
LANGUAGE SWITCHING PARADIGMS AS A TOOL FOR INVESTIGATING BILINGUAL SPEECH PRODUCTION

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Abstract: Research in bilingualism has grown increasingly popular in recent years, leading to an abundance of empirical evidence that has made it possible to outline the techniques used to investigate bilingual language production. Language switching paradigms have become an essential tool employed by researchers to investigate the mechanisms responsible for bilingual language control in laboratory settings. They provide an opportunity to study how bilinguals are able to accommodate both languages in their brain and switch between them effortlessly. The current review focuses on four prominent language switching paradigms: cued language switching, alternating language switching, voluntary language switching, and the read aloud task summarizing their respective applications and advantages. Close attention is paid to the experimental setup of each paradigm, including the type of stimuli employed, the sequence of language switching during the trials, and the use of different performance measures, such as reaction time, and/or the rate of within or between language errors. The possibility of language preplanning in switching, the ability of the paradigm to elicit natural speech, and the ease of administration of each paradigm are also discussed. Two fascinating findings—asymmetrical switch costs and reversed language dominance effect—are outlined as pertinent to determining whether the cognitive control processes of inhibition or selection govern language switching in bilinguals. The review concludes with an analysis of the language pairs that have been studied so far, revealing an evident limitation of language variety that must be addressed by future studies.

Keywords: language switching paradigms, bilingual speech production, language control, selection, inhibition

1. INTRODUCTION

More than one half of the global population at present can speak two or more languages (Zhu & Sowman, 2020), which indicates that bilingualism is integral to modern society and thus a relevant topic in psycholinguistic research. That is why it is not surprising that the last two decades have seen a rise in behavioral and cognitive neuroscience research specifically aimed at understanding how bilinguals encode, convert, and retrieve information in each language (Green, 1998; Costa & Santesteban, 2004; Declerck & Philipp, 2015; Goldrick & Gollan, 2023). However, there is still debate on which mechanisms enable bilinguals to choose what language to speak in and switch between languages at will.

The issue of language control is crucial to answering this question, since it is an essential feature of human cognitive control in language use. In fact, lexical access in bilingual speech production shares common features with the architecture of the speech production system in general. Evidence suggests that the semantic system actually activates other semantically related words in addition to the word that corresponds to the intended meaning (Costa & Santesteban, 2004). Regarding bilingual speech production, it is generally accepted that both languages share semantic concepts, which means that lexical items are conceptually activated and are therefore language non-specific—the semantic system activates the lexicons of each language. This can cause substantial interference of the non-target language when bilinguals are speaking in the intended language, making it much harder to select and produce the right word in the right language. Such cross-language interference must therefore be resolved so that bilinguals can effectively and fluently process the two languages (Christoffels et al., 2007; Philipp & Koch, 2009).

Previous research has identified two competing theories that attempt to explain which cognitive processes help bilingual speakers coordinate both languages successfully—the Inhibitory Control Model (Green, 1998) and the Language-Specific Selection Model (Costa et al., 1999). According to the Inhibitory Control Model, appropriate language control is maintained by inhibiting the non-target language. Thus, in order for bilinguals to speak in the intended language without any interference, they must suppress the other language. Green assumed that inhibition is applied proportionally to the non-target language based on its activation level, and this inhibition persists until the non-target language is needed for production, whereupon the inhibition is lifted. This process is quite effortful because it corresponds to the amount of inhibition that was applied on the non-target language (Kleinman & Gollan, 2018).

Conversely, the Language-Specific Selection Model states that only lexical items in the target language can be selected, regardless of the parallelly activated non-target items. Based on this model, lexical access is conceptually driven, meaning that language control mechanisms are tagged for language and thus only allow for the selection of lexical items in the appropriate language (Christoffels et al., 2007). As a result, although semantically related words

in the non-target language are also activated at the same time, they do not interfere with the selection of target words.

To investigate which language control mechanisms—inhibition or selection—actually govern language switching in bilinguals, researchers use experimental tasks that prompt participants to switch between languages in the laboratory. These tasks are referred to as language-switching paradigms, and each type of paradigm has its own advantages, applications, and findings.

