RT data and 12.6% of the language switching RT data were excluded from analysis.

The RT and error data were analyzed using linear or logistic mixed-effects regression modeling, respectively (Baayen, Davidson & Bates, 2008; Jaeger, 2008). Both participants and items were considered random factors with all fixed effects and their interactions varying by all random factors (Barr, Levy, Scheepers & Tily, 2013).[4] Finally, *t*- and *z*-values larger or equal to 1.96 were deemed significant (Baayen, 2008).

Results and discussion

Register switching

As can be seen in Table 2, the error rate 2 (formal vs. informal) × 2 (switch vs. repetition) analysis showed no significant effect of speech register, transition, or their interaction. As can be seen in Table 3, the RT analysis showed a main effect of speech register, with faster responses during formal (1026 ms; see Table 4) than during informal French (1208 ms). There was also a main effect of transition, with repetition-trial responses (1085 ms) being faster than switch-trial responses (1145 ms).[5] The interaction between speech register and transition was not significant.

Language switching

As can be seen in Table 2, the error rate 2 (French vs. English) × 2 (switch vs. repetition) analysis showed no significant effect of language, transition, or the interaction. As can be seen in Table 3, the RT analysis showed only a main effect of transition, with repetition-trial responses (938 ms) being faster than switch-trial responses (1043 ms).[5]

Switch cost correlations

To get a sense of the degree of overlap between the mechanisms used in register and language switching, we also examined the correlations of the average register- and language-switch costs. The results showed a significant positive relationship in RT between register- and language-switch costs, r(24) = .570, $p = .004$.

Formal French responses in the context of register switching vs. language switching

When comparing formal French responses across the two switching tasks in a 2 (speech register vs. language switching) × 2 (switch vs. repetition) analysis, no switch costs difference was observed between the tasks for RT, $b = 11.82$, SE = 23.83, $t = 0.50$, and error rates, $b = 0.40$, SE = 0.39, $z = 1.03$.

Discussion

Taken together, Experiment 1 showed that switching between speech registers produced switch costs, which was also the case for switching between languages with the same stimuli. This result is, to our knowledge, the first demonstration of control processes applied to words from different registers.

With regard to our main focus, the correlation analysis showed a substantial positive correlation coefficient between register- and language-switch costs. Additionally, similar switch costs were observed for formal French across the two switching tasks. These findings indicate an overlap in the control processes implemented in a single and dual language context.

One difference across the two switching tasks was that an overall speech register difference was observed, whereas no substantial language difference was observed. This could be due to a larger difference in base activation between speech registers than between languages. Alternatively, it could be that the first

[4]To circumvent convergence issues in the RT analyses for the language switching data, we determined the maximal random effects structure permitted by the data (cf. Barr et al., 2013), which led to a model without the random by-item slope for the interaction between language and transition.

For the error analyses, both the language switching and register switching analysis model contained random intercepts. Only the by-participant slope for the main effect of transition was included.

[5]There was no effect of switching task order on language- or register-switch costs, *ts* < 1.39.

Table 2. *b*-, *z*-values, and standard errors of error analyses.

Factors	*b*-value	SE	*z*-value
Experiment 1			
Register switching			
Transition	0.24	0.29	0.83
Register	0.49	0.27	1.80
Transition × Register	0.01	0.39	0.03
Language switching			
Transition	0.05	0.30	0.18
Language	0.05	0.27	0.17
Transition × Language	0.18	0.35	0.51
Experiment 2			
Register switching			
Transition	0.55	0.29	1.92
Register	0.95	0.42	2.27
CSI	0.27	0.30	0.91
Transition × Register	0.23	0.54	0.43
Transition × CSI	0.27	0.39	0.70
Register × CSI	0.30	0.53	0.56
Transition × Register × CSI	0.09	0.71	0.12
Language switching			
Transition	0.70	0.43	1.61
Language	1.41	0.79	1.78
CSI	0.23	0.48	0.48
Transition × Language	1.40	1.29	1.09
Transition × CSI	0.10	0.58	0.17
Language × CSI	0.18	1.03	0.18
Transition × Language × CSI	1.29	1.52	0.85

Table 3. *b*-, *t*-values, and standard errors of RT analyses.

