Code-switching and code-mixing in bilinguals: Cognitive, developmental, and empirical approaches

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The study of how individuals use and process two or more languages is an extremely important area of research, especially as the world’s bilingual population continues to increase. It has been reported that currently, a majority of people worldwide are bilingual (Bhatia and Ritchie, 2004; Edwards, 2004; Tabouret-Keller, 2004). Although much of the research conducted in the domain of cognitive psychology has focused on the interesting question of how a bilingual represents or stores both of their languages in memory, there is a growing body of literature designed to explore how bilinguals process and switch in and out of languages. This usually occurs in speech production when an individual is speaking one language (i.e., referred to as the matrix or base language) and then rapidly replaces a word or phrase in that language with a word in the other language (i.e., guest language) (Li, 1996). For example, Heredia and Altarriba (2001, p. 164) introduced an example of code-switching that could be observed in the informal speech of a Spanish-English bilingual: “Dame una hamburguesa sin lettuce por favor?” (“Give me a hamburger without lettuce please?”), where in this statement the English word lettuce is used in place of its Spanish translation.

Although the terms code (language)-mixing and code-switching are used interchangeably in current discussions (Heredia and Altarriba, 2001), differences between the two phenomena have been pointed out in previous work. Code-mixing was originally described as using words and phrases from one language in place of those in the other language within a single sentence (i.e., the previous example where switching languages occurs within one sentence) (Sridhar and Sridhar, 1980, p. 408). On the other hand, code-switching has been described as switching between languages based on changes in the speech situation, where the topic or members of the conversation change (see e.g., Altarriba and Santiago-Rivera, 1994, for
further discussion). This implies that code-switching does not occur within a sentence, whereas code-mixing is intra-sentential and does not rely on situational changes in the conversation (Sridhar and Sridhar, 1980). Since more recent work has not focused on differences between these two terms, the current chapter will refer to the switching between languages (i.e., whether it be within topics, paragraphs, sentences, etc.) as code-switching, the terminology most frequently used within the domain of cognitive psychology.

Several different reasons as to why bilinguals code-switch have been proposed (Heredia and Altarriba, 2001). One of the most common reasons is that bilinguals use words from the other language because they do not know the proper word in the language they are currently using. Therefore, they go in and out of languages because they do not have all the necessary vocabulary in both languages (Grosjean, 1982). However, Heredia and Altarriba (2001) have suggested that the absence of lexical knowledge may not be responsible, but rather the ease/difficulty of retrieval is responsible. A bilingual may know the needed word in both languages, but they may use the needed word more frequently in one language as compared to the other, and therefore, they are able to retrieve the word faster from memory in that language. Secondly, bilinguals may code-switch because the expression or feeling that they are trying to communicate has a better translation in one language or because no identical translation in the other language exists (Heredia and Altarriba, 2001; Wei, 2002). Altarriba (2003) explains this situation by providing the example of the Spanish word cariño, described as a combination of the English words liking and affection, although neither English word in and of itself is capable of fulfilling the true definition and meaning of the Spanish word. Research has also revealed that code-switching may be used as a defense mechanism in clinical settings where individuals may speak in their second or less dominant language in order to remove themselves from a painful or hurtful emotional experience (Altarriba and Santiago-Rivera, 1994). Lastly, code-switching also appears to have advantages in the marketplace (Luna and Peracchio, 2005), where it has been shown that persuasive advertising for products and services increases when advertisements or slogans that are normally presented in the second language (L2) include code-switches to the first language (L1) (e.g., “Twenty million hijas are covered by AFLAC, is yours?, where the word hija replaces the English word daughter; Luna and Peracchio, 2005, p. 760).

The aim of the current chapter is to discuss general code-switching patterns that have been observed in bilinguals, with a focus on the cognitive processes that underlie the switch between languages. Several theories and models of bilingual processing are briefly discussed in terms of the processes responsible for controlling the switch. The current chapter will explore if there is a cognitive cost (i.e., time consuming process) involved in code switching and if so, how it is affected as level of proficiency and developmental stages evolve over time. Lastly, code-switching patterns will also be discussed in terms of how they are influenced by various contextual constraints, stimulus manipulations, and differing task responses.
THEORIES AND MODELS BEHIND THE PROCESSES INVOLVED IN CODE-SWITCHING

The Revised Hierarchical Model (RHM)

One of the main questions that arises in bilingual research, and code-switching more specifically, is how bilinguals access or select the appropriate response when they have competing or alternative choices. As Green (1998a) suggests, this issue appears to be linked to the question of how a bilingual’s two languages are represented in memory, but there are some differences as these models and accounts are not always designed to address issues in processing and selecting between the two languages. One of the most recent and widely cited models of bilingual language representation is the Revised Hierarchical Model (RHM) introduced by Kroll and Stewart (1994). This developmental model is able to account for a portion of the bilingual data that has been reported (however, see Altarriba, 2000, and Altarriba and Mathis, 1997, for further discussions). Figure 1 depicts this model, which shows a distinction between the conceptual and lexical levels of language representation.

