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Psycholinguistics of Multilingual Code-Switching

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17.1 Introduction

Code-switching, the fluid alternation between languages in text or during speech, is a hallmark of multilingualism requiring a high degree of proficiency across languages. For instance, in Spanish–English bilingual communities in South Florida, it is common to hear utterances such as *pero no tenían el flag out there?* "But didn't they have the flag out there?" in which the two languages are seamlessly mixed (example from Bangor Miami Corpus; Deuchar et al., 2014). Most prior work on code-switching has focused on bilingual speakers analyzed within social and theoretical perspectives (for reviews, see Bullock & Toribio, 2009; Gardner-Chloros, 2009; Chapter 16 of this volume). Based on this prior work, we know that code-switching follows grammatical constraints and that its use is subject to individual, social, and pragmatic factors. In short, code-switching is a community-supported practice that requires a high degree of proficiency across languages. Despite its associations with haphazard, agrammatical, or even "corrupted" language use in many societies, it is a systematic and a highly skillful linguistic act.

Within the last two decades, psycholinguists have shown increasing interest in the cognitive and neural processes that support code-switching, yet less is known about multilingual code-switching. In this chapter, we provide an overview of the psycholinguistics of code-switching by first contextualizing code-switching within research on broader switching phenomena, including single word cued language switching – a common experimental paradigm used to investigate bilingual language control. We discuss linguistic and extra linguistic factors that affect the production and comprehension of intrasentential

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code-switching (i.e., code-switches that occur within the level of a sentence). Due to the paucity of experimental work on multilingual code-switching, we dedicate the second half of the chapter to investigating these factors in multilingual speakers in Algiers, Algeria who speak French, Standard Arabic, and Algerian Arabic and are habitual code-switchers. We discuss what questions can be answered by studying the psycholinguistics of code-switching in a multilingual community like Algiers. We conclude with a call to understand the diversity of social contexts in which multilinguals find themselves to lay the groundwork for studying the processing of multilingual code-switching.

17.2 The Psycholinguistics of (Bilingual) Code-Switching

17.2.1 Cued Language Switching

Psycholinguistic research on bilingualism has produced a body of work converging on the finding that bilinguals activate both of their languages to some extent during listening, reading, speaking, and writing (Kroll et al., 2016) yet most bilinguals are biologically constrained to produce words only in one language at any given moment (i.e., unimodal bilinguals). Interestingly, bimodal bilinguals, or bilinguals whose languages are represented across two modalities such as in speech-sign bilinguals, demonstrate the ability to code-blend, producing a sign and spoken utterance at the same time (Emmorey et al., 2008a). This modality distinction leads to differences in language control as evidenced by bimodal bilinguals' preference for code-blending over code-switching (Emmorey et al., 2008b; Blanco-Elorrieta et al., 2018). Our use of the term "bilingual" in this chapter will refer to spoken language, unimodal bilinguals. Kroll and colleagues (2012) have used the analogy of the "mental juggler" to describe the bilingual's experience of constantly navigating between languages and the need to attend to the intended language via domain-general cognitive mechanisms. Therefore, a focus of psycholinguistic research in bilingualism is understanding the linguistic, cognitive, and neural mechanisms that successfully guide bilinguals to select and switch among their languages. Despite the overwhelming and robust evidence of parallel language co-activation in bilinguals, psycholinguistic research on bilingualism primarily focuses on contexts in which a single language is ultimately selected, situations that we term *unilingual* contexts (in contrast to monolingual language use by monolingual speakers). Yet many bilingual speakers engage in bilingual speech practices such as code-switching in certain interactional contexts.

Bilingual language control refers to the cognitive mechanisms that underlie selecting a target-appropriate language. A widely used paradigm to study this issue is cued language switching using isolated words. Bilinguals are presented with pictures or numbers and are asked to name

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them in a target language as signaled by an external cue, such as the background color of a computer screen (e.g., Meuter & Allport, 1999; Costa & Santesteban, 2004; Gollan & Ferreira, 2009). Sequences are constructed such that a current trial represents a repeat or switch trial from the preceding named trial. For bilinguals, trials are named in a first (L1) or second (L2) language, thus further enabling an analysis based on switch direction. Cued language switch studies also commonly examine naming times for the same language in blocked unilingual sessions versus sessions in which both languages are to be named (i.e., mixed blocks). Our brief review primarily covers bilingual studies of cued language switching due to the paucity of research in multilingual speakers; however, we note that more research in multilingual speakers is needed as certain theoretical questions are confounded in bilingual populations. For example, a bilingual is either speaking one or the other language, thus obfuscating the precise contributions of inhibitory or attentional control in bilingual language control. Studies on multilingual speakers can help disentangle these factors.

A common finding in these production studies is that switching takes more time than staying in the same language, typically referred to as a switch cost. Another finding is that of a mixing cost: response times are longer for repeat trials when these are presented in the mixed-language block as compared to the unilingual blocked session. Switch costs may be affected by the direction of the switch, leading to an asymmetric switch cost, especially when language dominance differs greatly between the two languages among other factors, as discussed in Section 17.2.4.2. Generally, switching from the less dominant into the more dominant language is more costly than the other way around (Meuter & Allport, 1999; Declerck & Philipp, 2015). Such asymmetric switch costs have also been observed in nonlinguistic switch tasks, in which switching from a hard into an easier task is more difficult than switching from an easy into a harder task (e.g., naming shapes versus colors; Monsell, 2003). This finding has been explained in terms of inhibition: the bilingual individual must exert greater inhibition on the dominant language to successfully produce in the nondominant language. Consequently, when a participant encounters a trial in which they must switch back into the dominant language, they must overcome that greater inhibition, thus leading to an increase in response times. By comparison, successfully producing in the dominant language requires less inhibition of the nondominant language, leading to less costly switching when needing to switch back into the nondominant language (for alternative accounts, see Green 1998; Meuter & Allport, 1999; Linck et al., 2012; cf. Bobb & Wodniecka, 2013). Similarly, researchers have interpreted mixing costs as reflective of a proactive, global inhibition of the language not in use in the unilingual block, leading to less interference of the non-target language than in the mixed language block (e.g., Christoffels et al., 2007; Prior & Gollan, 2011).