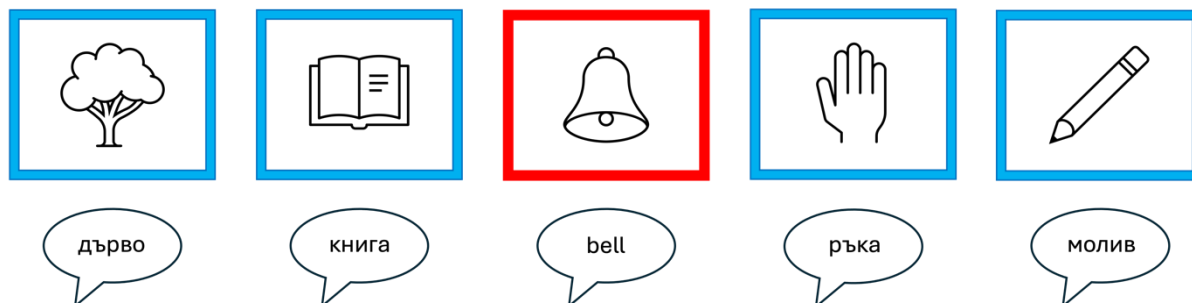
2. CUED LANGUAGE SWITCHING

The cued language switching paradigm is one of the most frequently used paradigms in language switching studies due to its ease of administration. The task typically involves bilinguals naming stimuli, which can be either digits or pictures, in one or the other language. The stimuli are often marked with a visual cue (e.g. differently colored frames, see Figure 1) to indicate what language should be used to name the stimuli currently displayed. Depending on the language cue used, participants can be prompted to either switch between languages (switch trial) or produce in the same language as the previous trial (repetition trial). The performance of participants is typically measured in reaction time (RT) and error rate, and certain studies even employ event-related brain potentials (ERPs) to further determine where language control is situated in the brain (Li et al., 2024). Previous research shows that participants' performance tends to be worse in switch trials compared to repetition trials, and this difference in performance is called “switch costs” (Declerck & Koch, 2023).

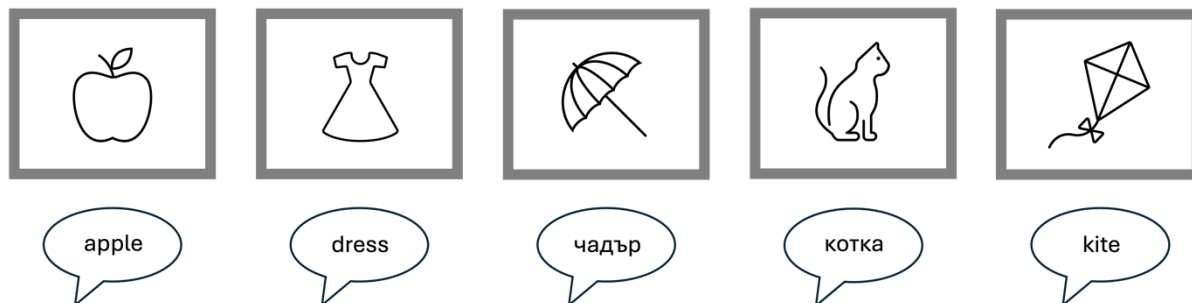
The processes at work during the cued language switching task are presently well-understood due to its wide use in an array of theoretical and empirical studies, which have shaped and enriched it. This is undoubtedly the main advantage of this paradigm. In addition, the cued language switching paradigm is also best-suited for investigating any variation in multiple time-based intervals because of its reliance on visual cues to facilitate switching between languages. This allows researchers to examine both the cue-to-stimulus interval and the response-to-cue interval, which are assumed to indicate active language preparation and passive decay, respectively (Kiesel et al., 2010). Manipulating these time-based intervals is much harder in other language switching paradigms.

Figure 1. Model of the stimuli used in cued language switching, alternating language switching, and voluntary language switching, tailored for Bulgarian-English bilinguals.

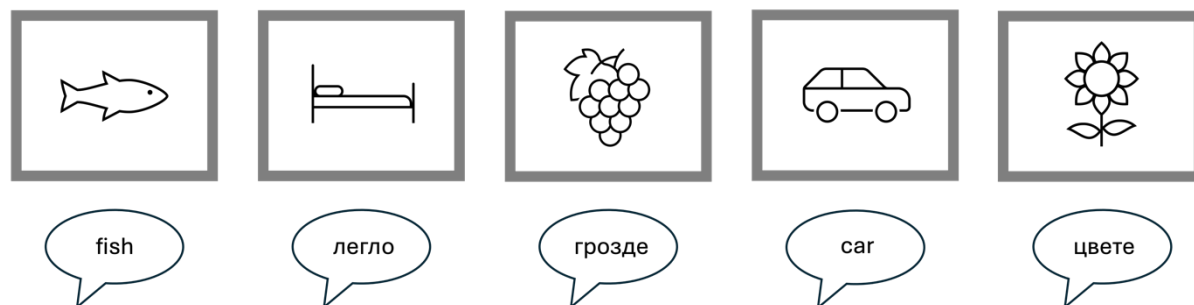
Cued language switching



Alternating language switching



Voluntary language switching



Source: Declerck & Koch, 2023

3. ALTERNATING LANGUAGE SWITCHING

In the alternating language switching paradigm, bilinguals are asked to switch between languages following a predictable sequence, usually after every second trial (e.g. L1-L1-L2-L2-L1-L1, etc.). Participants must name the stimuli (pictures or digits) in one language for a certain number of trials, then switch to the other language for the same number of trials. Alternating language switching typically does not use any language cues to indicate when to switch languages, though some studies have utilized redundant visual language cues, such as colored frames, to complicate the task. Switch costs have also been observed in both of these variants.