Each language is depicted as containing a separate and independent lexicon (i.e., mental dictionary), where the lexicon of the first (or dominant) language is pictured as being larger since vocabulary knowledge for this language is expected to be greater. The link between the L1 lexicon and concepts appears to be bi-directional and very strong, since a child acquiring their first language would form the strongest link between that language’s lexicon and the corresponding concepts. However, as a person acquires a second language, especially if it occurs later in life, L2 words would be integrated into memory by developing a pathway that is attached to the lexicon of the first language. The solid directional line connecting the L2 lexicon to the L1 lexicon explains this process. The opposing directional arrow between the L1 and L2 lexicon is described as a weaker link since this is not the direction in which a bilingual first acquires the translations of the new language. Finally, the connection between the L2 and concepts is illustrated as being weaker as well. However, it has been suggested...
that this link may increase in strength as the bilingual becomes more proficient or fluent in their second language (Kroll and Stewart, 1994). Although this model is advantageous in that it can account for changes in a bilingual’s proficiency level over time, it is not able to address how one language is selected over another. For example, the model does not provide an explanation as to how “a person translating from one language to another avoids naming the word to be translated” (Green, 1998a, p. 68).

### The Idea of a Dual Switch Mechanism

The process of selecting between languages and of switching in and out of two languages has introduced several questions. How active are both languages when switching is occurring? Does one language have to be inhibited in order to achieve a correct response? Are there rules to code-switching or certain circumstances dictating when it can occur? Is there a cognitive cost to code-switching behavior?

It has been shown empirically that switching between languages is a time consuming process, a finding that can be traced back to many decades ago when research on bilingualism was just beginning to emerge (Kolers, 1966; Macnamara and Kushir, 1971). Kolers (1966) reported that bilinguals were slower to read passages of text containing mixed languages (French and English) as compared to monolingual text (text that was only in French or only in English). This finding led Macnamara and Kushir (1971) to propose that switching between languages was a time consuming process because the bilingual linguistic system required that each language be either “on” or “off.” Their idea was based on the assumption that a switch mechanism determined which lexicon could be used and which one could not. Because both lexicons or linguistic systems could not be activated at the same time, processing material that contained mixed languages would be slowed down. This theory seemed plausible; however, it was later refuted by research that showed that both languages could be activated at the same time (Dijkstra and van Heuven, 1998; Grosjean, 1997). Grosjean (1997) suggested that both languages could be active, but if a bilingual selects one language to use, the activation of that language must be greater than the activation of the other (second) language. Furthermore, a current model of bilingual processing, the Bilingual Interactive Activation (BIA and BIA+) Model, is a computer-simulated model that provides support for the dual activation of a bilingual’s two languages (Dijkstra and van Heuven, 1998). Although this model is not specifically designed to predict code-switching behavior, it is a model that stresses that bilingual language processing in word recognition is nonselective and many of its processes can be applied to various aspects of bilingualism (Grainger and Dijkstra, 1992; see also Dijkstra and van Heuven, 1998, for a review of this model).

Other data in the bilingual research literature also seem to support the idea that both languages may be engaged simultaneously during the course of language processing. Those data stem from the use of the Stroop color-word task, within and between languages (Brauer, 1998; Dyer, 1971; Kiyak, 1982; Preston and Lambert, 1969; Tzelgov, Henik, and Leiser, 1990). In the typical monolingual version of this task, words that label colors are presented either in a congruent condition (e.g., the word red printed in the color red) or an incongruent condition (e.g., the word red printed in the color blue). The participant’s task is to name the color the word is printed in and not the word itself. This is a timed task, and it is generally found that color naming suffers from significantly more interference in the incongruent
condition, as compared to the congruent condition. It is often thought that this interference results from the competition involved between reading the word (an automatic process) and naming the color. This competition then produces interference. This task has been used in the bilingual literature to explore the activation and processing of words across a bilingual’s two lexicons. Across languages, if one sees a word in one language but is asked to respond in a second, known language, interference is often observed. Typically, the bilingual Stroop effect is studied in two language conditions:

- Congruency between the language in which words are written (e.g., English) and the language in which answers are requested (e.g., English)
- Incongruency between the language in which words are written (e.g., English) and the language in which answers are requested (e.g., Spanish)

Within-language interference is typically larger than between-language interference, in most studies. However, the important point for the current discussion is the idea that the inability to suppress or inhibit naming a word that appears in a language different from that required to perform a naming response indicates that indeed both mental lexicons of a bilingual speaker may be activated at the same time. Thus, it is conceivable that this “fluidity” in the activation of multiple languages can contribute to circumstances in which code-switching and language-mixing can occur. At the very least, these conditions can be viewed within the context of an experimental laboratory situation and more than likely, can translate to the natural, speaking environment.

In summary, recent research as a whole appears to show that bilinguals are capable of simultaneously activating both of their languages; however, this finding implies that one language is either activated more than the other and/or that the language not in use must be inhibited to some degree.

