

## **Code-switching**

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## **1. Introduction/definitions**

When bilinguals speak with each other, they regularly use words and phrases from their two languages and integrate these different language codes within a single utterance, often in a flexible and seemingly effortless way. This phenomenon is called code-switching and is unique to bilingual language processing. Code-switching overtly demonstrates one of the key findings in research on second language acquisition and bilingualism, namely that a bilingual's two languages are continuously active to some extent (for reviews, see Kroll et al., 2006; Van Hell & Tanner, 2012). Code-switching also illustrates that bilingual speakers can flexibly use and integrate both of their languages and that bilingual listeners need to continuously regulate and adjust the level of activation of their two languages to enable their comprehension of the code-switched utterance as it unfolds over time. The study of code-switching, therefore, is an ideal testbed for studying how bilingual speakers navigate their two language systems during speech planning and how bilingual comprehenders incrementally integrate new information, potentially coming from different languages, with the preceding context in order to build up a message level interpretation (e.g., Beatty-Martinez et al., 2020; Van Hell et al., 2015).

Why do bilingual speakers code-switch? If you ask this to a speaker who just code-switched, they may respond that the code-switch occurred unintentionally and just popped up without them realizing it (Grosjean, 2010; Heredia & Altarriba, 2001). Other speakers, particularly those who are less proficient in their second language, may say they did not know the particular word or phrase in the language they were using, so they resorted to their other language. Although there are still many gaps in our current knowledge on why bilinguals code-switch, the currently available evidence indicates that code-switching is rarely driven by a lack of lexical knowledge in the other language in fluent bilinguals. Furthermore, while a bilingual

may feel that a switch to the other language simply ‘popped up’, research has shown that intra-sentential code-switching is not haphazard, but governed by linguistic and socio-contextual principles. Research has also shown that switching into the other language is often associated with measurable cognitive effort, both in speaking and in comprehension, reminiscent of the well-documented cognitive costs associated with task switching (Kiesel et al., 2010).

This chapter focuses on intra-sentential code-switching, i.e., the alternative use of two languages within a clause or sentence (for studies examining inter-sentential code-switching, see, for example, Gullifer et al., 2013; Ibáñez et al., 2010; Pérez & Duñabeitia, 2019). The language into which a constituent from the other language has been inserted is often referred to as the base language or matrix language (cf., Myers-Scotton, 1993), as this language determines the morphosyntactic frame of the sentence. The language from which the constituent is taken is referred to as the embedded language. Intra-sentential code-switches can be characterized structurally as alternations, insertions, or congruent lexicalizations (Deuchar et al., 2007; Muysken, 2000). Alternations are code-switches that involve a complete switch of a sentence constituent (phrase, clause, etc.) into the other language (1).

(1) Je telephone à Chantal, he, *meestal voor commiskes te doen en eten.*

‘I call Chantal, hm, mostly to go shopping and eat.’ (Treffers-Daller, 1994, p. 213)

Insertions are characterized by the insertion of one grammatical constituent, typically consisting of one word or a few words, from one language into the sentence structure of the other language (2).

(2) Yo anduve *in a state of shock* por dos días.

‘I walked *in a state of shock* for two days’ (Pfaff, 1979, p. 219).

In congruent lexicalizations both languages are used to fill the grammatical slots, which typically takes place when the syntactic structure is shared (structurally congruent) between two languages (3).

(3) Dy lei dea yné hoeke, *verroerde* gjin vin.

‘He lay dead in the corner, did not stir at al.’

(Wolf, work in progress, as cited in Muysken, 2000, p. 138)

Code-switching is a discourse phenomenon, as it comprises the production and the comprehension of code-switched utterances. As we will see, most theoretical perspectives pertain to the production of code-switched utterances, but empirical studies have examined both the production and the comprehension of code-switched utterances. Furthermore, code-switching occurs more frequently in spoken than in written discourse. Although code-switching can occur during writing, existing corpora of code-switched discourse are all based on spoken utterances, usually as they emerged in natural discourse settings. However, a substantial part of the psycholinguistic and neurocognitive evidence on the comprehension of code-switching is based on bilinguals’ reading of code-switched utterances using, for example, eye-tracking (e.g., Guzzardo Tamargo, Valdés-Kroff, & Dussias, 2016) or electrophysiological methodology (see Van Hell et al., 2018).