This paradigm differs from cued language switching in that it allows for language preplanning, since bilinguals can prepare for the moment they have to switch based on the predictable pattern, which resembles the preplanning during natural language production. The preplanning possibility is a unique characteristic of the alternating language switching paradigm that could be advantageous in certain studies (Declerck & Philipp, 2015; Jackson et al., 2001).

4. VOLUNTARY LANGUAGE SWITCHING

Unlike cued and alternate language switching, the voluntary language switching paradigm lets bilinguals choose which language to use for every trial (Blanco-Elorrieta & Pykkänen, 2017; Liu et al., 2020). Interestingly, switch costs were observed even in voluntary switching studies despite the fact that bilinguals were allowed to name the stimuli in any language they wanted. In one study, however, no switch costs were observed when researchers explicitly told participants to use both languages in 50% of the trials (Gollan & Ferreira, 2009).

The benefit of using voluntary switching is that it resembles natural language switching even more than the alternating language paradigm. This is because it relies on internal language cues as opposed to external language cues, thus allowing for a greater degree of language preplanning. Moreover, the voluntary language switching paradigm enables researchers to use other measures to characterize participants' performance, such as when and how often bilinguals choose to switch between languages. Supplementary measures like these can provide further insight into the process of language selection during language switching.

5. READ ALOUD TASK

In the read aloud task, participants read paragraphs out loud as accurately as possible and at a comfortable pace. Two main types of the read aloud task have been used to investigate bilingual language control mechanisms—single language paragraphs and mixed language paragraphs. Single language paragraphs contain no language switching, i.e. they are written entirely in a single language. Because participants do not switch from one language to another while reading aloud, researchers measure the rate of within-language errors as an indicator of performance (e.g. saying *touch* rather than *much*). Most studies use single language paragraphs in conjunction with mixed language paragraphs to better examine the switch costs incurred while reading aloud (Gollan et al., 2014).

Mixed language paragraphs, on the other hand, contain switches between both languages (see Figure 2). The language that dominates the syntactic structure and the vocabulary of the paragraph is called the default language, while the parts of the paragraphs written in the other language are referred to as switch targets, which can be either single words or whole language switches (phrases). This type of read aloud task allows for the manipulation of several different factors, including the rate of switches (low or high frequency), part of speech of the switch target (content or function), and switch type (switch out of default language or switch back to default language) (Goldrick

& Gollan, 2023). Cognates present another interesting aspect because their phonological similarity has been shown to boost the activation of both languages, ultimately causing greater competition between languages and an amplified response conflict. This increases the production of intrusion errors while also aiding in the detection of errors during speech monitoring. (Li & Gollan, 2018).

Compared to the other switch paradigms, the read aloud task has the advantage of eliciting speech that best resembles natural speech (which is not usually uttered one word at a time), since it seems to elicit speech production errors through the same or similar processes that cause errors in spontaneous speech production (Goldrick & Gollan, 2023). Hence why the read aloud task is most often used to specifically examine language control mechanisms in connected speech. The key feature of this paradigm is that it can reliably elicit language control failures (*intrusion errors*) wherein bilinguals instinctively translate some of the switch words and produce them in the non-target language (e.g., mistakenly saying *врата* instead of *door* when reading: *На входната door се почука.*). Intrusion errors are measured because they serve as an index of language control difficulty. Although they rarely appear in natural speech—less than 1% of the time (Gollan et al., 2014)—they can be experimentally induced in larger numbers with this paradigm, which allows them to be reliable indicators of compromised bilingual language control.

Figure 2. An example of mixed language paragraphs with frequent switches in two default language conditions—Bulgarian and English

Bulgarian default:

Елица и нейната *mother* закъсняха. Васко беше започнал *to hope* че няма да дойдат. *His cousin was* една година по-малка от него, обаче винаги се държеше *as if she were* по-голямата. Ето, и сега—опита се да ѝ внуши, че ще ѝ е много *interesting* да го погледа как играе *on the computer*, но тя *mercilessly* го отрязва, защото според нея *there wasn't anything more boring* от игра на компютър. Васко *understood*, че трябва да се примири. Тя предложи да играят на дама. Излязоха *on the street* пред блока. Елица бръкна в чантичката си *and* извади *a small piece of chalk*.