THE INHIBITORY CONTROL MODEL (ICM)

In an effort to extend some of the ideas introduced by the Revised Hierarchical Model and to explain some of the processing shortcomings not accounted for by this and other models, Green (1998a) proposed the Inhibitory Control Model (ICM) that was designed to explain issues such as how a bilingual translating a word from the L2-L1 avoids naming the word in the L2, and vice versa. This model is depicted in Figure 2. In this model, there is a language independent conceptualizer, similar to the conceptual store of the RHM, which is involved in constructing the conceptual information during a linguistic task. The conceptualizer is motivated by the linguistic goal (G) that the bilingual hopes to fulfill (e.g., such as translating from L2-L1, speech production in L2, etc.). The lexical-semantic system is similar to the lexicons of the RHM in that it contains the words from the bilingual’s two languages, but it differs because the lexical items from both languages are depicted in the same store. However, each word or lexical entry has a lemma associated with it, which is language specific. Lemmas are best described as entries in the lexicon that contain information on the morphology, syntax, and phonology for each lexical item (Levelt, 1989).
Wei (2002) describes each lemma as being “tagged for a specific language,” a property of the lexical system that is vital to understanding how processing occurs in the ICM.

The *language task schemas* are “mental devices or networks that individuals may construct or adapt on the spot in order to achieve a specific task and not simply to structures in long term memory” (Green, 1998a, p. 69). These schemas are task specific in that if a bilingual needs to translate from L2-L1, they must access a “L2-L1 translation schema” to complete this task. If the bilingual needs to produce a certain word in the L1 they will be required to activate a “L1 word production” schema. Therefore, each language has a task schema that works with the lexicon, and competition arises between the schemas for each language (see de Groot, 1998 and Green, 1998b for a more in depth discussion on the use of the term *schema* in this model).

If the required task has been performed before, the task specific schema just needs to be retrieved from memory; however, if the task is new and cannot be performed automatically, the *supervisory attentional system* (SAS) will assist. The SAS also acts as a mediator between the task required and the goal that one is trying to achieve. The task schema in turn works together with the lexico-semantic system to determine which words are produced, as shown...
by the output (O). The task schema is very influential in that it can manipulate the amount of activation of the different lexical entries in the lexical system. It can control the language output by inhibiting or activating different representations.

With regards to code-switching, when the matrix language changes, the language schema must change to accompany the new (guest) language. The language schema of the matrix language must then become inhibited. However, after the code-switch, when the bilingual returns to using the matrix language, inhibition of the guest language must occur. The switch cost observed in bilingual code-switching is most simply due to the amount of time it takes for a task schema to recover from inhibition (Thomas and Allport, 2000). It is important to point out that inhibitory processes can occur in two different locations in the model. Inhibition can occur at the schema task level, as suggested above, but it can also occur at the lexical level where specific language tags may be suppressed. When this occurs, the task schema remains the same. For example, participants performing a lexical decision task (i.e., a task in which a string of letters is presented and a participant presses one key if it is a real word or a different key if it is a nonword) can continue using a “lexical decision schema,” they just need to wait until the appropriate language tag is activated so that they can respond (Green, 1998a, p. 74). Switch costs of this nature are generally smaller and reflect a cost that occurs within the lexical system, as compared to the larger costs that have been reported outside the lexical system when task schema switches occur (von Studnitz and Green, 1997). The magnitude of switching costs that have been reported in the literature will be discussed more in depth in a later section.

Thus, the ICM implies that language activation is nonselective, the conceptual/semantic component activates lexical entries in both languages (a similar assumption proposed by the BIA and BIA+ models (Dijkstra and van Heuven, 1998)). Once this activation takes place, the lexical entries of the language that is not going to be used are inhibited. Lastly, there is a relationship between the cost involved and the inhibitory process, such that the cost or amount of time needed to switch is predicted to increase as the level of inhibition increases. The more activation there is of lexical entries in both languages, the greater the inhibition will be for the language that is not going to be used. Therefore, the competition between two languages is expected to be greater for proficient bilinguals, who will in turn show more inhibition than less proficient bilinguals (Green, 1998b). In addition, less proficient bilinguals will take a longer amount of time to switch back to their L1 or dominant language, since it is assumed that this language (L1) will have experienced more inhibition. In contrast, when switching to the L2, this less dominant language would not be inhibited to as large a degree resulting in an easier, faster switch (Green, 1998a). Overall, the extant data appear to indicate that factors outside of the properties of the lexicon itself can mediate the extent to which differential costs occur as bilinguals switch between lexicons (see e.g., Thomas and Allport, 2000). More will be said about this conclusion, as it relates to the ICM model, in a later section of this chapter.