Factors	*b*-value	SE	*t*-value
Experiment 1			
Register switching			
Transition	60.53	25.76	2.35
Register	207.57	52.25	3.97
Transition × Register	24.52	34.84	0.70
Language switching			
Transition	123.07	21.35	5.76
Language	13.84	29.32	0.47
Transition × Language	29.66	29.24	1.01
Experiment 2			
Register switching			
Transition	54.05	22.37	2.42
Register	209.28	55.02	3.80
CSI	50.69	27.84	1.82
Transition × Register	0.91	30.00	0.03
Transition × CSI	23.87	29.89	0.80
Register × CSI	4.82	29.79	0.16
Transition × Register × CSI	47.36	41.97	1.13
Language switching			
Transition	85.86	18.93	4.54
Language	32.89	17.66	1.86
CSI	18.12	26.55	0.68
Transition × Language	4.20	21.98	0.19
Transition × CSI	49.75	21.86	2.28
Language × CSI	50.07	21.92	2.28
Transition × Language × CSI	62.96	31.05	2.03

language (L1) was inhibited relative to the second language (L2) to increase overall performance in mixed language blocks (cf. Christoffels, Firk & Schiller, 2007; Gollan & Ferreira, 2009; for a review, see Declerck, 2019), whereas no such process occurred in the register switching task. At this point it is difficult to conclusively say which of these two accounts best explains our data pattern.

Finally, while not the main focus of the current study, it is interesting that no asymmetrical switch costs, which entails larger switch costs for the more dominant response relative to the less dominant response, were obtained with either switching paradigm. This could be seen as evidence that no inhibitory control was implemented, since asymmetrical switch costs are taken as a marker of inhibitory control (e.g., Green, 1998; Meuter & Allport, 1999). However, many bilingual studies have shown absent asymmetrical switch costs with balanced (e.g., Costa & Santesteban, 2004) and unbalanced bilinguals (e.g., Christofells et al., 2007; for a review, see Bobb & Wodniecka, 2013). Some studies even found reversed asymmetrical switch costs (e.g., Declerck, Stephan, Koch & Philipp, 2015), with larger L2 than L1 switch costs. Hence, it seems unclear at this point how reliable asymmetrical switch costs are.

Experiment 2

In Experiment 2, we wanted to replicate the findings of Experiment 1, and at the same time further explore whether control processes overlap during single and dual language processing. To this end, we manipulated the CSI in the register- and language-switching task. Several studies have shown that increasing the CSI decreases language-switch costs (e.g., Costa & Santesteban, 2004; Fink & Goldrick, 2015; Ma et al., 2016). This effect is generally interpreted as a measure of active preparation of control processes. If control processes overlap during single and dual language processing, as suggested by Experiment 1, then register- and language-switch costs should be similarly sensitive to the CSI manipulation.

Method

Participants

24 different native French speakers that spoke English as their second language took part in the experiment (16 female, mean age = 22.2). Prior to the experiment they were asked to fill in

Table 4. Overall RT in ms and percentage of errors (PE) of Experiment 1, as a function of speech register (formal vs. informal)/language (French vs. English) and transition (switch vs. repetition)

		Speech registers		Languages	
	Transition	Formal	Informal	French	English
RT	Switch	1061	1230	1037	1050
	Repetition	990	1186	948	928
PE	Switch	1.6	2.5	2.9	2.6
	Repetition	1.7	2.7	2.1	2.2

the same language-history questionnaire and vocabulary tests as in Experiment 1 (see Table 1).

Stimuli and procedure

The stimuli were identical to those used in Experiment 1. The procedure was also similar to that used in Experiment 1, with the only difference being that one of the experimental blocks, for both the register- and language-switching task, used a long CSI (800 ms), whereas the other block had no CSI (0 ms). In the long CSI block, the cue was presented for 800 ms, followed by the presentation of both cue and stimulus, which remained on the screen until a response was registered. Finally, a pause of 600 ms would occur immediately after speech onset, which was followed by the next trial. In the no CSI blocks, a similar trial procedure was used, except that a blank screen was shown for 800 ms instead of the cue being present for this time in the long CSI blocks. The order of CSI blocks was counterbalanced across participants.

Analysis

The same outlier criteria were used as in Experiment 1. Taking these criteria into account, a total of 14.3% of the register switching RT data and 10.2% of the language switching RT data were excluded from analysis.

In this experiment, we also used linear or logistic mixed-effects regression modeling, respectively for RT and error rates. Both participants and items were again considered random factors with all fixed effects and their interactions varying by all random factors (Barr et al., 2013).[6]

Results and discussion

Register switching

As can be seen in Table 2, the error rate 2 (formal vs. informal) × 2 (switch vs. repetition) × 2 (no CSI vs. long CSI) analysis showed a main effect of speech register, with a smaller percentage of errors in formal (1.8%; see Table 5) than in informal French trials (4.2%). There were no other significant effects.