English default:

Elitsa and her *майка* were late. Vasko was starting *да се надява* that they wouldn't come. *Братовчедка му беше* one year younger than him, but she always acted *като че ли тя е* the older one. See, even now—he tried to convince her that it would be very *интересно* to her to watch him play *на компютъра*, but she *безжалостно* cut him off, because according to her *нямало по-скучно нещо* than playing on the computer. Vasko *разбра* that he must accept it. She suggested that they should play checkers. They went out *на улицата* in front of the apartment building. Elitsa reached into her bag *и* pulled out *едно малко парче тебешир*.

Source: Goldrick & Gollan, 2023

6. EXPERIMENTAL FINDINGS

The majority of bilinguals are more proficient in one language compared to the other. This more proficient language is commonly referred to as the dominant language (L1), and the other language is designated as the non-dominant language (L2). Given this fact, one might assume that switching to L1 is faster and easier than switching to L2. However, the empirical findings that have been observed from the previously discussed language switching paradigms are counterintuitive. Switch costs are actually higher when bilinguals switch into the dominant language (L1) as opposed to when they switch into the non-dominant language (L2) during language production tasks, a phenomenon referred to as asymmetrical switch costs (Declerck & Koch, 2023).

Sometimes, when bilinguals are cued to frequently switch back and forth between languages, dominance can even reverse. In this context, bilinguals demonstrate better performance in their non-dominant than in their dominant language, an effect known as reversed language dominance (Goldrick & Gollan, 2023). It is dubbed as “reversed” because the dominance pattern contradicts the outcomes usually encountered in single language blocks. This unusual pattern has been replicated in a variety of language switching paradigms, including voluntary switching (Gollan & Ferreira, 2009), cued picture naming (e.g., Costa & Santesteban, 2004; Christoffels, et al., 2007; Declerck & Philipp, 2015), and reading aloud of mixed-language paragraphs (e.g., Gollan et al., 2014; Li & Gollan, 2018; Goldrick & Gollan, 2023).

The Inhibitory Control Model offers the best account of these two findings because it proposes that reactive, lasting inhibition governs language control. In the case of asymmetrical switch costs, inhibition carries over from one trial

to the next. Since the dominant language is a lot easier to access than the non-dominant, it requires more inhibition when it is the non-target language in order to make both languages equally accessible and prevent interference. This is what causes longer reaction times (RT) in the dominant language compared to the non-dominant. In some cases, bilinguals can apply too much inhibition, to the point where they overshoot the preferred state of equal accessibility and end up responding faster and with fewer errors in their non-dominant than in their dominant language—a reversal of the standard relation of dominance.

Non-inhibitory theories of language control, such as the Language-Specific Selection Model, struggle to explain why researchers consistently observe longer reaction times (RTs) and more intrusion errors in the dominant language compared to the non-dominant (Declerck, 2020; Goldrick & Gollan, 2023), mainly because of the assumption that the simultaneous activation of the non-target language does not impede the retrieval and selection of lexical items in the target language. If only lexical items in the target language can be selected for production regardless of the activation level of non-target items, then bilinguals should make an equal number of errors in both languages and reaction times (RTs) should be relatively close for both languages as well.

It is worth mentioning that aside from these psycholinguistic findings, language switching paradigms also yield interesting clinical findings. Results of the read aloud and picture naming task demonstrate how speech errors could potentially be useful in diagnosing Alzheimer's disease (AD). In one study, bilinguals with AD made far more intrusion errors on cognate switch words compared to cognitively intact bilinguals, which was likely caused by monitoring deficits brought on by the progression of the disease. Such errors could potentially be used to create a comprehensive assessment that can distinguish healthy bilinguals from those with AD (Gollan et al., 2020).

7. PROSPECTS FOR FUTURE RESEARCH

The existing studies mainly focus on Indo-European languages, with a few studies on ideographic languages, e.g. Spanish-English, Spanish-Catalan, German-Dutch, German-English, German-English-French, Dutch-English, Finnish-English, Polish-English, Hebrew-English, Mandarin-English, and Arabic-English (Declerck & Koch, 2023; Goldrick & Gollan, 2023), revealing an evident limitation of language variety. Slavic languages that use the Cyrillic script still remain underrepresented. Future research should attempt to compensate for this limitation by studying as many languages as possible, particularly languages distinct in typology and characteristics, contributing thus to the replicability of the findings from the language switching paradigms.

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