Some lab-based psycholinguistic studies focus on externally induced switches, i.e., non-

spontaneous language switches where bilinguals switch languages as prompted by an external cue (e.g., a color cue or a flag denoting a particular response language); whether switches are externally induced or internally generated potentially impact behavioral patterns associated with the production of code-switched speech (see, e.g., Gollan & Ferreira, 2009). Studies of language corpora, on the other hand, typically reflect internally generated switches in natural discourse. Both externally induced switches and internally generated switches enable researchers to examine relevant questions related to language switching (see Gullberg et al., 2009).

### **1.a. Key terms and concepts**

Intra-sentential code-switching: the alternative use of two languages within a clause or sentence.

Externally induced switches: non-spontaneous language switches where bilinguals switch languages as prompted by an external cue.

Internally induced switches: spontaneous language switches occurring during natural discourse.

## **2. Historical perspectives and critical questions in the cross-disciplinary study of code-switching**

Code-switching emerges when two languages come into contact (Torres Cacoullos & Travis, 2018). For several decades, researchers have studied structural linguistic or sociolinguistic aspects of code-switching, often on the basis of linguistic corpora (for overviews, see Bullock & Toribio, 2009; Guzzardo Tamargo, Mazak, & Parafita Couto, 2016; Isurin et al., 2009; Stell & Yakpo, 2015). Structural linguistic approaches to code-switching seek to identify universal

grammatical constraints on code-switching. Several structural accounts have been particularly influential in the study of code-switching, including Poplack's (1980) model of the equivalence constraint and the free morpheme constraint, Myers-Scotton's Matrix Language Framework (e.g., Myers-Scotton, 1993), and the Minimalist Programme approach proposed by McSwan (2000). Focusing on lexical constraints, the triggering hypothesis, originally proposed by Clyne (1967; 2003), posits that code-switches are more likely to occur in the presence of language-ambiguous words, such as cognates, i.e. words that share semantics, phonology, and orthography across languages, such as Dutch-English 'appel-apple' or Spanish-English 'piano-piano'.

Sociolinguistic perspectives on code-switching examine the social, cultural, and communicative motivations driving code-switched speech, often studied through observations of code-switched discourse in naturalistic settings (Stell & Yakpo, 2015). Building on seminal work by Weinreich (1953) and Blom and Gumperz (1972), researchers have studied how code-switching patterns vary with, for example, language-ideological settings and language privileges (e.g., Muysken, 2000), the extent to which code-switching is socially acceptable within a community (e.g., Torres Cacoullos & Travis, 2018) or characteristics of the interlocutors, such as language background (e.g., Bentahila & Davies, 1992) or language attitudes (e.g., Badiola et al., 2018).

Linguistic and sociolinguistic perspectives have traditionally been tested via analyses of corpora of code-switched speech or observations of natural discourse. More recently, these perspectives have been examined in studies that used psycholinguistic and neurocognitive experimental research techniques to elicit code-switched speech (e.g., Fairchild & Van Hell, 2017; Kootstra et al., 2010; Lipski, 2019) or examine the online processing of code-switched sentences (e.g., Dussias, 2001; Vaughan-Evans et al., 2020; Suurmeijer et al., 2020; for reviews,

see Beatty-Martínez et al., 2018; Valdés Kroff et al., 2018; Van Hell et al., 2018). These studies typically merge linguistic or sociolinguistic perspectives on code-switching with cognitive processing models of speech production or comprehension and manipulate linguistic materials and experimental conditions to test specific predictions on the production or comprehension of code-switched sentences. This approach will be illustrated by discussing psycholinguistic research that tested specific linguistic and sociolinguistic perspectives: the triggering hypothesis and the impact of interlocutor characteristics (see Sections 3.1 and 3.2, respectively).

