languages

MDPI

Article

What Sentence Repetition Tasks Can Reveal about the Processing Effort Associated with Different Types of Code-Switching

Julia Hofweber [1,2] and Theodoros Marinis [3,*]

[1] Faculty of Philosophy, Northeastern University London, London E1W 1LP, UK
[2] Department of Psychology and Human Development, University College London, London WC1E 6BT, UK
[3] Department of Linguistics, University of Konstanz, 78457 Konstanz, Germany
* Correspondence: theodoros.marinis@uni-konstanz.de

Abstract: In this study, we explored the linguistic consolidation processes associated with bilingual processing using an experimental paradigm novel in bilingualism research, i.e., sentence repetition. We tested 46 L1-German L2-English bilinguals immersed in the L2 context. Firstly, we compared participants' sentence repetition accuracy in single-language sentences and in sentences involving code-switches. Secondly, we investigated the processing cost associated with different types of code-switching, i.e., *alternation*, *insertion*, and *dense* code-switching. Finally, we assessed the following potential predictors of repetition accuracy: regular usage of different code-switching types, executive functions (working memory and inhibitory control), as well as relevant bilingualism variables (proficiency, dominance, and immersion). Our first finding was that bilinguals displayed reduced repetition accuracy in sentences involving code-switches compared to single-language sentences, but only when the single-language sentences were in the participants' L1. This suggests that any processing costs associated with code-switching are modulated by bilinguals' language background. Moreover, bilinguals' poor performance in L2 compared to L1 single-language sentences, despite reporting high levels of L2 exposure frequency, highlights the importance of age of acquisition and dominance profiles for language processing. In terms of code-switching, our results revealed that bilinguals' repetition accuracy differed across different types of code-switching. The processing effort associated with different types of code-switching in the sentence repetition task was primarily driven by the structural depth and the degree of mixing of the involved code-switch, i.e., *dense* forms of code-switching involving high levels of linguistic co-activation were harder to repeat than *alternation*s involving unintegrated language switching. This effect partially converged with bilinguals' sociolinguistic practices because bilinguals also reported lower exposure frequency to *dense* code-switching, but no direct correlations were observed at the level of individual differences. In terms of general cognitive functions, repetition accuracy was modulated by working memory but not by inhibitory control. By investigating this issue, we hope to contribute to our understanding of language processing in the face of cross-linguistic consolidation processes.

Keywords: multilingualism; bilingualism; code-switching; sentence repetition; language processing

Citation: Hofweber, Julia, and Theodoros Marinis. 2023. What Sentence Repetition Tasks Can Reveal about the Processing Effort Associated with Different Types of Code-Switching. *Languages* 8: 70. https://doi.org/10.3390/languages8010070

Academic Editor: Luis López

Received: 1 August 2022
Revised: 6 January 2023
Accepted: 2 February 2023
Published: 28 February 2023

1. Introduction

1.1. Background

In this study we explored the linguistic processing cost associated with different types of code-switching using a novel sentence repetition paradigm. Bilinguals adapt the relative activation levels, usage, and processing of languages to the communicative contexts they find themselves in (Grosjean 1989, 2001). When in the presence of monolinguals, they operate in single-language modes, i.e., they stick to only one of their available languages. However, in the presence of other bilinguals with the same language combination, bilinguals commonly engage in bilingual modes allowing them to opportunistically draw upon linguistic resources (lexical items or grammatical structures) from either language. Such bilingual speech involves code-switching, i.e., the mixing of elements from two or more languages within the same utterance for communicative purposes (Bhatt and Bolonyai 2011). An example of such code-switching would be the following German–English bilingual sentence:

(1) Ich gebe dem Kinobesuch heute a miss.
"I give the cinema visit today a miss."

Despite the frequent occurrence of language mixing in bilingual conversations, the processing effort associated with code-switching is poorly understood. It is for instance unclear to what extent the constant monitoring of and consolidation of potentially conflicting lexical items and grammatical structures from different languages may incur a linguistic processing cost. This raises the question of whether sentences involving code-switching are harder to process than single-language sentence. To date, the evidence is mixed. Studies of experimentally induced language switching have revealed increased naming latencies at switch points, but this effect is modulated by a range of bilingualism variables (Moreno et al. 2009). A seminal study by Meuter and Allport (1999) for instance reported greater switch costs when switching back to the dominant L1 due to the heightened inhibitory cost associated with suppressing the L1 in the first place. This "switch cost asymmetry" effect has however been shown to be reduced in highly proficient balanced bilingualism (Costa and Santesteban 2004).

There are also several studies that do not support the notion of increased costs associated with language switching and mixing. A study by Kleinman and Gollan (2016) suggests that naturalistic "bottom-up" forms of code-switching may not be costly. In a similar vein, Gardner-Chloros et al. (2013) investigated pausing in authentic conversations, taking pausing as an indicator of increased processing effort. They found no difference in the amount of hesitations involved in bilingual versus single-language conversations amongst Cypriot Greek–English bilinguals. Crucially, the amount of pausing was modulated by a range of lexical, grammatical, and pragmatic factors.

Studies investigating the neural correlates of experimentally induced language switching suggest that whilst language switching triggers an N400 indicative of increased lexico-semantic consolidation efforts, the picture is complex because this effect is modulated by a range of bilingualism-related factors. In one of the first EEG studies on code-switching by Moreno et al. (2002), code-switching elicited an increased N400 amplitude, but the observed increase was comparable to that associated with semantic violations in single-language sentences, so it may be due to unexpectedness rather than cross-linguistic consolidation specifically. Crucially, the code-switching effect was not equal across participants but depended on bilinguals' proficiency levels. The importance of another factor, i.e., bilinguals' sociolinguistic profile, was highlighted by a study by Gosselin and Sabourin (2021), which found that increased lexico-semantic processing costs (N400) following code-switches only occurred in bilinguals who did not habitually engage in code-switching. Bilinguals who regularly code-switched did not incur this cost.

Existing studies suggest that code-switching per se is not necessarily more effortful but that the processing effort is modulated by a range of factors, such as bilinguals' proficiency and sociolinguistic practices. Moreover, recent studies investigating the amount of executive function involvement, i.e., the inhibition required to suppress non-target languages, in code-switching (Hofweber et al. 2016, 2020a) have highlighted the importance of differentiating between different types of code-switching. These studies suggest that *dense* code-switching requires high levels of monitoring of cross-linguistic co-activation, whilst *alternation* involves high levels of inhibition and less monitoring (Hofweber et al. 2016, 2020a; Han et al. 2022). In this study, we therefore explore the impact of the degree of cross-linguistic structural integration involved in different types of code-switching. Based on a review of existing sociolinguistic corpora, Muysken (2000) identified three prevalent patterns of code-switching that differ in their degree of language mixing and resulting demands to linguistic processing (Muysken 2000), as illustrated in examples (2) to (4).

Alternation describes code-switching involving switching between structurally independent sequences of languages, as in example (2). *Insertion* describes the integration of lexical items from one language into the grammatical framework of another language (example 3). Finally, *dense* code-switching would better be described as mixing rather than switching because languages remain co-activated, resulting in the integration of linguistic items and features at both the lexical and grammatical levels (example 4).

(2) *You know*, wir sitzen da oft stundenlang.
you know, we sit there often for hours
"*You know*, we often sit there for hours."

(3) Sie benutzt *special ingredients* für das Gericht.
she uses *special ingredients* for the dish.
"She uses *special ingredients* for the dish."

(4) Ich wollte nur *sorry* sagen *to her*.
I wanted just *sorry* say *to her*.
"I just wanted to say *sorry to her*."

It has been argued that the more languages are kept separate, the less monitoring and cross-linguistic consolidation is required (Muysken 2000; Green and Abutalebi 2013; Green and Wei 2014; Hofweber et al. 2016). *Alternation* between languages involves less simultaneous co-activation and greater levels of language separation, so could be predicted to be least effortful from the point of view of cross-linguistic integration. At the other end of the spectrum, *dense* code-switching could be viewed as most effortful from the point of view of cross-linguistic integration and monitoring because it involves language mixing at all levels of linguistic processing (Muysken 2000; Hofweber et al. 2016). During *insertion*, bilinguals use the grammatical structure of only one language (the matrix language) and occasionally slot lexical items from another language into the structural framework of the matrix language. Hence, *insertion* is somewhere in between the two extreme ends of the continuum because the two languages are co-activated at the lexical level, but the grammar of the non-matrix language is inhibited. In example (3) the matrix language is German, and the English noun phrase is integrated into German word order.