**RULES THAT APPEAR TO GOVERN CODE-SWITCHING BEHAVIOR**

While some research has focused on the cognitive aspects of code-switching—the cost involved and the processing mechanisms that underlie a language switch, other theories take a
more linguistic perspective that is based on empirical research conducted on naturalistic speech behavior and the structures that appear to accompany language switches. For example, do bilinguals follow the syntactic structure of only one language when code-switching or do they use the syntactic rules of both languages, if indeed the two languages follow different rules? For example, in the Spanish language, adjectives describing a noun usually appear after the noun (e.g., la casa verde), whereas in English they usually precede the noun (e.g., the green house). An additional possibility has been introduced by Mahootian (1993), who suggests that bilinguals use a combination of the two language structures, resulting in code-switching patterns that are determined by a “third grammar.”

Some of the earliest constraints reported in code-switching grammar implied that code-switching could not occur at a bound-morpheme boundary (Sankoff and Poplack, 1981), prepositions and other linguistic units like quantifiers and determiners (e.g., some, all, those, many) could not be switched, and the language in which a verb is used should dictate where the object will appear in the sentence (Mahootian, 1993). Some of these constraints are supported by Wei (2002), where code-switching patterns in Chinese-English bilinguals have been examined. His research has suggested that sentences containing code-switches only include content morphemes (i.e., nouns, verbs) from the guest language, while system morphemes (i.e., determiners) in the sentence are always presented in the matrix language. However, MacSwan (2000) argues that several of the original constraints do not always hold true. He introduces the very simple idea (i.e., Minimalist Program) that “all grammatical relations and operations which are relevant to monolingual language are relevant to bilingual language, and only these” (p. 43). According to this viewpoint, code-switching structure is not contingent on any principles of grammar; however, the phonology of each language remains separate and is language specific (see MacSwan, 2000 for an in depth review of this theory).

The idea of a divided phonological system has been supported by research conducted on bilingual speech production (Grosjean and Miller, 1994). In this study, voice onset times of French-English bilinguals were recorded as they read stories presented in either a monolingual or mixed language context. The results indicated that when a switch occurred, the phonology of the matrix language did not continue to influence the guest language, but rather the bilinguals were capable of shifting phonology very quickly. This finding proves to be very interesting because it suggests that language switches “involve a total change, not only at the lexical level but also at the phonetic level” (Grosjean and Miller, 1994, p. 205).

Although the study of when and where code-switches occur is useful in the study of bilingualism, Sankoff (1998) points out that one fundamental component of code-switching is that it is unpredictable, meaning that even if one knows the places and situations in which a code-switch can occur, one cannot predict that a code-switch will occur at that specific time and place. Further, “if a switch occurs at some point in a sentence, this does not constrain any potential site(s) later in the sentence either to contain another switch or not to—there are no forced switches” (Sankoff, 1998, p. 39).

Thus far, switching has been examined in terms of the models or theories that might predict certain outcomes and the ways in which code-switching and language-mixing may be governed by various rules that seem to be pervasive in the extant data. The following section, however, turns to the more developmental aspects of language switching behavior and attempts to draw certain conclusions related to maturational differences that occur from a lifespan perspective. To that end, this section will examine how the grammatical structure of
code-switching is learned in bilingual children, as well as how low and high levels of proficiency influence code-switching patterns.

**DEVELOPMENTAL ASPECTS OF CODE-SWITCHING**

**Code-Switching in Children and Adults**

Those interested in the development of childhood bilingualism have studied code-switching patterns in the natural speech of children, usually by way of case study, where the speech of one child is examined in depth (Lanza, 1992; Meisel, 1989). One question that has been highly debated in this domain of research is the age at which a child can begin to code-switch. It has been suggested that code-switching observed in infants is not the result of linguistic awareness and the mixing of the two languages, but rather the behavior is the result of the infant confusing the two languages as they begin to differentiate between them (Lanza, 1992). The absence of linguistic awareness at a very young age has been referred to as “the unitary language system hypothesis” (Genesee, 1989). However, there have been studies suggesting that children’s code switching patterns really do not differ that much from what has been observed in adults.

An examination of code-switching in a two-year-old Norwegian-English bilingual (Lanza, 1992) revealed that the child’s code switching patterns did not differ much from adults, but rather the individuals who were involved in the conversation with the child determined the pattern of code-switching used. This finding has been supported by research conducted on children three years old and older who revealed that the main factor influencing code-switching patterns was who was participating, while setting and topic were less influential variables (Fantini, 1985; McClure, 1981). However, according to the present authors, it is possible that as bilinguals get older, the influence of topic on code-switching may become a more important factor because the bilingual will have more life experiences stored in memory and they may tend to change how they code-switch (i.e., altering which language is the matrix language and which is the guest language) based on what experiences they are talking about (e.g., childhood stories versus politics or work-specific jargon) (see Bentahila and Davies, 1992, for further elaboration on these latter examples). In addition, Heredia and Altarriba (2001) suggested that individuals might code switch depending on certain specialized knowledge they have regarding specific topics. These “specialized topics” might moderate the frequency and nature of code switching within particular domains of knowledge.