Another focus in psycholinguistic research on intra-sentential code-switching focuses on (1) cognitive efforts and (2) cognitive control mechanisms associated with switching. This perspective originates from a long tradition in the broader field of cognitive psychology on switching costs and cognitive control (for a review, see Bobb & Wodniecka, 2013), and applies these cognitive mechanisms to the production and comprehension of code-switched sentences. As discussed in more detail in Section 3.3, psycholinguistic and neurocognitive research on intra-sentential code-switching has adapted the notion of switching costs to examine the extent to which more naturalistic intra-sentential switching incurs processing cost and which factors mitigate these costs, including switching direction and bilinguals' daily language use and code-switching habits.

A second line of psycholinguistic research on code-switching that builds on decades of research in cognitive psychology focuses on cognitive control mechanisms that are associated with the production of code-switched speech. In their Control Process Model (CPM) of code-switched speech, Green and Wei (2014; see also Green, 2018) relate cognitive control processes to codeswitching; this model will be further discussed in Section 3.4.

### 3. Theoretical perspectives and empirical studies

I will discuss four different theoretical approaches to intra-sentential code-switching and outline the empirical work in these domains by highlighting illustrative studies. Two positions originate in the linguistic literature (triggering theory, socio-pragmatics of interlocutor characteristics) and two in the psychological literature (modulators of switching costs and the Control Process Model).

#### 3.1. Triggering hypothesis

The triggering hypothesis was proposed by Clyne (e.g., 1967; 2003) based on corpus data on German, Dutch, Hungarian, Italian, Spanish, Croatian, and Vietnamese immigrants in Australia. Clyne noted that code-switches tend to occur when a sentence contains one or more cognates. He proposed that cognates, as well as other language-ambiguous words like proper nouns and homophones (words that share phonology, but not meaning across languages), can function as triggers that facilitate a switch to the other language. For example, the Croatian-English cognate ‘tennis’ triggered a switch to English in “Imam puno zadaca I sutra mi igramo *tennis* .. that’s about all” ([“I have a lot of assignments and tomorrow we are playing *tennis* .. that’s about all”]; Clyne 2003, p. 164). Broersma and De Bot (2006) integrated Clyne’s original triggering hypothesis with psycholinguistic models of bilingual speech production in their adjusted triggering hypothesis. Assuming that triggering occurs at the lemma level, this adjusted triggering hypothesis states that the selection of the lemma of a trigger word (e.g., a cognate) co-activates words in the currently used language A, but also words in the speaker’s other language B. This increased activation of language B makes it more likely that the speaker will subsequently select lemmas from language B downstream the utterance. The notion that cognates

co-activate words in two languages and boost activation of the non-target language is in line with a wealth of studies on bilingual lexical processing reporting that cognates are typically produced and recognized faster and more accurately than noncognates (for a review, see Van Hell & Tanner, 2012).

The idea that code-switches can be triggered by language ambiguous words, in particular cognates, has been tested in various corpus analyses (Broersma, 2009; Broersma & De Bot, 2006; Broersma et al., 2020; Broersma et al., 2009; Fricke & Kootstra, 2016; Soto et al., 2018) and experimental studies (Broersma, 2011; Bultena et al., 2015a;b; Gullifer & Titone, 2019; Kootstra et al., 2012; 2020; Li & Gollan, 2018). In the first systematic test of the triggering hypothesis, Broersma and De Bot (2006) analyzed conversations of three Moroccan Arabic-Dutch bilinguals and coded code-switches and trigger words (cognates and proper nouns). They found that code-switches occurred more frequently directly after a trigger word than could be expected by chance, especially if the trigger and code-switch appeared in the same clause. These findings were paralleled in subsequent corpus studies analyzing conversational speech of Dutch immigrants in New Zealand and Australia (e.g., Broersma, 2009), Russian immigrants in the USA (Broersma et al., 2009), and Welsh-English bilingual speakers (Broersma et al., 2020). In the latter study, Broersma et al. (2020) analyzed a large-scale corpus of over 50 natural conversations of approximately 100 Welsh-English bilingual speakers. Not only did they observe more code-switches in clauses containing cognates than in clauses without a cognate, they also found that a higher number of cognates within a clause increased the likelihood that speakers switched at some point downstream the utterance. Furthermore, speakers who used more cognates code-switched more frequently throughout the conversation, but a speaker's production of cognates did not increase the likelihood that their discourse partner code-switched when they