The most intense form of code-switching, *dense* code-switching, requires bilinguals to manage cross-linguistic co-activation not only at the lexical level but also at the grammatical level. In the original framework by Muysken (2000), *dense* code-switching was labelled as "*congruent lexicalisation*", whilst recent processing models of code-switching favour the term "*dense* code-switching" (Green and Wei 2014). A detailed list of classification criteria is provided by Deuchar et al. (2008). These criteria all indicate co-activation at both structural and lexical levels, and include qualitative factors, such as switches involving grammatical function words, mixed word orders, mixed-language idiomatic expressions, switching triggered by congruent structures or lexical items (cognates), or a high quantitative incidence of code-switches per utterance. The example given in (4) fulfils the qualitative criterion of using mixed-language idiomatic terms (English term translated into German), as well as displaying evidence of mixed-language word order (utterance follows partially English, partially German word order). Quantitatively, it can also be said that two switches within a relatively short utterance is quite a high incidence of switching. Although at first sight *dense* code-switching seems random, bilinguals closely follow the sociolinguistic practices of their communities or networks, even if those emergent conventions will be fluid and constantly negotiated ad hoc in conversations. It is predicted that the management of such high levels of linguistic co-activation will be effortful.

The prediction that *dense* code-switching is hardest from the point of view of cross-linguistic integration is in line with the observation about the occurrence patterns of these types of code-switching, namely that all bilinguals engage in *alternation* and *insertion* to some extent, but *dense* code-switching is rare and limited to "expert" bilinguals with high levels of proficiency in both languages or from communities with long-standing traditions of multilingual practices (Muysken 2000). *Dense* code-switching is also more common in closely related languages that could be hypothesised to be "easier" to consolidate (Muysken 2000). To some extent, our considerations about different code-switching types, thus, link back to the search for "constraints" in early code-switching research, which aimed to identify which code-switching types are "universally" (im)possible to process and produce (cf. Muysken 2000 for a detailed discussion). However, rather than taking an absolutist perspective, we explore this issue from a probabilistic perspective, assuming that, although all types of code-switching are theoretically possible and observed in sociolinguistic corpora, they may differ in the associated processing effort, which may in turn affect their occurrence frequency.

A useful task that is indicative of the processing effort associated with different linguistic structures is the sentence repetition task (MacDonald and Christiansen 2002; Marinis and Armon-Lotem 2015; Klem et al. 2015). Although sentence repetition has been suggested to be an insightful experimental task for studying code-switching (Gullberg et al. 2009), there is a dearth of research drawing upon sentence repetition to investigate sentence processing in sentences with code-switches. Nevertheless, the few existing code-switching studies using sentence repetition paradigms have revealed insightful effects with respect to different code-switching types. In a study conducted by Clyne (1972), German–English bilinguals repeated 32 sentences that involved code-switches. The code-switching stimuli were manipulated to occur either at the clause boundary or within the clause, and repetition accuracy turned out to be lower for highly integrated code-switches within clauses than for switching at the clause boundary. Although this study was not based on Muysken's (2000) code-switching typology, the categories map onto the three code-switching types to some extent: it could be argued that switching between clauses is more akin to *alternation*, whilst switching within clauses is more similar to what happens during *insertion* and *dense* code-switching. Hence, Clyne's (1972) findings suggest that *alternation*-like code-switches involving less cross-linguistic integration may be easier to repeat than more integrated *dense* forms of code-switching. The second study using sentence repetition to investigate the processing of code-switches (Azuma and Meier 1997) found higher repetition accuracy for code-switches involving open-class items than for code-switches involving closed-class items, such as functions words. Given that the involvement of function words is a classification marker for *dense* code-switching (Deuchar et al. 2008), this study therefore also points in the direction that *dense* forms of code-switching are harder to repeat (and process).

Regarding its function of tapping into processing, the sentence repetition paradigm could be argued to conflate the processes of comprehension and production because participants need to both comprehend and then re-produce linguistic stimuli. However, we argue that this characteristic actually increases the ecological validity of sentence repetition tasks. The comprehension–production sequence of processing mirrors real-life communicative settings, in which language production often takes place in response to a previous turn. Code-switching in particular is a phenomenon strongly associated with real-time communication settings involving turn-taking. In fact, bottom-up communicative processes, such as code-switching, often emerge from interactive alignment processes between interlocutors (Kootstra et al. 2020), suggesting that code-switching involves the interaction of comprehension and production phenomena. Consequently, French and Jacquet (2004) argue that the processes underlying language production and comprehension are based on similar cognitive mechanisms involving spreading activation. This particularly applies to bottom-up bilingual mode forms of communication that do not involve the top-down a priori language selection characteristic of monolingual modes. Hence, in this study, we deliberately abstain from differentiating between comprehension and production, as these two aspects of processing are intrinsically interrelated in bilingual modes, i.e., code-switching. Sentence repetition was therefore considered to be a paradigm reflective of the contexts in which naturalistic code-switching arises.

1.2. The Current Study

In this study, we applied the experimental paradigm of sentence repetition to explore the effort associated with cross-linguistic consolidation processes during code-switching. We focused on intra-sentential code-switching, assuming that consolidation efforts will be greatest within the processing unit of a sentence. Firstly, we compared participants' sentence repetition accuracy in single-language sentences and in sentences involving code-switches. Secondly, we investigated the processing cost associated with different types of code-switching, i.e., *alternation*, *insertion*, and *dense* code-switching (Muysken 2000). Sentence repetition is considered to be a processing task, and as such, it indicates the processing effort associated with different linguistic structures (MacDonald and Christiansen 2002; Polišenská et al. 2015). Repetition tasks have previously been suggested to be useful experimental tasks for studying code-switching (Gullberg et al. 2009). Our methodological approach is novel because only a few studies to date have exploited the potential of the sentence repetition paradigm to explore bilingual processing in sentences with code-switches (Azuma and Meier 1997; Clyne 1972). The current study also investigated the predictors of bilingual processing efforts. We explored the extent to which the processing of the different code-switching patterns was determined by the following factors: (1) the degree of mixing/separation involved in each code-switching type, (2) bilinguals' sociolinguistic practices, (3) their proficiency in each language, and (4) their general cognitive abilities.

To measure the processing of different bilingual structures, we compared bilinguals' performance in a code-switching repetition task based on authentic stimuli sourced from sociolinguistic corpora. We instructed 46 L1-German L2-English bilinguals to repeat sentences involving examples of each code-switching type, as well as single-language sentences in each language, presented in a pseudorandomised order. All bilinguals were dominant in their L1 (German) but frequent users of their L2 (English) due to their long-term immersion in an L2 context in the UK. There is a potential "chicken and egg" relationship between exposure frequency and processing difficulty: sentence repetition accuracy of different bilingual structures (here, of code-switching) could be driven by either the regularity of usage of these structures or by the general processing effort associated with different bilingual structures. To assess the extent to which code-switching frequency is a predictor of sentence repetition performance, the bilinguals were asked to provide frequency judgements of their regular code-switching habits. To tease apart the effects of exposure frequency and processing effort, we assessed the convergence and divergence between bilinguals' accuracy in repeating different types of code-switching and the frequency judgements of their usage of different code-switching types, both at the group level and at the individual level.

Moreover, we investigated how a range of factors related to individual differences would affect sentence repetition accuracy. Firstly, we assessed bilinguals' executive functions, notably working memory performance, as assessed by a digit span task, and inhibitory control, as assessed by a flanker task. Working memory was deemed to be a potentially influential factor because there is an ongoing debate about the extent to which sentence repetition accuracy reflects working memory abilities or linguistic processing, with some studies emphasising the relationship between sentence repetition and linguistic processing (Klem et al. 2015; Okura and Lonsdale 2012) and other studies emphasising its connection with working memory (Ebert 2014). Teasing apart the relative influence of working memory and processing is crucial to debates about the relative contribution of language-specific versus general cognitive processing to bilingual processing and language processing in general. Hence, we explored to what extent the predicted processing difficulty of different code-switching types versus working memory predicts repetition accuracy. Inhibitory control was measured because numerous studies suggest an involvement of executive functions in the processing of code-switching (Adler et al. 2020; Hartanto and Yang 2016; Hofweber et al. 2016, 2020a, 2020b; Han et al. 2022; Lai and OBrien 2020; Verreyt et al. 2016). In addition, relevant bilingual demographic and linguistic background variables, such as proficiency, dominance, and immersion, were assessed in a detailed language history questionnaire.