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A major insight from cued language switching studies is that switching and mixing costs and their (a)symmetry can be modulated by individual and task factors. For example, high proficiency Catalan–Spanish bilinguals demonstrated symmetric switch costs either due to higher proficiency or the degree of language contact between the bilingual's languages (Costa & Santesteban, 2004). Switch costs are robustly found in production but less reliably so in comprehension due to differences in processing stages across modality (for a review, see Declerck & Phillip, 2015). Switch costs are also attenuated under voluntary conditions; that is, when bilingual participants are permitted to name upcoming trials in either language, switch costs are reduced, in part, due to lexical accessibility and lexical activation levels (Gollan & Ferreira, 2009). Researchers have also recently argued for incorporating more social factors in cued language switching paradigms. Blanco-Elorrieta and Pylkkänen (2017) demonstrated that switch costs vary as a function of the social and pragmatic cues that establish the appropriateness of bilingual language use with switch costs becoming reduced in similar contexts as when bilinguals would naturally switch between languages (i.e., switching in the presence of a bilingual interlocutor versus switching with no interlocutor present). Similarly, bilinguals who habitually switch between languages show reduced switch costs as compared to bilinguals who switch less often (Festman et al., 2010; Prior & Gollan, 2011).

In comparison, few studies have utilized the cued language switching paradigm in trilingual or multilingual speakers. The handful of studies on multilinguals have provided valuable insights in teasing apart the effect of the speaker's general experience dealing with more than one language and the effects of proficiency level across each language (e.g., Costa & Santesteban, 2004; Costa et al., 2006; Philipp et al., 2007; cf. Mosca, 2019). However, these studies primarily examine switch and mixing costs in multilingual speakers' pairs of languages (e.g., L1 vs. L2, L1 vs. L3); exceptions are studies by Liu and colleagues (2020) and Mosca (2019). Liu and colleagues investigated different neural signatures underlying switching into a language and switching away from a language in Chinese (L1)–English (L2)–Japanese (L3) trilinguals using electroencephalography (EEG). They also measured proactive control using the AX-Continuous Performance Test (AX-CPT), a cognitive control task that measures proactive and reactive control and that has been used previously to investigate bilingual language control (Morales et al., 2013). This issue of switching-into versus switching-away cannot be investigated in bilingual speakers, since the two subprocesses of language control overlap in bilingual language control (i.e., speakers are both switching into Language B and switching away from Language A at the same time). Liu and colleagues demonstrated that these subprocesses are, in fact, dissociable leading to distinct neural signatures; specifically, that switching away increases negativity in an early time window (N2), reduces positivity in

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a later time window (LPC), and is correlated to proactive control. Mosca investigated trilingual language switching across two groups of trilinguals who share the same three languages, German, English, and Italian, but vary in their L1 (Group 1: Italian [L1]–German [L2]–English [L3]; Group 2: German [L1]–English [L2]–Italian [L3]), proficiency levels across languages, and their immersion contexts. This language combination further allowed Mosca to examine the role of typological similarity in multilingual language control by capitalizing on whether the first and second languages or the second and third languages were typologically more similar. The results are complex; for example, mixing costs were found in the first trilingual group with a larger magnitude for the L1 but no such greater mixing cost for the L1 was found for the second group. However, switch costs were consistent for switching back into the L1 but not for the L2. Typological similarity did not have an apparent effect on the magnitude of switch costs. These complex results are not surprising given the increased number of experimental variables that must be controlled and the substantial number of additional trials necessary to carry out a well-powered analysis. Additionally, the general dearth of experiments testing trilingual language experience make it currently hard to conclude the locus of any potential differences between languages or groups. More multilingual language-switching studies with a broader representation of languages will be necessary to disentangle the contributions of proficiency, immersion, and typological similarity.

17.2.2 Code-Switching in Sentence Contexts

While cued language switching has provided valuable insight into bilingual language control, it utilizes isolated words that come from the same semantic and/or grammatical category, leading to appreciable differences from the code-switches that bilinguals use and hear in their daily lives. For one, code-switches occur embedded in sentence contexts and are part of an interactive exchange that is supported by discourse and pragmatic functions. Code-switches can be infrequent and involve single-word insertions or may involve copious switches between languages and include multiword turns in each language (Muysken, 2000; Green & Wei, 2014). While the transitions between languages appear seamless, code-switching is not random and is therefore subject to grammatical constraints, although the search for universal grammatical constraints remains elusive (see Bullock & Toribio, 2009; Gardner-Chloros, 2009; Deuchar, 2020; see also Chapter 16 of this volume).

Likewise, bilinguals are well attuned to when and with whom they can engage in code-switching, and its level of support within a bilingual community is partially determined by community-supported practices as well as the individual-level variable of proficiency. Thus, even bilinguals who speak the same or similar language pairs may differ in their code-switching habits.

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For example, French–English bilinguals of the Ottawa-Hull region of Canada code-switch less frequently and use more restricted patterns than Spanish–English bilinguals in New York City (Poplack, 1988). Some scholars have recently classified such differences as the interactional context of the bilingual (Beatty-Martínez et al., 2020b) and have found that differences across interactional contexts can impact the recruitment of cognitive control and affect lexical access. Such highly experience-based effects are supported in recent theoretical frameworks such as the Adaptive Control Hypothesis (ACH; Abutalebi & Green, 2013). These frameworks hypothesize that control processes such as goal maintenance, response inhibition, and task engagement are exercised to different levels based on the cumulative experience that bilinguals have in their interactional contexts.

While there may be a myriad of reasons for why bilinguals code-switch, the emerging picture is that code-switching is a contextually supported bilingual speech act. Consequently, bilinguals may learn to associate certain pragmatic functions with its use, including to encode upcoming unexpected (Myslín & Levy, 2016; Tomić & Valdés Kroff, 2021a) or emotionally charged content (Tomić & Valdés Kroff, 2021b). Because code-switches occur embedded within sentential contexts and are constrained by pragmatic, individual-level, and community-level factors, the degree to which cognitive mechanisms that support word-level cued language switching overlap with sentential code-switching is not known. Therefore, studies that investigate the production and comprehension of code-switching are necessary to disentangle their processing from those involved in language control.