started to talk in turn. This indicates that hearing (rather than producing) a lexical trigger does not affect the listener's likelihood to code-switch when it was their turn to speak. Together, these corpus studies provide compelling quantitative evidence that trigger words co-occur with code-switches in a speaker's utterance, and that these effects can be observed across a variety of different language combinations.

A second line of research testing the predictions of the triggering hypothesis sought to provide more insight into the processing mechanisms underlying triggered code-switching, using experimental techniques that enable specific manipulations of critical variables (Broersma, 2011; Bultena et al., 2015a;b; Gullifer & Titone, 2019; Kootstra et al., 2012; 2020; Li & Gollan, 2018). Even though these techniques generally come with less natural and ecologically valid discourse situations, they allow for a more systematic control of potentially confounding or modulating factors. The evidence provides mixed support for the lexical triggering hypothesis, particularly in the context of intra-sentential code-switching, with studies using picture naming paradigms for nouns mostly supporting the triggering hypothesis (Broersma, 2011; Li & Gollan, 2018).

Using the structural priming technique (see Bernolet, this volume), Kootstra et al. (2012) first asked Dutch-English bilinguals to repeat a code-switched sentence that started in Dutch and switched into English, and then describe a target picture using a sentence that switched from Dutch to English. The object noun in the prime sentence (e.g., 'bal' in 'De jongen gooit een bal to the butcher [The boy throws a ball to the butcher]) was either a cognate (here: bal–ball) or a noncognate, and was either repeated in the subsequent target picture (e.g., a picture of a boy throwing a ball to a diver) or not. Analyses of the target sentences produced to describe the pictures showed that the location of the switch in the target sentences was more likely to be similar to the switch location in the prime sentence when the object noun was a cognate than a

noncognate, and when the same noun was repeated across prime and target sentences. These cognate-related switching effects were more pronounced in the group of highly-proficient bilinguals than in lower proficiency bilinguals. This study suggests that cognates enhance the likelihood that the switch location in a spoken sentence aligns with the switch location of a previously produced utterance, indicating that cognate nouns can affect code-switching patterns.

Mimicking a dialogue situation using confederate-scripted priming, Kootstra et al. (2020) examined the impact of different types of lexical triggers on the production of code-switched sentences. Dutch-English bilingual participants and confederates took turns in describing a pictured event to each other after which their discourse partner had to select the correct picture from their screen. Each picture contained an actor, an action, and a patient (e.g., a picture of a hunter putting a rose on a chair). The patient was either a cognate (e.g., *roos*–*rose*), an interlingual homophone (*rok* [*skirt*]–*rock*), or a noncognate (e.g., *fiets*–*bike*). The confederate was scripted to code-switch from Dutch to English directly after the critical trigger word (cognate or homophone) or the non-trigger noncognate in half of the picture descriptions, or produce the entire sentence in Dutch in the remaining half. After the participant had selected the picture just described from two pictures on their screen, the participant was presented with a pictured event they had to describe. The patient objects in the participants' pictures (e.g., a woman putting a baby on a chair) were either cognates, homophones, or noncognates. Participants were free to use English or Dutch and were not forced to code-switch. The critical question was whether participants would code-switch more frequently when their picture contained a trigger word, and whether their code-switching behavior would be affected by that of the confederate. Participants code-switched more frequently when pictures contained a cognate

rather than a noncognate, but only when their discourse partner had code-switched in the preceding trial. Homophones did not enhance the likelihood of switching.