Our overall research design was motivated by the following research questions:

Research questions

RQ1: What processing effort is associated with code-switching?

(a) Is there a difference in repetition accuracy between code-switching sentences and single-language sentences?

(b) Does sentence repetition accuracy differ as a function of code-switching type?

RQ2: If differential effects are observed, which factors explain performance variance?

(a) Does bilinguals' repetition accuracy converge with their sociolinguistic practices, i.e., exposure frequency?

(b) Which individual difference factors predict repetition accuracy in terms of bilinguals' general cognitive abilities and language background?

Predictions

RQ1 Predictions

(a) Sentences involving code-switching will be repeated less accurately than single-language sentences, but this effect may be modulated by bilinguals' background, notably proficiency, dominance, and immersion.

(b) The cross-linguistic consolidation efforts will increase with the level of mixing involved in the different code-switching types. Thus, sentence repetition accuracy should be highest in *alternation*s, followed by *insertion*s, followed by *dense* code-switching.

RQ2 Predictions

(a) Convergence between the frequency judgement and the sentence repetition accuracy will be indicative of exposure frequency driving sentence repetition performance. Divergence between the frequency judgement and the sentence repetition accuracy would suggest that other factors, such as processing effort, drive repetition accuracy.

(b) We predict that a range of background variables will modulate sentence repetition accuracy, but the exact nature of the modulation is exploratory due to the dearth of existing studies on sentence repetition and code-switching.

2. Materials and Methods

To measure the processing of different bilingual structures, we compared bilinguals' performance in a code-switching repetition task based on authentic stimuli sourced from sociolinguistic corpora. We instructed the 46 L1-German L2-English bilinguals to repeat sentences involving examples of each code-switching type, as well as single-language control sentences, presented in pseudorandomised order. To assess the predictors of sentence repetition performance, the bilinguals were asked to provide self-reports of their language proficiencies, as well as self-reports and real-time online frequency judgements of their regular code-switching habits and of frequency of use of each respective language. Importantly, we also assessed bilinguals' executive functions, notably working memory performance, as assessed by a digit span task, and inhibitory control, as assessed by a flanker task.

2.1. Participants

All 46 bilinguals in this study were L1-German L2-English bilinguals. Thus, the first language of all bilinguals was German. English was their L2 with a mean age of onset of 8.83 years (SD = 4.46). Their self-reported L1 proficiency was greater than their L2 proficiency, which was taken as an indication that they were L1-dominant, despite being frequent users of their L2 due to their long-term immersion in an L2 context in the UK. The bilinguals' mean age was 32, and they had all emigrated to the UK as adults after the age of 18. Most bilinguals had been immersed in the L2 English environment for an average of ten years (M = 9.32) at the time of testing, but there was considerable variation regarding the number of years of immersion (SD = 9.26). The bilinguals rated themselves as highly advanced in their English proficiency with a mean score of 6.37 out of 7 (SD = 0.60). Recruitment happened predominantly through the Facebook group "Germans in London", which is a loosely connected online community of practice exchanging advice regarding life in the UK and organising occasional social events. An adapted version of the Language History Questionnaire LHQ was used to collect linguistic background variables (Li et al. 2014).

2.2. Materials and Procedure

The experimental procedure lasted around 2 h, during which participants first completed the executive functions tasks (flanker task and digit span task), followed by the linguistic tasks (frequency judgement task and sentence repetition task), followed by the background questionnaire. The frequency judgement task and the flanker task were created using Psychopy 1.81 and presented on a 13-inch-screen HP beats-audio notebook. All tasks were administered in a quiet room.

Sentence repetition task. In this task, participants were asked to repeat the sentences exactly as heard. They were presented with 14 code-switches of each type: (1) *insertion* English into German, (2) *insertion* German into English, (3) *alternation*, and (4) *dense* code-switching, as well as with 14 single-language sentences (7 German and 7 English). Participants listened to each sentence only once. The sentence repetition task was administered in a quiet room (good acoustic conditions without distractions), but participants did not use headphones. We used Audacity to record participants' responses.

The code-switching stimuli (cf. Appendix A for full list of stimuli) were authentic utterances taken from existing German–English code-switching corpora (Eppler 2005; Eppler 2010; Clyne and Clyne and Clyne 2003), as well as from bilingual speech collected on social media fora. The majority of stimuli were sourced from a study conducted by Eppler (2005, 2010), who had collected data from 1st-generation immigrant bilinguals in urban contexts in the UK, so bilingual speakers had profiles comparable to the participants in the existing study. Although most code-switching stimuli were authentic examples of bilingual speech, the exception were code-switches in the category *insertion*s of German into an English matrix language. As we found too few instances of this direction of *insertion* in the corpora, artificial stimuli needed to be created. These were matched to the other direction of *insertion* in terms of the sentence function of the inserted element, so that the number of inserted subjects, verbs, and objects was identical for both directions of *insertion* (German into English and English into German). The code-switches were classified using Deuchar et al.'s (2008) classification criteria (cf. Hofweber et al. 2019 for a detailed discussion of the classification procedure). The stimulus sentences were matched in terms of number of words (M = 8) and syllable length (M = 13). Single-language sentences were created to match the code-switching sentence, although the average length of words and syllables per sentence was slightly lower (words M = 7; syllable M = 11). The sentences involving *alternation*s were matched for direction of switching (German to English vs. English to German).

The task was administered in an engaging self-paced PowerPoint format, based on a design developed by Marinis and Armon-Lotem (2015). Participants clicked on individual icons presented in sequence, each of which played a pre-recorded sentence that they were instructed to repeat. Responses, i.e., the sentence repetitions, were audio-recorded using the Audacity software. When scoring, we focused on accuracy, i.e., number of verbatim responses in relation to total responses. It should be noted that the total number of responses per condition was not always 14 because some responses had to be discarded due to poor audio quality.

Frequency judgement task. To assess participants' regular code-switching habits, we conducted a frequency judgement task in which participants were presented with sentences and asked to rate the frequency with which they came across these types of sentences when speaking to other German–English bilinguals. Similarly to the sentence repetition task, the code-switching stimuli of the frequency judgment task were authentic utterances taken from existing German–English code-switching corpora (see Appendix A for list of stimuli); however, the stimuli represented a different set of sentences. The stimuli were sourced from existing (written) corpora of German–English bilingual speech. All stimuli were subsequently voice-recorded by a German–English bilingual with language background similar to those of participants, i.e., a late German-L1 English-L2 bilingual immersed in an L2-English context. The same bilingual individual read out both the bilingual and monolingual sentences. We used the bilingual speaker to read out the monolingual sentences too because the instruction to participants was that they should imagine they were speaking to a German–English "bilingual friend", so a native English accent would have distorted the situational context we wanted to evoke in participants.

During the experiment, each utterance was presented in audio and visual format in a pseudorandomised order to avoid priming participants into particular code-switching modes. Each stimulus was preceded by a 200 ms fixation cross and presented for up to 30 s, during which participants could rate the frequency with which they would encounter an utterance of this type when talking to another bilingual. Once a response had been given, the next trial would automatically start. Participants were instructed to imagine that they were having an informal conversation with a German–English bilingual friend and were asked to rate the frequency with which they would encounter utterances similar to the stimuli on a scale from "1" = "never" to "7" = "all the time". This frequency judgement task has been shown to converge with bilinguals' code-switching patterns during language production, so it was deemed to be a sufficiently ecologically valid representation of bilinguals' sociolinguistic practices (Hofweber et al. 2019). Participants were presented with 14 code-switches of each type: (1) *insertion* English into German, (2) *insertion* German into English, (3) *alternation*, and (4) *dense* code-switching. In addition to that, 14 single-language utterances were presented, with 7 utterances presented in German and 7 utterances presented in English.