As can be seen in Table 3, the RT analysis showed a main effect of speech register, with faster responses during formal (999 ms) than during informal French (1188 ms), and transition, with repetition-trial responses (1069 ms) being faster than switch-trial responses (1115 ms).[7] None of the other effects were significant.

Language switching

As can be seen in Table 2, the error rate 2 (French vs. English) × 2 (switch vs. repetition) × 2 (no CSI vs. long CSI) analysis showed no significant effects.

As can be seen in Table 3, the RT analysis showed a main effect of transition, with faster repetition-trial responses (898 ms) than switch-trial responses (967 ms).[7] The interaction between language and CSI was significant, with a larger difference between French (979 ms) and English (943 ms) when there was no CSI than when French (910 ms) and English (898 ms) were produced with a long CSI. The interaction between transition and CSI was also significant, with smaller switch costs when the CSI was long (58 ms) than when there was no CSI (80 ms). The three-way interaction was also significant, with similar French switch costs when there was no CSI (82 ms) than when the CSI was long (91 ms) and larger English switch costs when there was no CSI (78 ms) than when CSI was long (27 ms). None of the other interactions were significant.

Overlap between register- and language-switch costs

Similar to Experiment 1, we also examined the correlations of the average register- and language-switch costs per CSI condition. The results showed a significant positive relationship in RT between register- and language-switch costs with a long CSI, $r(24) = .465$, $p = .022$, and with no CSI, $r(24) = .609$, $p = .002$.

Formal French responses in the context of register switching vs. language switching

When comparing formal French responses across the two switching tasks in a 2 (speech register vs. language switching) × 2 (switch vs. repetition) × 2 (no CSI vs. long CSI) analysis, no switch cost differences were observed between the switching tasks for RT, $b = 30.03$, $SE = 37.44$, $t = 0.80$, and error rates, $b = 1.02$, $SE = 1.31$, $z = 0.78$. Moreover, the CSI effect on switch costs was also similar across the two switching tasks for RT, $b = 11.45$, $SE = 35.10$, $t = 0.27$, and error rates, $b = 1.56$, $SE = 1.54$, $z = 1.03$.

Discussion

In sum, the correlation coefficients between register- and language-switch costs showed a positive relationship, and a similar switch cost pattern was observed with formal French during speech register switching and language switching. These results are in line with Experiment 1 and indicate an overlap of control processes in a single and dual language context.

However, smaller English switch costs were found with a long CSI, whereas no CSI effect was observed in the speech register task. These different patterns indicate that control processes implemented during single and dual language production do not entirely overlap. More specifically, this result indicates that

[6]To circumvent convergence issues in the RT analyses for the language switching data, we determined the maximal random effects structure permitted by the data (cf. Barr et al., 2013), which led to models with random intercepts and by-participant slopes for the main effects of language, transition, and CSI. Additionally, also random by-item slopes were included for the main effects of language and transition. For the Register switching data, we also had to take out the random by-item slope of language.

For the error analyses, both the language switching and register switching analysis model only contained a by-participant intercept. The same pattern was observed with a random by-item intercept.

[7]There was no effect of switching task order on language- or register-switch costs, $ts < 0.63$. Additionally, there was no interaction between switching task order, CSI, and language- or register-switch costs, $ts < 0.91$.

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Table 5. Overall RT in ms and percentage of errors (PE) of Experiment 2, as a function of speech register (formal vs. informal)/language (French vs. English), transition (switch vs. repetition), and CSI (no CSI vs. long CSI)

		Speech registers				Languages			
		Formal		Informal		French		English	
	Transition	No CSI	Long CSI	No CSI	Long CSI	No CSI	Long CSI	No CSI	Long CSI
RT	Switch	1047	1018	1239	1155	1020	957	982	912
	Repetition	991	943	1207	1149	938	866	904	885
PE	Switch	1.6	2.4	5.1	5.1	1.5	1	2.4	3.3
	Repetition	1.2	2.1	3.0	3.9	0.3	4.5	1.2	1.5

control processes can actively be prepared in a dual language setting, as has been observed in prior studies (e.g., Costa & Santesteban, 2004; Fink & Goldrick, 2015; Ma et al., 2016), but not necessarily in a single language setting.

General Discussion

The goal of the present study was to investigate whether control processes implemented in a dual language context, measured by language switching, are similar to those implemented in a single language context, measured by register switching. The results showed substantial positive correlations between register- and language-switch costs, and similar formal French switch costs across the two switching tasks. Yet, language-switch costs were reduced with a long CSI relative to when there was no CSI for the non-dominant language (English), while register-switch costs were not affected by the CSI manipulation.