Cognate triggering effect in sentences, if they occur at all, may be restricted to noun cognates and do not emerge in verb cognates (Bultena et al., 2015a;b). Using a shadowing task, Bultena et al. (2015a) tested whether verb cognates would modulate the production of code-switches presented downstream the sentence. Dutch-English bilinguals listened to sentences that started in Dutch and switched into English, or vice versa; the code-switch was preceded by a cognate or noncognate verb. Upon the start of the sentence, participants were asked to repeat ('shadow') what they heard as quickly and as accurately as possible. Shadowing latencies (delay between word onset in the original recording and the participant's reproduction of the word) showed that producing verb cognates or noncognates did not affect the later production of the code-switch, in either switching direction and in both syntactic structures tested (word orders shared (SVO) or not shared (XVSO) across Dutch and English).

Bultena et al.'s (2015a) findings were paralleled in a self-paced reading study in Dutch-English bilinguals (Bultena et al., 2015b): reading a verb cognate did not facilitate the reading of the subsequent code-switched word. Testing French-English bilinguals, Gullifer and Titone (2019) also observed that the reading of switched nouns with higher or lower form overlap that appeared early in the sentence did not affect the reading of words downstream the sentence.

In sum, quantitative analyses of corpus studies suggest that lexical triggers co-occur with code-switches in different types of bilingual speakers, in line with Clyne's (1967; 2003) original trigger hypothesis and the adjusted triggering hypotheses proposed by Broersma and De Bot (2006). However, the psycholinguistic studies using controlled lab-based experimental techniques indicate that lexical triggering in and of itself is not a fundamental cognitive

mechanism that elicits code-switched speech in all circumstances or affects the processing of code-switched sentences. Rather, in a speaking context in which bilinguals were free to code-switch (or not), cognates or false friends only triggered a code-switch when the speaker's discourse partner had just code-switched (Kootstra et al., 2020), suggesting that lexical triggering is restricted to discourse situations in which code-switching occurs frequently. Actually, this discourse situation best mimics the contextual situation in which linguistic corpora are collected, suggesting that quantitative analyses of code-switches in corpora may reflect code-switching behavior in specific discourse situations.

### **3.2. Sociolinguistic perspectives: the impact of interlocutor characteristics**

Recently, psycholinguistic studies have adopted sociolinguistic perspectives on code-switching and use experimental research techniques to examine how social factors affect the comprehension and production of intra-sentential code-switches. Here, I will highlight psycholinguistic and neurocognitive studies that examined how interlocutor characteristics influence code-switching patterns (Blanco-Elorrieta & Pylkkänen, 2017; Grosjean, 1997; Kaan et al., 2020; Kapiley & Mishra, 2018).

To examine how language mode affected bilinguals' code-switching behavior, Grosjean (1997) had 15 French-English bilinguals, all French native speakers who had immigrated to the United States, retell stories to three French interlocutors who also lived in the United States. Half the stories were French-only, and described typical French situations accompanied by cartoons of French scenes. The other half of the stories were also in French, but contained English code-switches and described typical American situations. Prior to the story retelling task, participants were told that the interlocutors differed in their fluency in English and their attitude towards

code-switching (ranging from being a French purist to having positive attitudes towards code-switching). Different code-switching patterns emerged during the retelling of the stories: The French ‘purist’ interlocutor and French-only stories triggered the least amount of code-switches in the participants’ retellings, whereas retelling stories to the interlocutor with the most positive attitude towards code-switching elicited most code-switches.

More recently, Blanco-Elorrieta and Pylkkänen (2017) examined neural responses associated with the production and comprehension of cued language switches in Arabic-English bilinguals, using magneto-encephalography. The cues were either static portraits of individuals who had been introduced as bilinguals or monolinguals (social cue), or were color cues indicating a particular language (color cue). In the cued picture naming task, the bilingual portrait cue indicated that participants could freely choose the output language, and the monolingual portrait cue indicated they had to name in the language of the monolingual. The color cue indicated which particular language to use. In the comprehension task, bilinguals were presented with one of the cues, followed by an auditory stimulus. They then had to judge whether this auditory stimulus matched the picture that was presented next. The finding most relevant to the present discussion was behavioral switching costs and measurable neural effects in the executive function network were smaller, or even absent, in the socially cued conditions than in the condition that used color as a switch cue.