Flanker task. The flanker task measures inhibitory control (Eriksen and Eriksen and Eriksen 1974). Participants are presented with a row of three arrows and asked to indicate the direction of the central arrow (left or right). In congruent trials, all arrows face in the same direction. These are contrasted with incongruent trials, in which the trials surrounding the target arrow face in the opposite direction, requiring the inhibition of the distractor arrows to produce accurate responses. Inhibitory performance is measured in the conflict effect, i.e., the performance difference between congruent and incongruent trials. Based on Costa et al. (2009), we administered three conditions differing in congruent–incongruent trial split: a 50–50 condition, a 75–25, and a 92–8 condition. Each of these conditions produced the predicted conflict effect. We adopted the timings used by Costa et al. (2009), so each trial started with a fixation cross presented for 200 ms, followed by the 1000 ms stimulus presentation with a maximum of 1500 ms response time. As soon as a response was given, the trial interval was triggered. Trial intervals were jittered.

Digit span task. To assess short-term memory and working memory abilities, we used Wechsler's (1997) digit span task that consists of a digit forward and a digit backward task. In the digit forward task, participants are asked to repeat increasingly long series of numbers, which taps into short-term memory. In the digit backward task, participants repeat increasingly long series of numbers backwards, which measures working memory abilities. The bilingual participants in this study completed these tasks in both their L1 German and their L2 English.

Fluid intelligence (non-verbal IQ). Participants completed the Raven's progressive matrices task that measures fluid intelligence and reasoning (Raven et al. 1998). This presents participants with sequences of shapes. In each sequence, there is a gap. Participants have to choose from a range of possible solutions which shape most logically completes the sequence.

Background questionnaire. To assess bilinguals' general demographic and language background, an adapted version of the language history questionnaire LHQ (Li et al. 2014) was administered. The questionnaire was filled in by participants after taking part in the study to avoid triggering heightened levels of metalinguistic awareness that would influence the performance in other tasks. The questionnaire generated information about the following participant characteristics: age (years), education (years spent in formal education), L2 immersion duration (years), L2 proficiency, balance (difference between L2 and L1 proficiency), age of L2 onset (years).

3. Results

3.1. RQ1: Sentence Repetition Accuracy in Different Sentence Types

Accuracy in the sentence repetition task was measured as the ratio between verbatim repetitions and the number of total repetitions in each condition (Table 1). The accuracy scores were not normally distributed (Kolmogorov–Smith test: $p < 0.01$). Hence, we conducted a non-parametric Friedman test with the dependent variable being accuracy and the independent variable being sentence type (*dense* code-switching, *insertion* German into English, *insertion* English into German, *alternation*, single-language English, and single-language German) to compare repetition accuracy across the different conditions. The Friedman test indicated that accuracy across the different sentence types differed significantly from each other [Friedman's Q (5) = 80.40, $p < 0.01$].

Table 1. Accuracy in the sentence repetition task.

Accuracy	Mean Average	Std. Deviation	Minimum	Maximum	Mean Rank
Dense	0.71	0.13	0.38	0.94	4.62
Insertion E > G	0.82	0.13	0.45	1	1.89
Insertion G > E	0.86	0.12	0.58	1	3.99
Alternation	0.9	0.09	0.62	1	3.46
Single-language German	0.9	0.12	0.71	1	2.6
Single-language English	0.77	0.16	0.43	1	4.45

The difference was further explored in pairwise Friedman tests, presented in Table 2. Single-language sentences involving participants' dominant language German were repeated more accurately than *dense* code-switches and *insertion*s of English into German, but the difference between *alternation* and *insertion* of German into English did not reach significance. Interestingly, single-language sentences in participants' non-dominant L2 English generated as many non-verbatim responses as *dense* code-switching. In the code-switching conditions, bilinguals performed least accurately in sentences involving *dense* code-switching and best in sentences involving *alternational* code-switching, suggesting that the repetition of *dense* code-switches was easier than the repetition of *alternations*. Sentences involving *dense* code-switching also triggered lower accuracy than sentences involving *insertion*s, suggesting that it was also harder for our bilinguals to repeat *dense* code-switches than to repeat *insertion*s. In fact, Figure 1 displays a gradual increase in accuracy from *dense* code-switching to *insertion* and to *alternation*, which may reflect the processing difficulty associated with the three types of code-switching. Crucially, *dense* code-switching is clearly different from the other types of code-switching and from L1 sentences. However, *insertion* of German into English was not different from *alternation* (and neither are different from L1 German sentences). Moreover, the two types of *insertions* did not differ from each other accuracy-wise.

Table 2. Pairwise comparisons sentence repetition task.

Pairwise Friedman Tests	*Dense*	*Insertion* E > G	*Insertion* G > E	*Alternation*	Single-Language German	Single-Language English
Dense	NA	$Q(1) = 17.04$ * $p < 0.01$	$Q(1) = 25.13$ * $p < 0.01$	$Q(1) = 34.78$ * $p < 0.01$	$Q(1) = 34.78$ * $p < 0.01$	$Q(1) = 0.78$ $p = 0.38$
Insertion E > G	$Q(1) = 17.04$ * $p < 0.01$	NA	$Q(1) = 0.56$ $p = 0.46$	$Q(1) = 15.36$ * $p < 0.01$	$Q(1) = 6.10$ * $p = 0.01$	$Q(1) = 5.00$ * $p = 0.03$
Insertion G > E	$Q(1) = 25.13$ * $p < 0.01$	$Q(1) = 0.56$ $p = 0.46$	NA	$Q(1) = 1.98$ $p = 0.16$	$Q(1) = 2.19$ $p = 0.14$	$Q(1) = 15.16$ * $p < 0.01$
Alternation	$Q(1) = 34.78$ * $p < 0.01$	$Q(1) = 15.36$ * $p < 0.01$	$Q(1) = 1.98$ $p = 0.16$	NA	$Q(1) = 0.24$ $p = 0.62$	$Q(1) = 24.64$ * $p < 0.01$
Single-language German	$Q(1) = 34.78$ * $p < 0.01$	$Q(1) = 6.10$ * $p = 0.01$	$Q(1) = 2.19$ $p = 0.14$	$Q(1) = 0.24$ $p = 0.62$	NA	$Q(1) = 11.65$ * $p < 0.01$
Single-language English	$Q(1) = 0.78$ $p = 0.38$	$Q(1) = 5.00$ * $p = 0.03$	$Q(1) = 15.16$ * $p < 0.01$	$Q(1) = 24.64$ * $p < 0.01$	$Q(1) = 11.65$ * $p < 0.01$	NA

* = statistically significant.

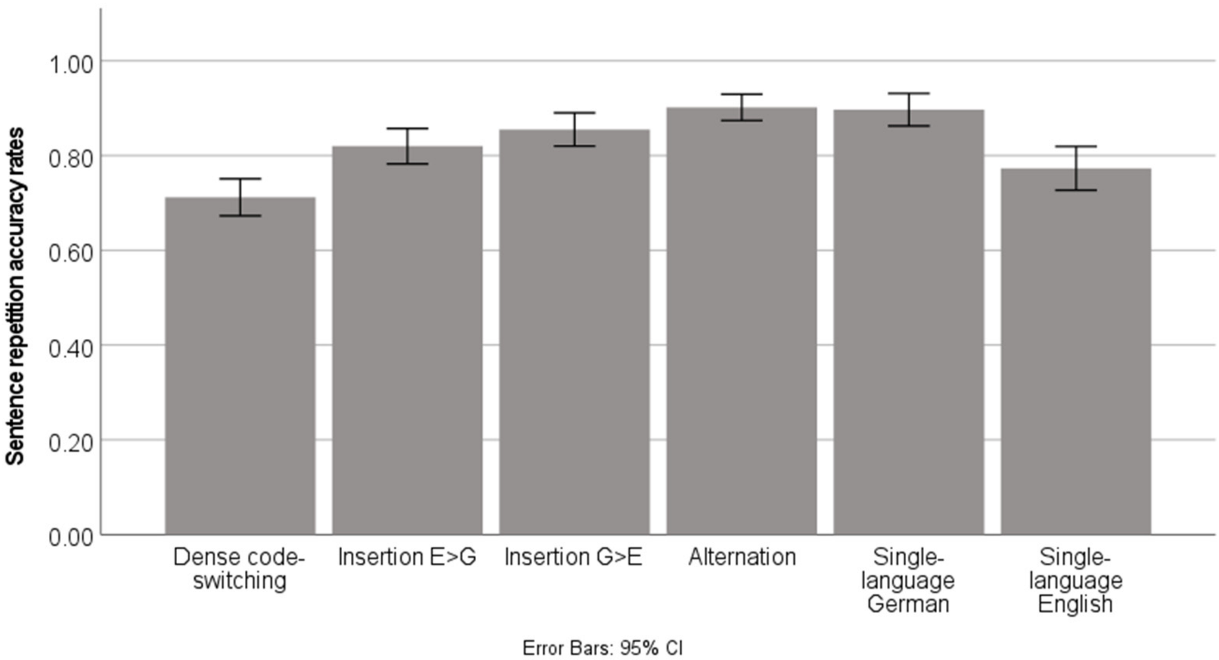

Figure 1. Sentence repetition accuracy by sentence type.