The most obvious and interesting finding in Lanza’s (1992) study was that the child tended to make grammatical code-switches in Norwegian when speaking to her English dominant mother, but when speaking to her Norwegian dominant father, she only appeared to make lexical switches in English. Based on this observation, it was suggested that the child in this study was Norwegian dominant, which implies that those examining code-switching in children (and adults too) need to take into account dominance issues and context (Lanza, 1992), two points that will be discussed more in the following section. More importantly, this finding indicates that young children are able to develop some sort of linguistic awareness for their two languages.
Studies that have investigated code-switching behavior in groups of child bilinguals, as opposed to longitudinal case studies, are able to provide more insight into the underlying processes that dictate how bilingual children use their two languages. In an interesting study conducted by Lederberg and Morales (1985), code-switching in children and adults, as well as code switching experience, was examined. In this study, Mexican-American bilinguals who were born in the U.S. were placed into one of four groups: 1) 8-10 years old, 2) 10-11.5 years old, 3) 12-13 years old, and 4) adults (18-43 years old). In addition, a second group of adult bilinguals (28-35 years old) who were born in a Spanish speaking country, but who moved to the U.S. as adults participated. Based on research by Poplack (1980), it was hypothesized that this second group of bilinguals would not have as much experience code-switching as the individuals who grew up in the U.S.

In the experiment, participants had to determine whether sentences containing code-switches were grammatical and if not, they had to correct them so that they fit the rules of how they would naturally code-switch. Data from the two groups of adult bilinguals revealed that the bilinguals who emigrated to the U.S. late in life did not perform as well as American born bilinguals. However, a more in-depth analysis of the different types of sentences revealed that both groups used similar response patterns and appeared to make judgments using the same rules, suggesting that “the rules governing code-switching are not based on extensive exposure to code-switching” (p. 134).

Across the age groups, the results indicated that the two youngest groups of bilinguals accepted more sentences than the older groups, especially on the mixed verb sentences (e.g., the boy was aprendiendo how to read; note the combination of the English word learning and its Spanish translation aprendiendo). This implies that there may be some type of developmental change in one’s code-switching behavior. The authors suggest that children growing up in bilingual environments may create more general or flexible rules of grammar as compared to monolinguals or to adult bilinguals, such that they think it is appropriate to incorporate inflections or derivations from one language into the other language. However, Lederberg and Morales (1985) point out that other issues, an increase in general language knowledge and sentence structure or an increased ability to make grammatical judgments, could also be responsible for the developmental change they observed in code-switching, a finding that has been supported by Paradis, Nicoladis, and Genesee (2000). It is possible that children of this age have not fully conceptualized how words, sentences, and phrases interact, and therefore they believe that they can break up these linguistic forms in whatever manner they choose.

Paradis et al. (2000) examined code-switching behavior in two-year-old French-English bilinguals every six months over an eighteen-month time frame. They examined several of the constraints proposed in code-switching behavior and discovered that over time, the children violated one of the constraints less frequently, pointing to a developmental change in code-switching. However, like Lederberg and Morales (1985), the authors propose that since a change was observed for only one of the constraints when several were examined, it is possible that a developmental change in code-switching was not responsible, but that the child’s general syntactic and linguistic knowledge matured. Overall, their results suggested that the children exhibited code-switching behavior that resembled that found in adults, which contradicts the idea of a developmental shift in code-switching.

In conclusion, it appears that code-switching in children is really not that different from what has been observed in adults, but that changes in children’s overall linguistic knowledge and experience are responsible for developmental changes that have been reported. However,
research conducted on aging bilinguals has revealed that changes do occur in code-switching behavior when one gets older (Hernandez and Kohnert, 1999). As one ages, code-switching appears to become a more difficult and slower process, with more errors being reported in experimental tasks. This is most likely due to increased task demands placed on the executive processing system of older adults. In the next section, the influence of age of acquisition and language dominance will be explored in order to see if those variables are capable of influencing how bilinguals code-switch.

**THE INFLUENCE OF AGE OF ACQUISITION, DOMINANCE, AND LANGUAGE TYPE ON CODE-SWITCHING**

The issue of proficiency and language dominance is obviously a very important one for those conducting research on bilingualism. Originally, it was assumed that a person’s L1 was their more dominant language. However, more recent suggestions and empirical research have suggested that this is not the case for all bilinguals (Altarriba, 1992; Altarriba and Basnight-Brown, 2007; Heredia, 1997). Often, Spanish-English bilinguals in the United States who have grown up in Spanish speaking homes and communities, but who have attended school in predominantly English speaking environments, appear to show a shift in language dominance, such that their L2 (English) tends to become their more dominant language. This is an important issue to consider and one that can greatly influence how one interprets code-switching behavior, because the first language learned cannot always be assumed to be the more dominant language.