Awareness of interlocutor identity also influenced code-switching patterns in Telugu-English bilinguals (Kapiley & Mishra, 2018). Participants were introduced to cartoon images of interlocutors who were either more or less proficient in their L2 English. In a picture naming task, speakers switched into L2 English less often in the presence of low-proficiency cartoons as opposed to high-proficiency cartoons. This suggests that bilingual speakers are sensitive to the

identity of their interlocutor and their communicative needs, which influences how they plan their language use and switching behavior.

Studying intra-sentential code-switching rather than isolated item switching (Blanco-Elorrieta & Pykkänen, 2017; Kapiley & Mishra, 2018), Kaan et al. (2020) had Spanish-English bilinguals read sentences with or without a code-switch in the presence of an individual who they knew was a Spanish-English bilingual speaker or an English monolingual speaker. The rationale here is that code-switching is not socially allowed in the presence of a monolingual, which may then affect the degree to which the bilingual participants expect a switch or co-activate their Spanish knowledge. Brain activity was recorded during reading using the Event-Related Potential technique. Switches elicited an early fronto-central positivity, which was attenuated in the presence of the bilingual speaker during the first part of the study. In addition, the switch-related late positivity was smaller in the presence of a bilingual than a monolingual, but only for participants who were sensitive to the other's language knowledge as measured in their off-line judgements. Kaan et al. (2020) take these results to imply that, when initially joined by a bilingual individual, bilingual readers expected and activated both languages and more easily accommodated intra-sentential code-switches in the presence of a bilingual speaker relative to a monolingual speaker, suggesting that sentence revision and updating is easier when code-switching is socially permitted. This study provides important insights into the prominent role of social factors, like speaker identity, on the comprehension and production of intra-sentential code-switches: Even the identity of silent bystanders can affect bilinguals' quiet reading of code-switched sentences.

The findings of the studies discussed in this section support the idea that code-switching patterns are affected by speaker identity and perceived language knowledge of the individual

(real or imagined) present in the code-switching context, in line with sociolinguistic perspectives on code-switching. Moreover, the corollary that language control associated with the production or processing of code-switched utterances can be modulated by interlocutor characteristics aligns with the Control Process Model posited by Green and Wei (2014; Green, 2018), which will be discussed in more detail in section 3.4.

### **3.3 Factors that modulate switching costs**

Psycholinguistic and neurocognitive research on cognitive efforts associated with intra-sentential code-switching is largely based on the psycholinguistic literature on processing costs that reports longer response times associated with switching languages when producing or processing single items, such as pictures, numbers, or words (Bobb & Wodniecka, 2013). Even though bilinguals often report that producing or listening to code-switched speech in natural discourse is effortless, analyses of natural discourse in linguistic corpora confirm that code-switching comes with measurable changes in speech variables. In their analysis of spontaneous code-switches in the Bangor Miami Corpus (Deuchar et al., 2014), Fricke et al. (2016) found that bilingual speakers slowed their speech rate in anticipation of a language switch and adapted VOTs of words close to an upcoming switch (see also Balukas & Koops, 2015; but see Johns & Steuck, 2021).

Recent psycholinguistic and neurocognitive studies on intra-sentential code-switching examined which factors mitigate cognitive efforts associated with the production or comprehension of code-switched utterances. One modulating factor is switching direction (Bultena et al., 2015a;b; Gullifer & Titone, 2019; Suurmeijer et al., 2020). Specifically, switching from the dominant language or L1 into the weaker language of L2 has been found to be cognitively more effortful than switching in the opposite direction, as evidenced in reduced