We conducted additional qualitative analyses exploring whether participants had made changes to the type of code-switching when repeating the stimulus sentences. Our tentative prediction was that there would be a tendency for participants to change *dense code-switches* to other less demanding forms of code-switching. These analyses revealed that in 92% of cases, no category changes were made. So, bilinguals broadly speaking stuck to the same type of code-switching in the repetitions. Amongst the sentences in which category changes occurred, changes most frequently occurred for *dense code-switching* (42%), followed by *insertion* of German into English (25%), followed by *alternation* (21%), followed by *insertion* of German into English (13%). Thus, dense code-switching was indeed the type of code-switching that was most frequently changed to another type of sentence. The observed changes involved changes of *dense code-switching* to either *insertions*, *alternations* or single-language sentences. The pattern of category changes, thus, converged with the assumption that *dense code-switching* is hardest to process.

3.2. RQ2: Predictors of Sentence Repetition Accuracy

RQ2a posed the chicken-and-egg question of whether sentence repetition accuracy was driven by exposure frequency or by processing effort. Convergence between the sentence repetition task and the frequency judgement task will be taken as an indicator of the influence of usage frequency. This section discusses the degree of convergence and divergence between the two tasks. The frequency judgement task generated scores ranging from 1, indicating low exposure frequency, to 7, indicating high usage frequency. Table 3 presents the scores from the frequency judgement task on a scale from 1 to 7. The scores generated by the frequency judgement task were not normally distributed (Kolmogorov–Smith test: $p < 0.01$). Hence, we conducted a non-parametric Friedman test with the dependent variable being frequency scores and the independent variable being sentence type (*dense* code-switching, *insertion* German into English, *insertion* English into German, *alternation*, single-language German, and single-language English) to compare frequencies across the different sentence types. The Friedman test indicated that frequency scores across the different sentence types differed significantly [Friedman's Q (3) = 180.17, $p < 0.001$].

Table 3. Frequency scores from the judgement task (scale 1–7).

Frequency	***Mean Average***	***Std. Deviation***	***Minimum***	***Maximum***	***Mean Rank***
Dense	2.51	0.80	1.14	4.5	1.74
Insertion E > G	4.89	1.42	1.9	6.86	4.04
Insertion G > E	2.29	1.06	1	5.07	1.44
Alternation	3.78	1.43	1.14	6.50	2.98
Single-language German	6.59	0.63	3.57	7	5.6
Single-language English	6.43	0.69	3.71	7	5.21

The difference was further explored in pairwise Friedman tests, presented in Table 4. Overall, bilinguals indicated they were exposed to single-language sentences more frequently than to sentences involving code-switching. Despite their residency in an L2-English context, bilinguals rated their exposure to German sentences as marginally more frequent than their exposure to L2 English sentences. In the code-switching conditions, the lowest frequency levels were reported for *dense* code-switching and *insertion* of German into English. The code-switching type bilinguals come across most frequently was *insertion* of English into German, followed by *alternation* (Figure 2).

Bilinguals' sentence repetition accuracy and their exposure frequency to different structures converged to some extent but also diverged in some respects. The two tasks converged in revealing that both the exposure frequency and the repetition accuracy were lowest for *dense* code-switching and highest for sentences in the bilinguals' dominant L1 German. However, there was also considerable divergence. In *alternation*, bilinguals displayed very high accuracy levels but only medium levels of usage frequency. Moreover, whilst bilinguals reported low exposure frequency to *insertion* of German into English, their repetition accuracy for these types of *insertion* was high. Finally, bilinguals displayed low repetition accuracy for single-language sentences in the non-dominant L2, although they reported being exposed to L2 single-language sentences highly frequently. So, whilst their L2 exposure frequency was unsurprising given their residency in an L2 context, the repetition accuracy of L1 and L2 sentences diverged.

Table 4. Pairwise comparisons frequency judgement task.

Pairwise Friedman Tests	***Dense***	***Insertion* E > G**	***Insertion* G > E**	***Alternation***	**Single-Language German**	**Single-Language English**
Dense	NA	$Q(1) = 40.00$ * $p < 0.01$	$Q(1) = 2.95$ $p = 0.09$	$Q(1) = 27.92$ * $p < 0.01$	$Q(1) = 41.00$ * $p < 0.01$	$Q(1) = 41.00$ * $p < 0.01$
Insertion E > G	$Q(1) = 40.00$ * $p < 0.01$	NA	$Q(1) = 41.00$ * $p < 0.01$	$Q(1) = 31.41$ * $p < 0.01$	$Q(1) = 33.39$ * $p < 0.01$	$Q(1) = 29.88$ * $p < 0.01$
Insertion G > E	$Q(1) = 2.95$ $p = 0.09$	$Q(1) = 41.00$ * $p < 0.01$	NA	$Q(1) = 33.39$ * $p < 0.01$	$Q(1) = 41.00$ * $p < 0.01$	$Q(1) = 37.10$ * $p < 0.01$
Alternation	$Q(1) = 27.92$ * $p < 0.01$	$Q(1) = 31.41$ * $p < 0.01$	$Q(1) = 33.39$ * $p < 0.01$	NA	$Q(1) = 41.00$ * $p < 0.01$	$Q(1) = 33.39$ * p < 0.01
Single-language German	$Q(1) = 41.00$ * $p < 0.01$	$Q(1) = 33.39$ * $p < 0.01$	$Q(1) = 41.00$ * $p < 0.01$	$Q(1) = 41.00$ * $p < 0.01$	NA	$Q(1) = 4.80$ $p = 0.03$
Single-language English	$Q(1) = 41.00$ * $p < 0.01$	$Q(1) = 29.88$ * $p < 0.01$	$Q(1) = 37.10$ * $p < 0.01$	$Q(1) = 33.39$ * $p < 0.01$	$Q(1) = 4.80$ $p = 0.03$	NA

* = statistically significant.

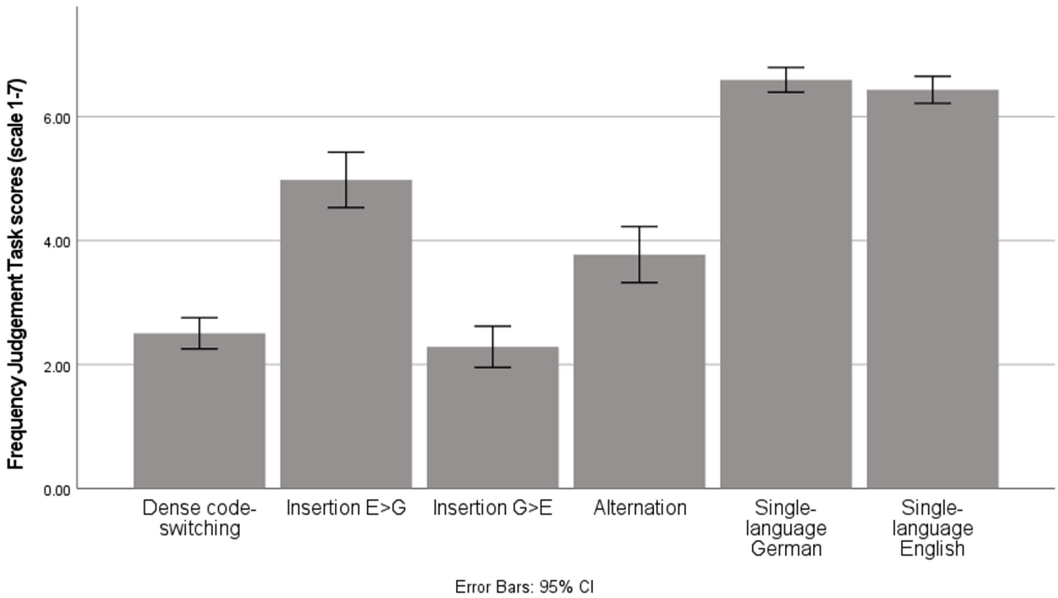

Figure 2. Frequency judgement task scores (scale 1 to 7).