As expected, research has shown that individuals who are less proficient in their second language have more difficulty code-switching (Rakowsky, 1989; Toribio, Roebuck, Lantolf, and Perrone, 1993; cited in Toribio, 2001). McClure (1981) reported that Spanish-English bilingual children with low proficiency in their L2, tend to code-switch “at the word level,” usually by substituting L2 nouns into sentences, while code-switching of more balanced Spanish-English bilingual children exhibits switches in more advanced parts of speech. Bentahila and Davies (1992) found a similar effect of proficiency in adult bilinguals, when they examined code-switching occurrences in the natural speech of balanced and unbalanced Arabic-French bilinguals. As compared to the more balanced bilinguals, the less proficient bilinguals (i.e., native Arabic speakers with lower French proficiency) appeared to use Arabic for grammatical aspects of sentences (e.g., prepositions, pronouns, etc.) and French primarily for nouns and verbs. In addition, the less proficient group also made switches within single words, a pattern not observed by the balanced group. The authors also point to the influence of the L2 learning environment as an influential factor, a suggestion that proves to be an important one. Because the age of acquisition of French was later for the less-proficient as compared to the balanced bilinguals, this group learned French in a formal school setting where vocabulary and grammatical rules were often taught by rote memorization. Therefore, it is not surprising that this group of bilinguals revealed a tendency to use memorized French lexical entries “within a clearly Arabic background structure,” especially when talking about specific or technical topics that where learned within the context of French (Bentahila and Davies, 1992, p. 453).
In a recent study designed to examine the automatic processing that underlies code-switching by using a naming task (i.e., participants name aloud the word presented on the computer screen and the response latency is recorded in milliseconds (ms)), an effect of proficiency also proved to be salient (Costa and Santesteban, 2004). Spanish-Catalan and Korean-Spanish bilinguals who were less proficient in their second language appeared to have a more difficult time switching from the less proficient (L2) language into their native language (L1). This cost in task-switching diminished when bilinguals who were highly proficient in both Spanish and Catalan performed the same task, suggesting that different processing mechanisms are responsible for how switches occur in balanced and unbalanced bilinguals (Costa and Santesteban, 2004).

However, a less dominant or weaker language does not always influence code-switching in a negative way. Chan, Chau and Hoosain (1983) reported that their Chinese-English bilingual participants code-switched to English (L2) words when the words were harder to retrieve in Chinese. They suggested that code-switching in “natural and spontaneous” environments occurs due to greater cognitive and emotional availability of the words in the L2, a finding supported more recently in the research literature (Altarriba, 2003; Altarriba and Santiago-Rivera, 1994; Bentahila and Davies, 1992; Heredia and Altarriba, 2001).

Thus, it appears that a bilingual’s proficiency level is capable of influencing the mechanisms that underlie the code-switching process, but that there are several instances where a less proficient (L2) language can be advantageous for code-switching. In the following section, the influence of environmental cues and task situations on code-switching will be discussed, as well as a more in-depth explanation of the costs involved when switching between languages.

COGNITIVE STUDIES OF TASK SWITCHING AND THE COST INVOLVED

Contextual and Task Determinants of Code-switching

Although there has been a plethora of research conducted on code-switching in linguistic and socio-linguistic domains, it is only more recently that research studies on the cognitive aspects of code-switching, where cognitive experimental paradigms are used, have begun to increase in number. These studies are particularly interesting because they attempt to examine the automatic processing that underlies code-switching.

It has been reported that code-switching behavior can change depending on the level of stress in the environment (Javier and Marcos, 1989), the individuals participating in the conversation (e.g., acquaintance vs. spouse) (Yoon, 1992), the type of task (e.g., brainstorming) (Blot, Zárate, and Paulus, 2003), sentence context (Li, 1996), and the constraints placed on the word stimuli used in the task (Grainger and Beauvillian, 1987; Orfanidou and Sumner, 2005; Thomas and Allport, 2000). All of these studies suggest that the environmental or linguistic context that a bilingual is performing in can influence their code-switching behavior.

Whereas most of the studies discussed so far have been concerned with language production in code-switching, Li (1996) conducted a very interesting study aimed at determining how listeners of code-switched speech recognize and process mixed languages.
In his first experiment, Chinese-English bilinguals were presented with auditory sentences that were in Chinese, but which contained a code-switched word in English. A gating procedure was used—a task which involves presenting code-switched words at increasing intervals and requiring participants to determine the target word (i.e., the code-switched word). For example, the first gate would begin at the onset of the word and last for 30-50 ms; the second gate would include an additional 30-50 ms of the word, and so forth until the entire word has been heard. Li (1996) explains that the motivation behind this task is that it allows one to examine how much phonetic information about a word is needed in order for someone to identify what word is being said.

An additional manipulation included in this experiment was context (short vs. long) in which the code-switched word appeared. A short prior context sentence appeared as “his/her flight is delayed” and a long prior context sentence as “he/she boarded a delayed flight,” where flight was the code-switched word and the rest of the sentence appeared in Chinese. The results revealed that context definitely played a role in how the code-switched words were processed. In the long context, where participants were given more contextual information, it was observed that on average, only 59% of the word was needed in order for the bilingual to determine the correct word, whereas 72% of the word needed to be presented in order for participants to identify it in the short context. A similar pattern of results was replicated in a second experiment where Li (1996) used a word-shadowing task with the goal of tapping into even more automatic processes. In this type of task, participants heard the same sentences and were asked to name aloud the word that appeared after a predesignated point. Overall, this study provided insight into the way in which context can influence code-switching by showing that “context operates from early on to help bilingual listeners select the appropriate word” (Li, 1996, p. 772).