17.2.3 Psycholinguistic Methods and Switch Costs

As with single-word cued switching, psycholinguistic studies on intrasentential code-switching generally report switch costs (e.g., Altarriba et al., 1996; Moreno et al., 2002). The few studies investigating production suggest that code-switching may also subtly affect production (Beatty-Martínez et al., 2020a; Johns & Steucke, 2021). For instance, investigating data from the Bangor-Miami corpus, Fricke and colleagues (2016) show that speech rate slows down in spontaneous speech before code-switches to the other language, which in turn becomes exploited by listeners in comprehension (see also work by Gollan, Goldrick, and colleagues for inferences on intrusion errors, grammatical class, and priming in language control by investigating read-aloud paradigms with artificially mixed language texts; e.g., Gollan & Goldrick, 2016; Schotter et al., 2019).

Most psycholinguistic studies on intrasentential code-switching investigate online comprehension. The most commonly used techniques to study online sentence comprehension are self-paced reading, eye-tracking, and EEG (Gullberg et al., 2009; Van Hell et al., 2018; Valdés Kroff et al., 2018). In a self-paced reading study, participants read a sentence word by word.

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Every time they press a button, the current word disappears, and the next word is presented. Button press response times for each word are therefore a proxy of reading times. Generally, switch costs are found such that encountering a code-switch leads to a measurable slowdown as compared to continuing in the same language (Altarriba et al., 1996; Bultena et al., 2015; cf. Gullifer et al., 2013; Johns et al., 2019). In eye-tracking studies, participants read sentences on a screen while their eye-movements are recorded. This technique allows investigators to see how much time participants spend fixating or re-reading certain words. When reading times are compared between sentences with and without switches, increased reading times are observed for the switch word versus a non-switched control word (Altarriba et al., 1996; Bultena et al., 2015). Eye-tracking is also used to investigate auditory comprehension using the visual world paradigm (Tanenhaus et al., 1995). In this paradigm, participants examine a visual scene as they listen to speech. Because participants fixate on relevant images as they process speech, researchers can use the timing to fixate on critical items as well as overall proportion of fixations on target items to infer how difficult or easy a sentence is to process in code-switched as compared to unilingual sentence contexts (Fricke et al., 2016; Byers-Heinlein et al., 2017; Valdés Kroff et al., 2017).

EEG, and in particular event-related potentials (ERPs), has been an increasingly popular method in identifying various processes or mechanisms that underlie the comprehension of intrasentential switches. EEG studies record electrical brain activity from the scalp while participants are reading or listening to sentences (e.g., Moreno et al., 2002; Ng et al., 2014; Beatty-Martínez & Dussias, 2017; Litcofsky & Van Hell, 2017; Fernandez et al., 2019; Valdés Kroff et al., 2020; Vaughan-Evans et al., 2020). ERPs are obtained by taking the EEG that is time-locked to the onset of a code-switched word of interest and comparing this to the EEG time-locked to a non-switch control word. Code-switches typically elicit a Late Positive Complex ERP component (LPC; Moreno et al., 2002). This component has been interpreted as reflecting sentence-level revision and updating and/or encountering unexpected continuations (Van Hell et al., 2018).

17.2.4 (Extra)Linguistic Factors Modulating Intrasentential Switch Costs

Studies on the comprehension of intrasentential code-switching find evidence of switch costs (Altarriba et al., 1996; Moreno et al., 2002; cf. Johns et al., 2019). This finding is in contrast to comprehension studies using single-word cued language switching paradigms, in which switch costs have been rarely attested (Declerck et al., 2019). On the surface, this difference between comprehension tasks suggests that the sentence context imposes additional constraints on processing code-switches or may

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lead to greater unexpectancy of an upcoming code-switch – these constraints do not appear to be present in single-word contexts. Given the ubiquity of code-switching in certain multilingual communities, these comprehension-based switch costs further suggest that they can be attenuated by other factors, both linguistic and extralinguistic. We present a short overview of example factors here (for more extensive recent reviews, see Myers-Scotton and Jake, 2015; Van Hell et al., 2015, 2018; Beatty-Martínez et al., 2018; Valdés Kroff et al., 2018; Deuchar, 2020).

17.2.4.1 Linguistics Factors

Corpus-based studies have examined whether code-switches are more likely to occur after certain words that are shared between languages such as cognates, proper names, or cultural references (e.g., Broersma & De Bot, 2006; Broersma et al., 2020) – an idea that originates from the triggering hypothesis (Clyne, 1967). The locus of this effect is that shared forms activate both languages to higher levels, making code-switching more likely. This higher incidence of code-switches has empirical support in bilingual production data, although less so in comprehension-based experimental tasks, which may in part be due to differences in speech planning versus bottom-up recognition processes necessary for comprehension (Bultena et al., 2015). Similarly, lexical and structural priming have been proposed to affect code-switching (e.g., Fricke & Kootstra, 2016; Kootstra et al., 2012). Lab-based priming tasks typically use a picture naming task in which naïve participants are paired with confederates who follow a script and whose status as a member of the experimental team is hidden from the participant. Confederates and participants take turns describing images with the ultimate goal of examining whether the scripted syntactic structure of the confederate's utterances affects the participant's production choices. These tasks also show an effect of cognates on the likelihood of producing code-switches, as well as greater incidence when there is structural overlap between the languages (Kootstra et al., 2012, 2020).