Although bilinguals' sociolinguistic code-switching habits converged with repetition accuracy to some extent, they could not fully explain the observed pattern. To further investigate the predictors of sentence repetition accuracy at the level of individual differences, we conducted stepwise regression analyses to explore the predictors of the outcome variable accuracy in the different code-switching conditions (*dense* code-switching, *insertion* E > G, *insertion* G > E, and *alternation*). We investigated the following non-linguistic and linguistic predictors: age (years), education (degree level 1–6), IQ scores, inhibitory control performance (conflict effect) in the three conditions of the flanker task (92–8, 75–25, and 50–50), short-term memory German, short-term memory English, working memory German, working memory English, L2 immersion duration (years), balance (difference between L2 and L1 proficiency), L2 proficiency, age of L2 onset (years), and exposure frequency to the four different code-switching types separately, as assessed in the frequency judgement task (scale 1–7). Table 5 presents a summary of participants' performance in the different background measures (cf. Table 3 for a summary of the exposure frequency to different code-switching types).

Table 5. Background variables describing bilingual participants.

	Mean	*Std. Deviation*	*Minimum*	*Maximum*
Age (years)	32.1	9.76	19	71
Age of onset L2	8.83	4.46	0	27
Immersion (years)	9.32	9.26	1	48
Self-rated proficiency L2	6.37	0.61	4.25	7
Balance (L1–L2 proficiency; 0 = most balanced)	0.58	0.96	0	5.06
Education (degree level)	4.17	1.12	1	6
Fluid intelligence (non-verbal IQ) (0–150)	116.59	13.83	75	145
Short-term memory German (digit span)	6.56	0.99	5	9
Short-term memory English (digit span)	6.16	0.96	5	9
Working memory German (digit span)	4.36	0.85	3	7
Working memory English (digit span)	4.74	1.04	2	7
Flanker task performance 92–8 (ms)	80.27	32.34	11.35	154.11
Flanker task performance 75–25 (ms)	62.32	24.1	10.51	117.32
Flanker task performance 50–50 (ms)	53.86	13.83	21.12	84.82

When investigating accuracy in the *dense* code-switching condition, none of the predictors entered into the stepwise regression were singled out as significant. Accuracy in the condition presenting *insertion*s of English into German were best predicted by a model incorporating education and age, with accuracy increasing as a function of education and decreasing as a function of age. This model explained 25% of performance variance [R(1,40) = 0.54, R2 = 0.29, adj. R2 = 0.25, education: B = 0.045, β = 0.38, constant = 0.79, age: B = −0.005, β = −0.37, constant = 0.79, F-change = 7.19, p = 0.01]. In the condition involving *insertion* of German into English, a model based on performance at working memory German explained 17% of performance variance [R(1,40) = 0.43, R2 = 0.19, adj. R2 = 0.17, B = 0.06, β = 0.43, constant = 0.58, F-change = 9.05, $p < 0.01$]. Finally, *alternational* code-switching was best explained by a model comprising the factors of age and short-term memory English, which explained 30% of performance variance [R(1,40) = 0.58, R2 = 0.34, adj. R2 = 0.30, age: B = −0.004, β = −0.41, short-term memory English: B = 0.03, β = 0.30, constant = 1.06, F-change = 4.70, p = 0.04]. To summarise, working and short-term memory, as well as age and education, featured as prominent predictors of sentences repetition accuracy. However, code-switching frequency as indicated by the frequency judgement task did not predict accuracy at the level of individual differences.

4. Discussion

This study investigated the processing effort associated with code-switching using a sentence repetition paradigm with L1-German L2-English bilinguals. Our first research question investigated whether code-switching incurred a processing cost compared to single-language sentences. The results revealed that single-language sentences were repeated more accurately than sentences involving code-switches, but only when the language of the single-language stimuli was the participants' dominant L1. Bilinguals' performance in L2 single-language sentences was not better than their performance in mixed-language sentences. In fact, bilinguals performed better in *insertion* and *alternation* compared to L2 single-language sentences. This is in line with previous research showing that the processing cost of code-switching depends on bilinguals' proficiency and dominance profiles (Moreno et al. 2002). In fact, the processing cost of code-switching can be overwritten by other factors, such as bilinguals' proficiency and dominance, or indeed by their regular code-switching habits. However, when interpreting this result we need to bear in mind the limitation that code-switching in experimental tasks and settings may be processed differently to naturalistic code-switching (Gardner-Chloros et al. 2013; Kleinman and Gollan 2016). Future research should explore the modulatory impact of other variables on the processing impact associated with code-switching specifically and in greater detail.

Going beyond a mere comparison of single-language and bilingual sentences, we were interested in the processing effort incurred by different types of code-switching, i.e., *alternation*, *insertion*, and *dense* code-switching. We predicted that the cross-linguistic consolidation efforts will increase with the level of mixing involved in the different code-switching types. In line with predictions, higher levels of cross-linguistic activation coincided with greater processing efforts to monitor and consolidate potentially conflicting linguistic structures and items. Thus, bilinguals found it hardest to repeat *dense* code-switches and easiest to repeat *alternation*s. This is in line with previous research showing that *dense* code-switching requires high levels of monitoring required to manage cross-linguistic co-activation (Hofweber et al. 2016; Han et al. 2022). It is also in line with the observation that *dense* code-switching occurs less frequently in corpora of bilingual speech than other forms of code-switching (Muysken 2000).

Performance differences in sentence repetition may not only be due to the effort involved in processing different linguistic structures, i.e., different types of code-switches and single-language sentences. Another possible explanation for bilinguals' performance could be their sociolinguistic practices, i.e., they should perform more accurately in the types of code-switches they regularly use. The influence of bilinguals' regular code-switching habits on their performance in the sentence repetition task was investigated by considering exposure frequency as indicated in the judgement task in terms of (a) its degree of convergence with repetition accuracy at the group level, and (b) its explanatory power at the level of individual differences. In terms of the degree of convergence between repetition accuracy and usage frequency, the two tasks converged for *dense* code-switching and for L1 single-language sentences. However, there was also considerable divergence. In the case of L2 single-language sentences, bilinguals found these types of sentences hard to repeat, regardless of their high usage frequency. In the case of *Alternation*s, bilinguals found these easier to repeat despite only medium-level usage frequency. Moreover, the exposure frequency to different structures did not explain performance variance at sentence repetition accuracy at the level of individual difference either.

It is possible that the lack of an observed relationship between sociolinguistic practices and repetition accuracy is due to the limitations of the frequency judgement task in capturing bilinguals' regular code-switching habits. Although judgement tasks have been shown to be reasonably reliable indicators of bilinguals' code-switching (Hofweber et al. 2019), they can also be affected by participants' attitudes towards code-switching (Badiola et al. 2018). A more naturalistic production-based elicitation task, such as the short conversations recorded by Lai and OBrien (2020), could have yielded more reliable insights about the impact of regular code-switching habits on repetition accuracy. It is also possible that the bilinguals' codeswitching habits were accurately reflected in the frequency judgement scores, and the lack of an observed relationship is due to the limitations of the sentence repetition task as a measure of processing effort in code-switching. Thus, future research on code-switching should expand the measures used to tease apart the relative influence of bilinguals' regular code-switching habits and the processing efforts associated with different code-switching types.

Another limitation of this study is the low variability observed in *dense* code-switching in this particular bilingual group, which allows for only limited observations about correlations between exposure frequency and processing effort. Future research should explore communities that engage more regularly in *dense* code-switching to assess the effects of regular *dense* code-switching on repetition accuracy. A further limitation of this study is that participants may have been more used to repeating single-language sentences than code-switching sentences, which is a factor that could have confounded the differences between single-language and code-switching sentences.