Control processes in single vs. dual language production

The substantial correlations of register- and language-switch costs indicate that the control processes implemented during dual language processing are similar, to a certain degree, to those implemented in a single language context. Additionally, the similar switch costs of formal French during register switching and language switching also provides evidence to this effect. This is also the case for the similar effect of CSI on both register- and language-switch costs with formal French.

While a similar CSI effect on register- and language-switch costs was observed for formal French, the CSI manipulation of Experiment 2 indicates that there is also a difference between control processes during single and dual language production. The smaller English-switch costs with increasing CSI shows that it is possible to actively prepare for an upcoming language. In turn, control can be initiated for that language. This does not seem to be the case for speech registers, as there was no modulation of register-switch costs due to CSI. However, it should be noted that such an effect might occur with register switching in L2, something that was not tested in this study.

Overall, the current study demonstrates that control processes implemented during single and dual language production partially overlap (see also Abutalebi et al., 2008; Declerck et al., 2017b). With respect to similarities in control processes between single and dual language production, we assume that this is due to control processes occurring between task schemas, which are mental devices that are implemented to achieve task-specific goals (e.g., speaking a language, speaking in a speech register, or performing a task; cf. Green, 1998; see also Schwieter & Sunderman, 2008), during both single and dual language production since these control processes are assumed to be domain general.

One probable locus of differences in control processes between single and dual language production would be at the phonology level. There are substantial phonological differences between French and English, whereas formal and informal French both rely on the same set of phonemes. Indeed, prior research has indicated that phonology plays an important role during bilingual language control (e.g., Declerck & Philipp, 2015b; Gollan, Schotter, Gomez, Murillo & Rayner, 2014), possibly through interference resolution between language-specific phonemes. Hence, it could be that differences between single and dual language production were due to control occurring at the phonological level during dual language production, whereas this might not be the case for control processes during single language production. With respect to our CSI results, this would mean that during language switching (i.e., dual language production), preparation of phonological representations is possible, resulting in smaller language-switch costs. This is not the case during register switching (i.e., single language production), as no control processes are necessary at the phonological level.

Register-switch costs

The current study is the first to observe register-switch costs. These costs provide explicit evidence that control processes are required during the production of different speech registers. The observed register-switch costs also indicate that lexical representations contain tags for register membership, since language-switch costs are typically explained with mental representations of language membership, such as language tags (e.g., Green, 1998) or language nodes (Grainger, Midgley & Holcomb, 2010). Yet, we note that the only study of speech register processing known to us concluded that register (and dialect) membership are represented differently from language membership (Melinger, 2018). Melinger (2018) found that, in a picture-word interference experiment, distractors belonging to different speech registers (and different dialects) produced interference effects, differently from the facilitation produced by translation-equivalent distractors in the studies of Costa and colleagues (Costa & Caramazza, 1999; Costa, Miozzo & Caramazza, 1999). Due to this conflicting evidence, it is unclear at the moment whether register membership is tagged to lexical entries. Hence, more research will be needed to further investigate this issue.

However, since the formal French words used in the current study were more frequent than the informal French words, it could be that these switch costs were due to a difference in frequency. Switch costs have been observed in prior research when switching between high and low frequency words (Finkbeiner et al., 2006). Yet, we do not think that this was the reason switch costs were observed in this study. First, both formal and informal words used in this study were high frequency words (cf. Ferrand et al., 2010; van Heuven et al., 2014). So, while there might have been a slight difference in frequency, this should not have caused substantial frequency-switch costs. Additionally, Finkbeiner et al. (2006) observed larger switch costs for the high than the low frequency words. In the current study, no significant switch cost difference was observed between formal and informal words across both experiments. Hence, it seems unlikely that the switch costs observed in the register switching task were due to a difference in frequency.

Conclusion

Taken together, in the current study we observed evidence for switch costs when switching between formal and informal language. Correlation analyses showed a strong positive relationship between these register-switch costs and language-switch costs, as did similar formal French switch costs across the two switching tasks. A CSI manipulation, however, led to different patterns of register- and language-switch costs. These data indicate that control processes are partially shared across single and dual language production.

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Appendix

Stimuli list

English	Formal French	Informal French
car	voiture	bagnole
child	enfant	gamin
dog	chien	cleps
gun	pistolet	flingue
horse	cheval	canasson
house	maison	baraque
money	argent	fric