Additional studies have attempted to determine how code-switching behavior and the costs involved are influenced by manipulations of the type of word stimuli included in experiments (Grainger and Beauvillian, 1987; Orfanidou and Sumner, 2005; Thomas and Allport, 2000). Thus far, within the current chapter, the cost of switching has been generally defined by the extra time it takes a bilingual person to process a word in one language after hearing or reading a word or text in the other language. In the following experiments where participants are presented with hundreds of experimental trials where the words presented alternate languages at fixed or random points, the cost of language switching is defined as the difference in the mean reaction time (usually measured in milliseconds) between switch and nonswitch trials. For example, the amount of time needed to recognize an L1 word when it was preceded by an L2 (switch) trial would be compared to the time needed to recognize this same L1 word when preceded by an L1 (nonswitch) trial. A language switch could therefore be measured from the less dominant (L2) language to the more dominant (L1) language, or vice versa (L1-L2).

In a study conducted by Grainger and Beauvillian (1987), French-English bilinguals were presented with word lists that were mixed (i.e., lists that included a combination of words in both French and English) and with those that were not (i.e., lists containing only French or only English words). One word was presented at a time and participants performed a lexical decision task, where they pressed one key if the target word presented was in English or French and a second key if the word presented was a nonword in either language. The results indicated that the bilinguals were slower to recognize words in the mixed lists as compared to those that were not. Whereas French words in Experiment 1 were pronounceable using
English phonology (e.g., *trop*), French words in Experiment 2 were not (e.g., *oiseau*), and vice versa for English words (e.g., *cough*). An additional set of nonwords containing orthographies that were language specific was also created. The results from this experiment revealed that the cost of switching languages was greatly decreased when the words were orthographically specific to their respective languages. Participants could recognize those words faster because their orthographic form made them unique to one of the bilingual’s two languages, which resulted in the lemmas of only one language being activated. This finding suggests that the cost of language switching occurs within the lexical system.

In an effort to further examine the locus of control responsible for code-switching costs, Thomas and Allport (2000) extended the experimental ideas put forth by Grainger and Beauvillian (1987). These authors pointed out that the participants in Grainger and Beauvillian’s study might have been using a strategic process when performing the lexical decision task, which might be responsible for the results reported. Because of the types of nonwords used by Grainger and Beauvillian, it is suggested that participants may have hit the “yes” key whenever they saw words that were orthographically specific to only one language. This type of strategic processing is problematic because the bilinguals would not need to retrieve any lexical information in order to perform the task.

Thomas and Allport (2000) corrected this potential confound and discovered that orthographic specificity did not influence the cost of switching, but rather the magnitude of the cost was similar for words with both language-specific and non-specific orthographic forms. The finding is of particular interest because it suggests that “switch costs are a feature of the response mechanism rather than the lexicon and that the task schemas for the bilingual’s two languages compete to control the response” (p. 51), which implies that the processes underlying language switching in bilinguals can be viewed as being similar to the cognitive control that dominates switching between any two simple tasks (Rogers and Monsell, 1995). The finding of a locus of control that is outside of the lexicon supports the theories posited by the ICM that was discussed in the first section of the present chapter, where Green’s (1998a) model implied that word recognition was non-selective and that switch costs could be the result of response behavior.

Further support for the ICM comes from a recent study where the influence of language specific and non-specific orthography on code-switching was examined in Greek-English bilinguals (Orfanidou and Sumner, 2005). It was suggested that bilinguals of this nature, those who knew two languages that did not share the same alphabet, should be able to provide better insight into the mechanisms responsible for code-switching because words with language specific orthographies could be designed so that they were truly specific to each individual language. Two lexical decision experiments (i.e., word-nonword discrimination tasks) that included language specific and non-specific orthographic words in Greek and English were conducted in blocked, in terms of wordtype, (Exp.1) and unblocked (mixed) (Exp. 2) designs (Thomas and Allport used a mixed design only). The results from Experiment 1 revealed that there was an overall cost of switching (830 ms for switch trials vs. 788 ms on nonswitch trials = cost of 42 ms), but more importantly, the cost of switching was larger for the language non-specific words as compared to the language specific words, a finding that appears to contradict that reported by Thomas and Allport (2000). The results from Experiment 2 also indicated a significant switch cost (mean reaction time of 845 ms for switch trials vs. 800 ms for nonswitch = cost of 45 ms), but the difference between the non-specific and specific orthographic words reported previously was no longer reliable.
One of the main implications of Orfanidou and Sumner’s (2005) study is that both experiments revealed an interaction between the magnitude of the switching cost and the type of response (response repetition), indicating that the locus of code-switching costs occurs at the response level. However, the fact that the language switching cost was influenced by the type of stimuli in Experiment 1, does suggest that in a blocked design, costs may be influenced to some degree by mechanisms within the lexical system. In conclusion, Orfanidou and Sumner (2005) were able to determine that “switching between language schemas causes costs from at least two independent sources, one at the level of the response initiation and one at an earlier level that is sensitive to stimulus properties and context via their implications for strategic control” (p. 36).