Aside from slowdowns in speech rate, subtle phonetic shifts are noted in code-switched speech production. For example, voice onset time (VOT) is a phonetic parameter tied to stop consonants (e.g., /p t k/) and measures the time that lapses between the release of an occlusion and the onset of voicing. While languages may have similar stop consonant phoneme inventories, they may differ in their VOT values, as is the case of the shorter VOT values of Spanish /p t k/ versus longer VOT values in English. In turn, corpus analyses demonstrate that Spanish–English bilinguals shorten their English VOT values prior to a code-switch into Spanish, thus approximating Spanish VOT values (Balukas & Koops, 2015). Fricke and colleagues (2016) capitalized on these corpus-based findings by demonstrating that bilingual listeners show delayed processing of code-switches in the absence of these subtle phonetic shifts. Similarly,

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Cantonese–English bilinguals used knowledge of phonological constraints on word-initial consonant clusters to anticipate the presence of an English code-switch, as demonstrated in a gating paradigm (Li, 1996).

At the syntactic level, researchers examine whether the grammatical properties of the monolingual source grammars constrain speech production and comprehension at the code-switch juncture in multilingual speech. While Spanish has obligatory gender agreement between prenominal determiners and nouns, Spanish–English bilinguals are more flexible in whether the Spanish determiner agrees with the Spanish translation equivalent of the following English noun (e.g., *el house* vs. *la house* vs. *la casa* "the$_{fem}$ house$_{fem}$"). Consequently, bilinguals differentially process gender agreement from Spanish monolinguals (Valdés Kroff et al., 2017). Word order differences across languages is another important syntactic factor. One recent line of work investigates whether theoretical accounts of grammatical constraints in code-switching accurately predict difficulties in sentence processing in adjective-noun constructions when word order differs across languages (Pablos et al., 2018; Vaughan-Evans et al., 2020). These results have overall been mixed, indicating that parsing challenges do not directly stem from theorized syntactic constraints (for further discussion on syntactic constraints in code-switching, see also Chapter 16 of this volume).

17.2.4.2 Dominance and Proficiency

Individual factors such as language dominance or language proficiency are also shown to affect switch costs and are further modulated by switch direction. While these constructs are not well defined, proficiency can refer to receptive and/or expressive ability across languages and are usually measured via self-report and/or standardized assessments targeting different linguistic levels. Dominance refers to the relative proficiency of each language within the multilingual speaker (e.g., Hernández-Chávez et al., 2013). In comprehension studies, intrasentential switch costs are larger for switches into the weaker (or less proficient) language than for switches into the stronger (or more proficient) language (Bultena et al., 2015; cf. Litcofsky & Van Hell, 2017). In ERP studies, the LPC is larger for switches into the weaker language (Litcofsky & Van Hell, 2017; Fernandez et al., 2019). Switches into the stronger language instead lead to N400 effects, at least in the auditory modality (Fernandez et al., 2019). These findings point to another difference with single-word cued language switching where switch costs are greater for switching into the stronger language, at least in production. The asymmetric pattern in comprehension has been explained by the need to suppress the dominant language when switching to the weaker language. Since the dominant language is generally activated to a higher extent, a switch from the weaker into the dominant language does not require as many resources than a switch from the stronger into the weaker language. Alternatively, these differences

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could be due to the pragmatic functions signaled by intrasentential code-switches. Bilinguals typically switch to the societal language or language of power to signal new information, which, at least for a subset of multilingual code-switchers, coincides with their weaker language (e.g., switches into English in US bilingual speakers: Czech–English bilinguals, Myslín & Levy, 2015; Spanish–English bilinguals, Tomić & Valdés Kroff, 2021a). Therefore, measurable costs encountered while processing intrasentential code-switches may be due to the pragmatic infelicity of the switch, leading to the need to integrate and re-analyze unexpected linguistic content.

17.2.4.3 Exposure/Frequency of Code-Switch Pattern

Relatedly, experience-based factors modulate the switch cost in intrasentential switching. First, switch patterns that occur more frequently are processed more easily. For instance, for Spanish–English bilinguals, switching between the auxiliary and the participle within the verb phrase is more common with the auxiliary *estar* ("to be," e.g., *está cooking* "is cooking") than with the auxiliary *haber* ("to have," *ha cooked* "has cooked") as confirmed by a corpus analysis (Guzzardo Tamargo et al., 2016). This asymmetric pattern is also reflected in experimental data. When comparing switches before the verb phrase – considered to be an "easy" switch point between phrase boundaries – to switches within the verb phrase (i.e., after the auxiliary), only post-auxiliary *haber* switches led to increased reading times, indicating costlier processing (Guzzardo Tamargo et al., 2016). Furthermore, in daily bilingual language use, sentences with intrasentential switches are often found embedded in longer stretches of unilingual discourse. When this pattern is violated in an experimental context; that is, when every sentence contains a switch, code-switched sentences are read more slowly than when they are presented intermixed with unilingual sentences (Johns et al., 2019). In Vaughan-Evans and colleagues' (2020) study, Welsh–English bilinguals experienced greater processing differences as measured by EEG when encountering code-switched English adjectives in Welsh matrix clauses (i.e., the grammatical frame of the utterance was Welsh; Myers-Scotton, 1993a); however, code-switched Welsh adjectives inserted into English matrix clauses did not elicit such processing differences. Potentially, this asymmetry derives from greater exposure to and use of Welsh matrix clauses in Welsh-English code-switching, thus further highlighting how frequency of code-switching use affects sentence processing. The emerging picture is that switch costs are modulated by exposure-based factors; the more frequent certain production patterns are within a community of bilingual speakers, the smaller the switch costs in sentence processing.