shadowing and reading times (Bultena et al., 2015a; b). Electrophysiological research using ERP and time-frequency analyses also indicates that neurocognitive processes involved in reading (Litcofsky & Van Hell, 2017) and listening to (Fernandez, Litcofsky, & Van Hell, 2019) code-switched sentences vary by switching direction, as evidenced by different neural signatures associated with the two switching directions (see Van Hell et al., 2018, for more details). More specifically, processing sentences that begin in the dominant language and halfway switch into the weaker language engage lexical processes as well as sentence-level reanalysis to integrate the weaker language into the sentence structure the comprehender is incrementally building. In contrast, processing sentences that switch from the weaker to the dominant language engages lexical-semantic integration accompanied by inhibition processes: As the sentence starts to unfold in their weaker language, comprehenders must inhibit their dominant language, and this inhibition must be released upon hearing a switch into the dominant language.

Bilinguals' daily code-switching practices and language experience also affect cognitive efforts associated with intra-sentential code-switching (Adamou & Shen, 2019; Beatty-Martínez & Dussias, 2017; Kheder & Kaan, 2016; Valdés Kroff et al., 2018; Valdés Kroff et al., 2020). For example, presenting written code-switched sentences while recording participants' ERPs, Beatty-Martínez and Dussias (2017) observed an early frontal positivity in Spanish-English bilinguals recruited from an environment in which code-switching was rather uncommon (Spain), whereas Spanish-English bilinguals who frequently code-switched (recruited in the USA) did not show this ERP signature. Testing fluent Romani-Turkish bilinguals recruited from a community in which code-switching is highly common, Adamou and Shen (2019) also observed no switching costs for sentences that contained Turkish verbs that are frequently used in spontaneous conversations.

In sum, rather than considering switching costs as a given in bilinguals' switching between languages, an increasing number of studies on inter-sentential code-switching seeks to understand which factors mitigate cognitive efforts associated with code-switching. These studies often relate their findings to cognitive models of language processing and experienced-based or usage-based accounts, positing a strong link between cognitive representations and frequency of use of particular constructions, and argue that language processing is shaped by expectations based on recent and long-term exposure to the language (e.g., Backus, 2015).

### **3.4. Control Process Model and intra-sentential code-switching**

Relating code-switching to cognitive control, Green and Wei (2014) proposed the Control Process Model to account for code-switching in production (see also, Green, 2018). In a nutshell, this model posits that language task schemas that govern cognitive control processes cooperate in some contexts but compete in others, depending on specifics of the interactional context (single language, dual language, and dense code-switching contexts). Competitive control operates in a single or dual language context when only one language is selected, and items from the language not in use are blocked from entering the language planning system. Coordinate control operates in a code-switching context, involving insertion, alternation, and congruent lexicalization (Muysken, 2000) in one of two ways: coupled control or open control. Under coupled control, control passes back and forth such that the most appropriate item enters the language planning system. Alternation and insertion are realized by coupled control: The matrix language turns over control to the other language to allow the intended alternation or insertion after which control is returned back. Open control realizes congruent lexicalization: the control processes have no top-down control or biasing input and allow items from either language to enter the planned

utterance on an opportunistic basis, whichever is most appropriate at a given time. A further prediction of the model is that under open control, language switching costs are minimized, whereas coupled control can confer a switching cost.

So far, most studies testing the Control Process Model have examined how bilinguals' language experience and code-switching practices modulate performance on executive function tasks, such as Flanker (Adler et al., 2019; Hofweber et al., 2020), verbal Stroop and non-verbal global–local (Lai & O'Brien, 2020), or task-switching (Hartanto & Yang, 2016) tasks (for discussion, see Poarch, this volume). An emergent psycholinguistic literature on the processing of code-switched sentences focuses on the model's assumption that language switching costs are related to different types of cognitive control (Beatty-Martínez & Dussias, 2017; Broersma et al., 2020). For example, Beatty-Martínez and Dussias (2017) interpret the early positivity present in non-habitual code-switchers but absent in habitual code-switchers as an attentional shift from a more competitive to a more cooperative state of bilingual language control. Further research is needed to test the model's predictions related to code-switched sentence processing.