Finally, we investigated which other individual differences predicted bilinguals' repetition accuracy, exploring a wide range of bilingualism factors, as well as executive functions, such as inhibition and working memory. The most prominent predictors of repetition accuracy were working memory, age, and education. The effect of working memory confirmed previous observations that working memory contributes to sentence repetition abilities to some extent (Ebert 2014). However, the differential effects observed in relation to different structures suggest that sentence repetition tasks also reflect linguistic processing demands. Contrary to predictions, we did not find inhibitory control to affect sentence repetition accuracy. This absence of an effect of inhibitory control could be due to the nature of the task, tapping into language-specific processing. It could also be due to the fact that inhibitory control is less involved in repetition abilities than in free production and comprehension skills. Hence, it should be noted that processing of code-switches in a sentence repetition task may be fundamentally different from the processing of voluntary code-switches in free bilingual speech.

Interesting observations were also made about the role of dominance and age of acquisition. Bilinguals performed better at single-language sentences in their dominant L1 than in single-language sentences in their non-dominant L2, despite being long-term immersed in the L2 context and reporting a high L2 usage frequency. This highlights the importance of the age of acquisition of another language and of bilinguals' dominance profiles for linguistic processing (Treffers-Daller 2016). To conclude, our study provides evidence for processing differences between different types of code-switching. It also suggests that sentence repetition is a useful task that could be exploited by future bilingualism studies.

Author Contributions: This research was conceptualised by J.H. and T.M. and conducted by the J.H.. The J.H. is responsible for data collection and analysis. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the University of Reading.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki. It was reviewed by the University of Reading School of Psychology and Clinical Language Sciences' Research Ethics Committee and was given a favourable ethical opinion for conduct (2014-105-TM).

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

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation, to any qualified researcher.

Acknowledgments: We would like to thank Charlotte Cheyne for her assistance with the data coding.

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

Appendix A. Sentence Repetition Stimuli

Code-Switching Type	Code-Switching Stimulus
Alternation	aerzte muessen erreichbar sein always on call
Alternation	die leute hier leben von landwirtschaft mainly cattle farming
Alternation	der zug war verspaetet due to adverse weather conditions
Alternation	we can meet up but besser hier in der naehe
Alternation	ich sage immer the more the merrier right
Alternation	schick mir ein paar daten und we arrange something
Alternation	you know wir sitzen da oft stundenlang
Alternation	the message was implied aber nur unterschwellig
Alternation	ich kenne wenige deutsche and thats not a problem
Alternation	es hat sich nie ergeben what a shame
Alternation	we bought a car was einkaufengehen vereinfacht
Alternation	the thing about driving is man muss sich konzentrieren
Alternation	he found the tickets nachdem er aufgeraeumt hatte
Alternation	I'm going home weil ich muede bin

Dense	die polizei musste nun disciplinary action gegen ihn ergreifen
Dense	ich gebe dem kinobesuch heute a miss
Dense	canceln wegen einer better offer ist nicht ok finde ich
Dense	wir haben die conversation to private mails verlagert
Dense	morgen bin ich fuer einen coffee locally available
Dense	das zimmer ist zehn minuten laufabstand von reading uni
Dense	ich wollte nur sorry sagen to her
Dense	the message was eben irgendwie unterschwellig darin implied
Dense	das war eine meile oder meil nd a half noerdlich
Dense	die dont mind aber i do
Dense	ich werde keine big night out haven dieses weekend
Dense	ich habe versucht die armee zu deserten
Dense	ich bin heute almost a stunde auf der polizei gewesen
Dense	das is noch a mehr reason nicht to come out
Insertion German into English	i may be zu muede on saturday
Insertion German into English	i didnt bring the right schuhwerk for it
Insertion German into English	the architect is finally building his traumhaus now
Insertion German into English	this weekend is going to be such a hundeweather again
Insertion German into English	his more recent behaviour has been unbegreiflich for me
Insertion German into English	the condition was blamed on a kreislaufzusammenbruch
Insertion German into English	at night I wore several pullovers uebereinander
Insertion German into English	we invited only the junggebliebenen to the reunion
Insertion German into English	the real message was implied unterschwellig in the letter
Insertion German into English	the students are ueberfordert by the task
Insertion German into English	frequent wiederholung of words is key for learning new languages
Insertion German into English	in some areas the pollution values have been grenzwertig
Insertion German into English	they built the local secondary school gegenueber vom supermarkt
Insertion German into English	at the hospital there is always a warteliste
Insertion English into German	ich denke oft an die possibilities you had
Insertion English into German	ich denke mir wir haben alle eine similar heritage
Insertion English into German	bei guten aerzten gibts eben immer eine lange waiting list
Insertion English into German	ich brauche meine left-over holidays fuer ein projekt auf
Insertion English into German	free range eggs waeren mir ehrlich gesagt lieber
Insertion English into German	das hoert sich alles ziemlich time consuming an
Insertion English into German	die sind ja meistens eher nice looking sage ich immer
Insertion English into German	im moment bin ich super busy auf der arbeit
Insertion English into German	sie benutzt special ingredients fuer das gericht
Insertion English into German	ich dachte die reservierung sollte ein einzelbooking fuer mich sein
Insertion English into German	wir suffern immer alle miteinander wenns wieder mal schiefgeht
Insertion English into German	ich enjoye es schon hin und wieder mal
Insertion English into German	one thirty nine haben wir dort frueher immer fuer brot bezahlt
Insertion English into German	und sie hatten nochdazu keine nurse fuer sie
Single-language English	this new disease can be really treacherous indeed
Single-language English	his more recent behaviour has been incomprehensible to me
Single-language English	frequent repetition of words is key for learning new languages
Single-language English	we have finally switched internet provider
Single-language English	we are back in the game he said
Single-language English	we are going to the mountains by car
Single-language English	i know hardly any english people because my husband was also Viennese

Single-language German	morgen machen wir einen ausflug in die berge.
Single-language German	mein koffer ist zum bersten voll
Single-language German	der laden ist an der ecke dort
Single-language German	mit deutschen spreche ich deutsch ansonsten englisch
Single-language German	ich sitze im garten wie gewoehnlich
Single-language German	ich kann nichts versprechen aber ich gebe mein bestes
Single-language German	morgen machen wir einen ausflug in die berge.

References

Adler, Rachel M., Jorge R. Valdés Kroff, and Jared M. Novick. 2020. Does integrating a code-switch during comprehension engage cognitive control? *Journal of Experimental Psychology: Learning, Memory, and Cognition* 46: 741. [CrossRef] [PubMed]

Azuma, Shoji, and Richard P. Meier. 1997. Open class and closed class: Sentence-imitation experiments on intrasentential code-switching. *Applied Psycholinguistics* 18: 257–76. [CrossRef]

Badiola, Lucia, Rodrigo Delgado, Ariane Sande, and Sara Elizabeth Stefanich. 2018. Code-switching attitudes and their effects on acceptability judgment tasks. *Linguistic Approaches to Bilingualism* 8: 5–24. [CrossRef]

Bhatt, Rakesh M., and Agnes Bolonyai. 2011. Code-switching and the optimal grammar of bilingual language use. *Bilingualism: Language and Cognition* 14: 522–46. [CrossRef]

Clyne, Michel. 1972. Perception of code-switching by bilinguals: An experiment. *ITL-International Journal of Applied Linguistics* 16: 45–48. [CrossRef]

Clyne, Michael, and Michael G. Clyne. 2003. *Dynamics of Language Contact: English and Immigrant Languages*. Cambridge: Cambridge University Press.

Gosselin, Leah, and Laura Sabourin. 2021. Lexical-semantic processing costs are not inherent to intra-sentential code-switching: The role of switching habits. *Neuropsychologia* 159: 107922. [CrossRef]

Costa, Albert, and Mikel Santesteban. 2004. Lexical access in bilingual speech production: Evidence from language switching in highly proficient bilinguals and L2 learners. *Journal of Memory and Language* 50: 491–511. [CrossRef]

Costa, Albert, Mireia Hernandez, Jordi Costa-Faidella, and Núria Sebastian-Galles. 2009. On the bilingual advantage in conflict processing: Now you see it, now you don't. *Cognition* 113: 135–49. [CrossRef]

Deuchar, Margaret, Pieter Muysken, and Sung-Lan Wang. 2008. Structured Variation in Codeswitching: Towards an Empirically Based Typology of Bilingual Speech Patterns. *International Journal of Bilingual Education and Bilingualism* 10: 298–340. [CrossRef]

Ebert, Kerry Danahy. 2014. Role of auditory non-verbal working memory in sentence repetition for bilingual children with primary language impairment. *International Journal of Language & Communication Disorders* 49: 631–36.