17.2.4.4 Individual Habits and Social Factors

Frequency and type of code switching are subject to societal norms, but even within a community of speakers, individuals can differ in their

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code-switching habits (Kheder & Kaan, 2016). Beatty-Martínez and Dussias (2017) compared a group of Spanish–English bilinguals in Granada, Spain, who maintain a functional separation between their languages in their daily conversations, and a group of Spanish–English bilinguals in the United States, who were habitual code-switchers. This difference in code-switching use was later confirmed by a conversational map task. The two bilingual groups read sentences that contained an embedded noun phrase in which a Spanish determiner was followed by either a continuation in unilingual Spanish or a code-switch into an English noun (e.g., *el tenedor* vs. *el fork*), a common code-switch in US Spanish–English bilingual conversation (Poplack, 1980). The Spanish translation equivalent of the English noun after the switch either matched or did not match the gender of the determiner (*el* vs. *la spoon*, Sp. *la cuchara*). Bilinguals who did not habitually code-switch were not sensitive to the gender incongruency for the English code-switches; whereas those who habitually code-switched showed an N400 component in gender-incongruent English noun conditions following the feminine determiner *la*. However, no such effect was found when an English noun followed the masculine determiner *el*, regardless of the gender of the translation equivalent. The latter is a commonly observed pattern in code-switching: switches are more frequent after a masculine determiner, even when the translation equivalent of the English noun is feminine (e.g., Valdés Kroff, 2016). This asymmetric grammatical gender sensitivity to different code-switched noun phrases suggests that both exposure to frequent code-switching patterns in naturally occurring bilingual discourse as well as an individual's use of such code-switching patterns are relevant factors that affect the processing of code-switched speech.

Along the same lines, several recent EEG studies have reported an early positive component emerging around 200–300 ms after word onset (the exact component remains unclear) for switch versus non-switched words in sentence contexts that is larger for bilinguals who self-report that they do not code-switch frequently in their daily lives (Beatty-Martínez & Dussias, 2017; Kaan et al., 2020; Valdés Kroff et al., 2020). This early positivity has been interpreted as indexing proactive inhibition of one language. Individuals who do not habitually code-switch are more likely to not expect the other language during a conversation or while reading text, leading to a "narrow" scope of attention. When a code-switch occurs, the bilingual must release proactive inhibition and shift toward a "broad" scope of attention to both languages (Green & Wei, 2014).

The appropriate pragmatic context for code-switched speech is also determined by the interlocutors present during the conversational exchange. For code-switching to be used felicitously, all conversation partners should share the same languages. Recently, the effect of the interlocutor's known languages has been shown to affect how bilinguals

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process code-switches. Kaan and colleagues (2020) had Spanish–English bilingual participants read unilingual English sentences and sentences that began in English and contained a code-switch into Spanish. While completing the reading task, participants were accompanied by someone who they either knew as another Spanish–English bilingual or who did not speak Spanish, as determined by a communicative exchange task prior to the main experimental session. The amplitude of the commonly elicited LPC for code-switches was smaller when the bilingual participants were paired with a bilingual interlocutor than with a monolingual interlocutor. These findings suggest that, even within the same bilingual individual, code-switches can be processed differently depending on the pragmatic context. These newer lines of experimental approaches that incorporate pragmatic and sociolinguistic variables are, of course, a starting point and require replication and further investigation. Nevertheless, they point to the processing of code-switching as a highly contextually driven phenomenon with implications for multilingual speakers.

In sum, even though intrasentential code-switching is ubiquitous in some communities, there is evidence that code-switching remains costly in terms of processing. These switch costs can be modulated by linguistic and extralinguistic factors related to proficiency, experience, and social norms. There remain, however, several questions concerning the interaction between these multiple variables. For one, multilinguals are likely to vary in their proficiency levels across languages, yet community norms may constrain code-switches to be more likely between pairs of languages. Consequently, will switch patterns that match community use outweigh proficiency? Such an outcome may lead to scenarios in which switch costs between a third and second language may be greater than a third and first language. Additionally, when considering the variables that affect multilingual language control, as reviewed in Section 17.2.1, multilingual code-switching may further reveal the relationship between typological similarity, language co-activation, and subprocesses of language control such as switching-into and switching-away from multiple languages. We illustrate how these experiential factors come into play by summarizing recent studies on Algerian multilinguals in the next section.

17.3 Multilingual Language Use in Algeria

Anyone who visits Algeria will quickly realize that Algerians navigate between four different language varieties across different conversational settings. These varieties are Standard Arabic, Algerian Arabic, Berber (Tamazight), and French. Berber is an Indigenous language of North Africa, and Arabic and French arrived later through language contact with Arab or French settlers. Algerian multilingualism ranges from speakers of two to all four languages. The functional distribution between

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Algerian and Standard Arabic is described as diglossia. The more standardized form, Standard Modern Arabic (SA), is regarded as having a high status and its vernacular form, Algerian Arabic (AA), has a low status (Fergusson, 1959). Standard Arabic is accorded public and prestigious functions. It is learned through formal education and is used in writing but also dominates media in spoken news as well as political, scientific, and religious discourses. Algerian Arabic is acquired at home usually before children enter school. Algerian Arabic is widely used for everyday communication: at home, in the streets, dealing with different transactions, and on television. Berber is more limited to areas where most of the people are speakers of Berber. However, even in places where Algerian Arabic is commonly used in public spaces, Berber speakers may still use it at home with family. With the gradual imposition of French in schools and institutions, its acceptance was relatively slow through the 130 years of French settlement but has ultimately become a part of the multilingual repertoire of the region. Contrary to Standard Arabic, Algerian Arabic has incorporated many French lexical borrowings. Today, French is taught at schools from second or third grade, and many fields in higher education use French as the only medium of instruction. Outside of school, exposure to French varies. French appears on TV, radio, and in several written newspapers. While language policy implements French instruction from early on, proficiency in French varies widely due to complex sociohistorical factors that include language attitudes, urbanization, and socioeconomic status (Benrabah, 2014). Nevertheless, Algeria is considered to be the second most populous French-speaking country outside of France (Chemami, 2011).