#### **4. Current trends and future directions**

A growing body of research on code-switched sentence processing examines the cognitive and neural mechanisms that underlie the comprehension and production of code-switched utterances, using quantitative corpus analyses, laboratory-based experimental-behavioral and neurocognitive techniques that seek to maximize experimental rigor while maintaining the integrity of natural code-switched sentences common in bilingual discourse. These studies have provided a wealth of insights, but there are still many topics that require further experimentation or questions that as of yet remained largely unexplored.

One of the topics requiring further experimentation pertains to the role of bilinguals' code-switching practices and experiences on the production and comprehension of code-switched sentences. Green and Wei's (2014) Control Process Model that relates variability in bilingual experience to different types of language control is an excellent starting point to examine these factors in the context of the production and comprehension of code-switched sentences.

Furthermore, much of our current insights into the cognitive and neural mechanism of the comprehension of code-switched sentences is based on reading rather than listening to code-switched utterances. As code-switching occurs more frequently in spoken than in written discourse, more knowledge on the comprehension of code-switched speech is needed. Studying code-switched speech also opens up a new line of research into the role of speaker identity on code-switched sentence processing. For example, many bilinguals who code-switch have a perceivable accent in one or in both of their languages, and accented speech may cue or facilitate the listeners' comprehension of code-switched speech (cf. Fernandez & Van Hell, submitted). Relatedly, studying speech comprehension using the visual world paradigm, Fricke et al. (2016) found that bilingual listeners can exploit low-level phonetic cues to anticipate that a code-switch is coming. Do listeners exploit these cues to predict an upcoming switch and how do these cues affect their comprehension of code-switched speech downstream? How does the listener's knowledge of a speaker's code-switching practices and language experiences modulate these mechanisms?

In addition, theoretical models on the cognitive and neural basis of language processing need to be tested in experimental studies, but also via computational or neural network modeling. Some first efforts have been made to test some specific theories of code-switched sentence

processing using computational modeling (Cohen et al., in press; Tsoukala et al., 2021), but clearly more work is needed in this area as well as in the neural network domain.

As of yet, most psycholinguistic work on the comprehension and production of code-switched sentences studied Indo-European languages, recruiting bilinguals in the USA and Europe. We know little about the cognitive and neural mechanisms of code-switching in bilingual/multilingual communities in other regions of the world, for example, the African continent, Oceania, or South East Asia. We also know very little about code-switching patterns in trilingual speakers.

Finally, code-switching in bimodal bilinguals, users of a signed language and a spoken language, is particularly interesting, because in their code-switching behavior (termed code-blending) propositional content can be expressed simultaneously (saying ‘cat’ and signing ‘cat’ at the same time), rather than linearly as in spoken languages (Emmorey et al., 2008; Emmorey et al., 2020). Exploiting the simultaneity offered by the spoken and manual modalities, these code-blends provide unique insights into theoretical models of sentence production and comprehension.

#### **4a. List of open questions and issues**

How do bilinguals' code-switching practices and experiences influence the production and comprehension of code-switched sentences?

How does the listener's knowledge of a speaker's code-switching practices and language experiences modulate cognitive and neural processes associated with the comprehension of code-switched speech?

Code-switching across the lifespan: What are the developmental dynamics of the comprehension and production of code-switched speech across the lifespan?

#### **5. Further reading**

Special Issue in *Frontiers in Psychology*, March, 2021: Behavioral and neurophysiological approaches to codeswitching and language switching. Editors: J. Treffers-Daller, E. Ruigendijk, and J. Hofweber.

This issue contains 19 articles addressing: (1) the relationship between codeswitching/language switching and cognitive control; (2) linguistic processing of codeswitches/language switches; (3) neural and electrophysiological correlates of switching; and (4) linguistic and orthographic analyses of codeswitches/language switches.

Special Issue in *Linguistic Approaches to Bilingualism*, 2018, Issue 1: Methodologies for intra-sentential code-switching research. Editors: A. Munarriz-Ibarrola, M. C. Parafita Couto, and E. Vanden Wyngaerd.

This issue contains six articles describing psycholinguistic methodologies used in intra-sentential code-switching research.

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