Eppler, Eva Maria. 2005. The Syntax of German-English Code-Switching. Ph.D. thesis. Available online: http://discovery.ucl.ac.uk/1383656/ (accessed on 18 March 2015).

Eppler, Eva Maria. 2010. "Ich spreche Enlisch, ich spreche Deutsch, aber was ist das fuer eine Sprache?" Emigranto—A grammatical approach to CS. *Arbeiten aus Anglistik und Amerikanistik* 35: 165–87.

Eriksen, Barbara A., and Charles W. Eriksen. 1974. Effects of noise letters upon identification of a target letter in a non- search task. *Perception and Psychophysics* 16: 143–49. [CrossRef]

French, Robert M., and Maud Jacquet. 2004. All cases of word production are not created equal: Reply to Costa and Santesteban. *Trends in Cognitive Sciences* 8: 254. [CrossRef]

Gardner-Chloros, Penelope, Lisa McEntee-Atalianis, and Marilena Paraskeva. 2013. Code-switching and pausing: An interdisciplinary study. *International Journal of Multilingualism* 10: 1–26. [CrossRef]

Green, David W., and Jubin Abutalebi. 2013. Language control in bilinguals: The adaptive control hypothesis. *Journal of Cognitive Psychology* 25: 515–30. [CrossRef]

Green, David W., and Li Wei. 2014. A control process model of Code-switching. *Language, Cognition and Neuroscience* 24: 499–511. [CrossRef]

Grosjean, François. 1989. Neurolinguists, Beware! The Bilingual Is Not Two Monolinguals in One Person. *Brain and Language* 36: 3–15. [CrossRef]

Grosjean, François. 2001. The bilingual's language modes. In *One Mind, Two Languages: Bilingual Language Processing*. Edited by J. Nicol. Hoboken: Blackwell Publishing, pp. 1–22.

Gullberg, Marianne, Peter Indefrey, and Pieter Muysken. 2009. Research techniques for the study of code-switching. In *The Cambridge Handbook on Linguistic Code-Switching*. Edited by B. E. Bullock and J. A. Toribio. Cambridge: Cambridge University Press, pp. 21–39.

Han, Xuran, Wei Li, and Roberto Filippi. 2022. The effects of habitual code-switching in bilingual language production on cognitive control. *Bilingualism: Language and Cognition* 25: 869–89. [CrossRef]

Hartanto, Andree, and Hwajin Yang. 2016. Disparate bilingual experiences modulate task-switching advantages: A diffusion-model analysis of the effects of interactional context on switch costs. *Cognition* 150: 10–19. [CrossRef]

Hofweber, Julia, Theodoros Marinis, and Jeanine Treffers-Daller. 2016. Effects of *dense* code-switching on executive control. *Linguistic Approaches to Bilingualism* 6: 648–68. [CrossRef]

Hofweber, Julia, Theodoros Marinis, and Jeanine Treffers-Daller. 2019. Predicting executive functions in bilinguals using ecologically valid measures of code-switching behaviour. In *Bilingualism, Executive Functions, and Beyond*. Questions and Insights. Studies in Bilingualism. Edited by Irina A. Sekerina, Lauren Spradlin and Virginia Valian. Amsterdam: Benjamins Publishing.

Hofweber, Julia, Theodoros Marinis, and Jeanine Treffers-Daller. 2020a. How different code-switching types modulate bilinguals' executive functions: A dual control mode perspective. *Bilingualism: Language and Cognition* 23: 909–25. [CrossRef]

Hofweber, Julia, Theodoros Marinis, and Jeanine Treffers-Daller. 2020b. Experimentally Induced Language Modes and Regular Code-Switching Habits Boost Bilinguals' Executive Performance: Evidence From a Within-Subject Paradigm. *Frontiers in Psychology* 11: 542326. [CrossRef] [PubMed]

Kleinman, Daniel, and Tamar H. Gollan. 2016. Speaking Two Languages for the Price of One: Bypassing Language Control Mechanisms via Accessibility-Driven Switches. *Psychological Science* 27: 700–14. [CrossRef] [PubMed]

Klem, Marianne, Monica Melby-Lervåg, Bente Hagtvet, Solveig-Alma Halaas Lyster, Jan-Eric Gustafsson, and Charles Hulme. 2015. Sentence repetition is a measure of children's language skills rather than working memory limitations. *Developmental Science* 18: 146–54. [CrossRef] [PubMed]

Kootstra, Gerrit Jan, Ton Dijkstra, and Janet G. Van Hell. 2020. Interactive alignment and lexical triggering of code-switching in bilingual dialogue. *Frontiers in Psychology* 11: 1747. [CrossRef] [PubMed]

Moreno, Eva M., Kara D. Federmeier, and Marta Kutas. 2009. Code Switching and the Brain. In *The Cambridge Handbook of Linguistic CS*. Edited by B. Bullock and A. J. Toribio. Cambridge: Cambridge University Press, pp. 1–22.

Lai, Gabrielle, and Beth A. OBrien '. 2020. Examining language switching and cognitive control through the adaptive control hypothesis. *Frontiers in Psychology* 11: 1171. [CrossRef]

Li, Ping, Fan Zhang, Erlfang Tsai, and Brendan Puls. 2014. Language history questionnaire (LHQ 2.0): A new dynamic web-based research tool. *Bilingualism: Language and Cognition* 17: 673–80. [CrossRef]

MacDonald, Maryellen C., and Morten H. Christiansen. 2002. Reassessing working memory: Comment on Just and Carpenter 1992 and Waters and Caplan 1996. *Psychological Review* 109: 35–54. [CrossRef]

Marinis, Theodoros, and Sharon Armon-Lotem. 2015. Sentence repetition. In *Methods for Assessing Multilingual Children: Disentangling Bilingualism from Language Impairment*. Edited by S. Armon-Lotem, J. de Jong and N. Meir. Bristol: Multilingual Matters, pp. 95–124.

Meuter, Renata FI, and Alan Allport. 1999. Bilingual Language Switching in Naming: Asymmetrical Costs of Language Selection. *Journal of Memory and Language* 40: 25–40. [CrossRef]

Moreno, Eva M., Kara D. Federmeier, and Marta Kutas. 2002. Switching Languages, Switching Palabras (Words): An Electrophysiological Study of Code-switching. *Brain and Language* 80: 188–207. [CrossRef]

Muysken, Pieter. 2000. *Bilingual Speech: A Typology of Code-Mixing*. Cambridge: Cambridge University Press.

Okura, Eve, and Deryle Lonsdale. 2012. Working memory's meager involvement in sentence repetition tests. *In Proceedings of the Annual Meeting of the Cognitive Science Society* 34: 2131–37.

Polišenská, Kamila, Shula Chiat, and Penny Roy. 2015. Sentence repetition: What does the task measure? *International Journal of Language & Communication Disorders* 50: 106–18.

Raven, John, John C. Raven, and John Hugh Court. 1998. *Manual for Raven's Progressive Matrices and Vocabulary Scales*. Oxford: Oxford Psychologists Press.

Treffers-Daller, Jeanine. 2016. Language Dominance: The construct, its measurement and operationalisation. In *Language Dominance in Bilinguals*. Issues of Measurement and Operationalization. Edited by J. Silva-Corvalan and C. Treffers-Daller. Cambridge: Cambridge University Press, pp. 174–95.

Verreyt, Nele, Evy Woumans, Davy Vandelanotte, Arnaud Szmalec, and Wouter Duyck. 2016. The influence of language-switching experience on the bilingual executive control advantage. *Bilingualism: Language and Cognition* 19: 181–90. [CrossRef]

Wechsler, David. 1997. *Wechsler Memory Scale*, 3rd ed. San Antonio: The Psychological Corporation.