17.3.1 Code-Switching in Algeria

Due to its highly multilingual environment, code-switching is observed to be an unmarked communicative choice across North Africa (Myers-Scotton, 1993b). Long, sustained contact with French, especially in regions where French settlement was relatively high, has led to code-switching becoming a highly visible form of speech. While multiple language varieties are present, individual switching patterns display highly conventionalized forms (Boumans & Caubet, 2000). Patterns include complete or partial noun phrase switches, prepositional phrases, adverbial phrases, and whole independent or subordinate clauses (Bentahila & Davies, 2002; Davies & Bentahila, 2006). A characteristic of Algerian Arabic–French code-switching is the preservation of gender and number features across languages. For instance, data from Boumans and Caubet (2013) showed that feminine French nouns trigger feminine agreement in Algerian Arabic verbs and pronouns, and masculine nouns trigger masculine agreement. As for number, their data showed that embedded French nouns are used with French plural articles *les* ("the" [plural]) and *des* ("some")

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and are not morphologically marked with the Algerian Arabic plural marker. In definite noun phrases, Boumans and Caubet (2020) observed an asymmetry in determiner use. Most French embedded nouns are preceded by the French articles *l'*, *la,* or *les* instead of the Algerian Arabic article *el.* However, masculine singular French nouns are mostly preceded by the Algerian Arabic article *el,* which may further be accompanied by phonological assimilation.

Despite the high degree of multilingualism in Algeria, code-switching does not occur equally between all language pairs, and its frequency largely depends on context, individual profile, and community norms (Kheder & Kaan, 2016). Code-switching typically occurs between the spoken varieties of Algerian Arabic and Berber or between either of these varieties and French. Switching between Standard Arabic and French is very limited and is nearly absent in conversational exchanges, potentially because of the "high" register associated with Standard Arabic (Albririni, 2011). Individual speakers also vary in their frequency of code-switching use. The intricate distribution of code-switching between certain pairs of languages makes studying Algerian multilingual speakers an intriguing test case to investigate the role that several of the linguistic and extralinguistic variables reviewed in the previous section play in the processing of code-switched speech. We illustrate how investigating multilingual speakers can help inform psycholinguistic research by focusing on three areas: lexical activation and selection, cross-language interaction and switch costs, and the link between language processing and cognitive control. Specifically, examining multilingual code-switching allows researchers to disentangle variables that are otherwise dissociable in bilingual speakers, precisely because of the use of more than two languages. As will be seen in the rest of this chapter, Algerian speakers demonstrate a marked preference for switching between two of their multiple languages, suggesting a greater role for community norms in sentence processing.

17.3.2 Psycholinguistic Studies of Algerian Multilinguals

As previously reviewed, bilinguals must navigate and manage the simultaneous co-activation of their languages (e.g., Kroll et al., 2015). Lexical selection, therefore, requires a mechanism that enables bilinguals to appropriately select between competing language systems and to reduce possible interference. This mechanism, supposedly inhibitory in nature (e.g., Green, 1998), is presumably part of a set of domain-general cognitive processes. A central question has been whether the consequences of bilingual language experience shape cognitive function and brain structure in a profoundly different way than do the consequences of a monolingual language experience.

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The psycholinguistic use of "bilingualism" is broad and neutrally refers to speakers of more than one language without much differentiation between speakers of two or more than two languages. While on the surface the difference may seem to be merely in number, this difference triggers several questions on whether the addition of a third language further affects language control. If bilingualism is claimed to afford a lifetime of cumulative experience in navigating between languages leading to resultant changes in brain function and structure, in what ways do additional languages modulate this cumulative experience?

17.3.2.1 Lexical Activation and Lexical Selection

The varied linguistic experiences of multilingual speakers contribute to their pragmatic knowledge of when and under which contexts to use their languages. While an appropriate selection of a lexical item among available choices is directed by the speaker's intention and requires high language proficiency, it is additionally dictated by the communicative needs of each context (Myers-Scotton, 2000; Meuter, 2009). Speakers must be ready to integrate and respond in any language, which further involves seamless code-switching between languages. This readiness is partially guided by sensitivity to linguistic and extralinguistic cues such as accent and language-specific morphosyntactic patterns. Cue sensitivity depends on exposure, language use, and code-switching habits. Recently, these experiential factors have been investigated in bilinguals in between-group designs, comparing bilinguals of the same language pair in different communities (e.g., Hofweber et al., 2016; Beaty-Martínez & Dussias, 2017; Valdés Kroff et al., 2018).

Nevertheless, multilingual speakers afford researchers the opportunity to investigate many of the same factors in a within-groups design. Kheder and Kaan (2016) examined how language use and exposure affect the expectancy and or the integration of a language switch in trilingual Algerian speakers. The study compared code-switches between language pairs where code-switching is common (i.e., Algerian Arabic and French) to code-switches between language pairs where code-switching is infrequent (i.e., Standard Arabic and French). Experience-based psycholinguistic models of processing (e.g., MacDonald, 2013; Dell & Chang, 2014) predict that more frequent language usage should correspond with easier processing; thus, code-switches from Algerian Arabic to French should demonstrate facilitated processing as compared to code-switches from Standard Arabic to French.

To test this prediction, Algerian trilinguals listened to sentences that either started with Algerian Arabic (AA, 1a; 2 c) or with Standard Arabic (SA, 1b; 2d) and code-switched into a written French noun phrase (FR). Sentences were also either semantically high constraining (1) or low constraining (2) to test the effect of semantic expectancy on processing upcoming code-switches. Following the offset of the last auditory word,

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listeners had to read a French noun phrase continuation out loud as quickly and accurately as possible.

(1) Semantically high-constraint sentences
  (a) Kul-ma naɣaslu snaan lazem nʃallu **la bouche**. (AA-FR)
  (b) fi kuli maratin naɣsilu fiha ʔal ʔasnaan jaʤibu ʔan naʃtˁifa **la bouche**. (SA-FR)

"Every time we brush teeth, we rinse **the mouth**."

(2) Semantically low-constraint sentences
  (a) haad lewled ma rqadsh 3laxatˁerʃ kan ʕendu sˁtˁar fi **la bouche**. (AA-FR)
  (b) ʔina haað lwalad lam janam liʔanahu kaana juʕaani min ʔalamin fi **la bouche**. (SA-FR)

"This boy did not sleep because he had pain in **the mouth**."

In high-constraint sentences, French code-switches were named faster when the base language was Algerian Arabic (1a was faster than 1b). Several alternatives can account for these findings.

According to the language typological distance hypothesis (Pienemann et al., 2005), code-switching is possible and/or easier between typologically similar languages; however, typological distance alone cannot account for the results. Typological proximity between languages may be determined on various linguistic levels such as the lexicon, phonological/phonotactic cues, functional morphology, and syntactic structure (e.g., Rothman, 2015). In the case of switching between Arabic varieties and French, both varieties are distant from French on several levels. However, on the lexical level, Algerian Arabic shares more cognates with French due to sustained contact borrowing. In the current study, cognates were avoided; thus, all target French switches were noncognate French words. While the greater similarity between Algerian and Standard Arabic would suggest close to no differences in processing when code-switching into French, it is possible that the shared words between Algerian Arabic and French lead to greater co-activation of French, which may cause greater interference upon encountering French code-switches. Consequently, the results suggest that typological similarity by itself cannot explain this difference.

Activation accounts (La Heij, 2005; Finkbeiner et al., 2006; Blanco-Elorrieta & Caramazza, 2021) predict that the processing of a code-switch is affected by the degree of language activation. Multilinguals are sensitive to the language context of a given setting or exchange, leading to greater activation of context-relevant languages (Grosjean, 2001). This proactive activation of relevant language(s) can take place on a trial-by-trial basis in an experimental session. Thus, the ease of processing of French code-switches after hearing Algerian Arabic is due to its greater expectancy as compared to when hearing Standard Arabic. A frequency or

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exposure-based account makes similar predictions. French is commonly heard when Algerian Arabic is spoken, thus strengthening the association between these two languages. Therefore, when an experimental trial begins with Algerian Arabic, it primes the greater activation of French as well. The semantic cues in the high constraint sentences thus raised the activation of specific French lexical items and facilitated their selection. Overall, these results suggest that the way languages are used during everyday conversation modulates the strength of activation of each language and the ease with which code-switches are processed, even when the base languages are typologically similar. Consequently, these results may also have implications on theories of cross-language interference and suggest a greater role for experience-based variables in determining the strength of crosslinguistic effects (e.g., Fallah & Jabbari, 2018).

17.3.2.2 Cross-Language Interaction and Switch Costs

Code-switching in bilinguals has been associated with communicative benefits and costs (Myers-Scotton, 2000). The experimental literature reviewed in Section 17.2 generally finds processing costs when encountering code-switches, which may be modulated by linguistic or extralinguistic factors (Altarriba et al., 1996; Litcofsky & Van Hell, 2017). Cognates represent one such lexical factor. Switch costs are assumed to be the result of switching between language schemas during lexical selection (Green, 1998), but if a switch contains a word that is shared between the two languages its selection can be easier or harder depending on whether the cognate effect is facilitatory or inhibitory. Kheder and Kaan (2019) investigated this issue in Algerian multilinguals who habitually switch between Algerian Arabic and French but to varying degrees. Participants listened to French or Algerian Arabic sentence frames that ended with a written French noun phrase, which participants were instructed to read out loud. Thus, participants either produced French noun phrase continuations (3a) or code-switches (3b). Additionally, critical noun phrases could either be cognate or noncognate nouns and follow sentence frames that were either semantically constraining or neutral.

(3) (a) J'ai besoin d'argent, je dois passer aujourd'hui à **la banque**. (French no-switching)
(b) nɛsħaq ad-drahɛm, lazɛm nʤuz el-yuum ʕla **la banque**. (AA-FR code-switch)

"I need money. I have to stop today by **the bank**."

Cross-language interaction effects, as indexed by the cognate effect (the difference between reaction times [RTs] to cognate and non-cognate target NPs), manifested only in multilinguals who self-reported to frequently code-switch but who had lower French proficiency. These results suggest that lexical selection in highly proficient speakers proceeds rather in

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a language-specific manner. Alternatively, proficient speakers may be able to resolve interference more quickly. Interestingly, for lower-proficiency speakers, the French code-switches were easier to produce when the prior Algerian Arabic sentential context was semantically neutral. However, in semantically constraining sentential contexts, code-switches that were cognates were harder to produce. These findings reveal the highly dynamic process underlying the processing of sentential code-switches. The ease with which code-switches are processed efficiently is dynamic and influenced by several factors. Specifically, because cognates were easier to produce in neutral code-switching contexts, code-switching may be facilitated when speakers maintain no commitment to language-specific upcoming lexical items. These findings are in line with the Control Process Model of code-switching (Green & Wei, 2014; Green, 2018) where code-switching necessitates an opportunistic and open mode of control. If the habit of using languages in daily conversations induces different modes of language control, then the frequency of exercising that habit may have consequences on how bilinguals and multilinguals resolve cross-language interactions.

17.3.2.3 Cognitive Control and Code-Switching

Whether bilingual language experience leads to cognitive benefits remains controversial (e.g., Paap & Greenberg, 2013; Lehtonen et al., 2018; Grundy, 2020; Bialystok, 2021). The central claim is that bilinguals are reported to have enhanced aspects of cognitive control such as inhibition, monitoring, and conflict resolution as compared to monolinguals when tested on nonverbal tasks that require conflict resolution. Bilinguals are constantly in need of monitoring and resolving conflict between active competing representations to produce the target-appropriate output (cf. bimodal bilinguals where such conflict is reduced). Better performance by bilinguals on nonverbal tasks such as the Flanker or Simon tasks has been attributed to more efficient inhibition of the non-target conflicting cue or more effective selection of the target representation as compared to monolinguals (Bialystok et al., 2004, Colzato et al., 2008). Alternatively, bilinguals may be better able to monitor conflict in high-conflict contexts (Costa et al., 2009; Hilchey & Klein, 2011).

If bilingualism supposedly confers such benefits, then there are real outstanding questions of how multilingualism further impacts cognition. Multilingualism is an important puzzle piece in this critical issue, as diversity in language experience across individuals may be a reason behind the inconsistency in robustly replicating any cognitive advantages (Whitford & Luk, 2019). Two important dimensions shape diverse language experience in multilinguals: language dominance or proficiency, and code-switching frequency. Individuals in multilingual communities are not homogenous, even within the same community of speakers. Thus,

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understanding the cognitive consequences of multilingualism necessitates studying the effect of variability in language experience on cognitive control among multilingual speakers themselves. When this diversity remains uncontrolled (i.e., taking a strictly between-groups or static approach; Salig et al., 2021), we may not be capturing these subtle distinctions, especially given that cognitive control advantages are small effects (Grundy, 2020). The high degree of variability within multilingual communities and speakers provides a critical avenue for examining the effects of variability in language experience on cognitive control, thus instantiating a more dynamic view of multilingualism (Salig et al., 2021).

To highlight this approach, Kheder and Kaan (2021) recruited Algerian multilinguals with varying French proficiency and daily code-switching use to complete a mixed block of Simon trials. The Simon test is a classic psychological test that measures the engagement of cognitive processes such as conflict monitoring and conflict resolution. Each trial consists of colored squares that can appear in a left, right, or central location, and the participant is instructed to indicate the color of the square via a left or right color-coded button press. In congruent trials, the test square location coincides with the corresponding color-coded button (e.g., a left-located red button with a red square that appears in the left location). In incongruent trials, the test square location is on the opposite side of its corresponding color-coded button (e.g., a left-located red button with a red square that appears in the right location). Experimental blocks generally consist of an equal percentage of congruent and incongruent trials, and prior research robustly finds a congruence effect such that participants produce more errors and are slower to respond on incongruent trials.

In Kheder and Kaan's (2021) study, participants on the high end of the continuum in both French proficiency and frequency of code-switching use were better at conflict resolution over trials (i.e., had smaller conflict effects, measured as the difference between incongruent and congruent trials) than highly proficient speakers who code-switch less often. In addition, frequent code-switchers were better at monitoring conflict over time. The difference of the conflict effect in frequent code-switchers became smaller throughout the experimental session. These findings suggest that multilinguals differ in their ability to adapt their inhibitory and monitoring processes, both proficiency and frequency of code-switching use affect cognitive control processes, and frequent code-switching may aid with the dynamic adjustment of control processes in rapidly changing circumstances throughout the experimental session (i.e., states differences; Salig et al., 2021). Examining individual differences in language use and proficiency concurrently thus revealed intricate interactions that otherwise might remain undetected had each factor been examined separately. Given the immense variability in these multilinguals' experiences with languages, it is rather reasonable to

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further generalize that the consequences of multilingualism would be detected over a greater continuum as well when considering additional languages.

17.4 Theoretical Implications for Research on L3/*n* Code-Switching

The studies on Algerian multilinguals in this chapter highlight the roles that language experience and use play in multilingual sentence processing and cognition. While such factors are recognized in bilingualism research and even in explicit components of experience-based models such as the Adaptive Control Hypothesis (Green & Abutalebi, 2013), such variability is a fundamental property of multilingual individuals. Just the addition of one language to an individual's linguistic repertoire leads to a greater possible combination among the extant linguistic and extralinguistic variables reviewed in Section 17.2. Rather than strictly focusing on a traditional between-groups approach that investigates differences between bilingual and/or monolingual groups, multilingualism further allows researchers to take advantage of the inherent variability between individuals who speak more than two languages. While psycholinguistic research on bilingualism has advocated for incorporating variation into study (e.g., Beatty-Martínez et al., 2020b; Salig et al., 2021), such an approach is central to multilingualism research. As illustrated in Kheder and Kaan's (2016) study, examining Algerian trilinguals helped pinpoint the effect of code-switching experience in multilingual sentence processing. While Algerian and Standard Arabic are structurally similar languages, the processing of an upcoming French code-switch was dependent on prior code-switching experience.

Individual differences between speakers on factors such as dominance, proficiency, code-switching habits, and linguistic factors such as shared morphosyntactic structures and presence of cognates can all affect the degree of language co-activation and code-switching behavior in multilingual speakers. Additionally, community practices and the social setting are critical pragmatic cues for when and with whom code-switching occurs as its use is predominantly a social phenomenon. Our current understanding of how these social factors affect the processing of code-switching are mainly based on bilingual studies. To begin to understand how an additional third or more languages may affect multilingual processing of code-switching, we also need a better understanding of the social settings in which multilingual code-switching occurs. The Algerian linguistic scenario cautions against assumptions that code-switching will simply occur between all language varieties.

As an initial sketch, we might envision four different contact scenarios that would inevitably lead to differences in multilingual sentence processing. First, as in the case of Algeria, we can consider stable multilingual

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communities that simply co-exist with more than two languages in their environment. Further examples of this first scenario are prevalently found across North and sub-Saharan Africa (e.g., Kenya, Barasa, 2016; Ethiopia, Ado et al., 2021), where several local languages co-exist with far-spread regional languages and the languages of colonization. We can also consider the case of bilingual speakers where a third language is introduced either via immigration as in the case of Kurdish–Turkish bilingual immigrants acquiring German in Austria (Brizić, 2006) or due to the prestige status of a language acquired through formal education, such as English as a third language in Catalan–Spanish or Euskera–Spanish bilingual speakers in Spain (Cenoz, 2005). In the former scenario, issues of heritage language identity and attitudes are likely at play that differ from the latter scenario. Finally, monolingually raised individuals may acquire two additional languages later in life as is commonly found in European countries (e.g., Switzerland, Luxembourg; Jessner, 2007). The diverging sociolinguistic contexts shaping patterns of language use in each of these scenarios plausibly leads to differences in sentence processing and the ways in which multilinguals recruit domain-general cognitive mechanisms such as inhibition and conflict monitoring (Green, 2017). Thus, multilingualism opens new avenues for exploring interactions between linguistic and cognitive factors that cannot sufficiently be explored in bilinguals or monolinguals alone. Given the lack of experimental research in this area, investigating the complex ways in which multilinguals code-switch across their multiple languages will undoubtedly lead to a more comprehensive understanding of bi/multilingual language control and sentence processing, helping to refine theory along the way. To do so, researchers will need to provide comprehensive details on the interactional contexts of the multilingual communities under study, including which languages are most likely to be involved in code-switching, domains of language use, as well as individual-level variables such as proficiency, order of acquisition, and cognitive control.

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