**SWITCH COSTS OBTAINED IN EXPERIMENTAL TASKS REQUIRING DIFFERENT TYPES OF RESPONSES**

Whereas many of the studies just discussed used a lexical decision task to examine language switching, several other studies have used tasks that required the participant to make different types of decisions regarding the code-switched language stimuli that are presented (Meuter and Allport, 1999; von Studnitz and Green, 2002). In a study conducted by Meuter and Allport (1999), bilinguals were presented with single digits (from 1-9) on the computer screen and were instructed to name aloud the number in either their L1 or L2. Each number appeared in the center of either a blue or yellow rectangle, where the color of the shape was used to indicate which language (L1 or L2) the response should be in. The results revealed that as expected, response times were slower on switch trials as compared to nonswitch trials. Of greater interest was the finding of an asymmetry in the switch cost, such that costs in the L2-L1 direction (143 ms) were larger than those observed in the L1-L2 direction (85 ms). This finding also supports the ICM, where it was hypothesized that there was a positive correlation between the level of activation and inhibition. Because the dominant (L1) language is expected to be activated to a larger degree, this language also experiences greater inhibition. Therefore, L2-L1 switch costs are predicted to be larger because switching from a less dominant to a more dominant language requires one to overcome the large amount of inhibition associated with the L1 word.

A second study that used a different experimental task to examine code-switching in bilinguals required the participants to determine whether the English and German presented words were animate or inanimate (von Studnitz and Green, 2002). The results revealed that analogous to previous studies, participants were slower when responding to switch trials as compared to language nonswitch trials. In addition, the authors manipulated whether the correct response was repeated across two trials (e.g., animate-animate) or whether it was not (e.g., animate-inanimate). The data from this manipulation revealed that when the bilinguals were presented with switch trials that required the same response, response latencies were longer. The fact that the magnitude of the switch cost was found to interact with the type of response is interpreted as meaning that the cost of switching is not the direct result of processes occurring at the lexical level, but rather that it is due to “costs that arise in the course of mapping decisions onto responses” (p. 248).
In summary, studies that have used cognitive methodology and experimental tasks to explore code-switching suggest that there is a true cost involved when switching between two languages. This finding supports those reported in many of the linguistic and socio-linguistic fields that have shown that moving in and out of languages takes more time as compared to operating in a monolingual mode. However, many of the studies discussed in the current section are particularly useful because they are able to provide numerical estimates of the cost involved in switching and the cognitive capacity that is needed to perform a switch. Taken together, they also indicate that the result of this cost appears to be controlled by processing mechanisms that reflect the different and competing response schemas that the bilinguals are alternating between during code-switching. Furthermore, the costs observed under these experimental paradigms can most likely be applied to language processing in a more natural setting or environment. It has even been suggested that this concept could be extended to include monolinguals, in that those speaking in one language may use similar mechanisms to task switch between a “polite schema and a slang schema” (Orfanidou and Sumner, 2005).

**CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS**

The idea that bilingual speakers can at once, keep their languages apart when necessary, but switch between them as if they were both “available” poses an interesting conundrum that researchers have investigated from several perspectives. Is it that one language is suppressed or inhibited while the other one “takes the floor”? Or are both languages activated to some degree, simultaneously, when a bilingual is thinking about or producing utterances? The current chapter examined various aspects of code-switching from developmental perspectives to the extant models that purport to explain how switching between languages takes place. Through time, various “switching mechanisms” have been proposed. Switching behavior is seen to be moderated by a variety of influences, and the idea is often that one language is essentially “switched off” while another language is “switched on” (see e.g., Macnamara and Kushnir, 1971). However, empirical evidence (e.g., bilingual Stroop data) seems to indicate that one cannot always simply switch one language off in favor of another. Rather, the issue is one of suppressing or inhibiting the irrelevant language to some extent while performing a task in the relevant language (see e.g., Preston and Lambert, 1969 and Tzelgov et al., 1990). This argument seems plausible given that there is an apparent cost to switching between languages, as there might be in switching between other types of cognitive tasks (Meuter and Allport, 1999). It is likely that the model that stands to account for the bulk of the data related to language switching is that proposed by Green—The Inhibitory Control Model (ICM) (see Green, 1998 a and b). The idea that a language schema—not merely a word—is activated when an alternate language is to be engaged allows for a host of other relevant information pertinent to the language mode to also be engaged. Thus, in a more holistic sense, this model allows for the fact that one does not merely activate a single lexical representation, but likely through a process of spreading activation (Collins and Loftus, 1975), more information can be activated and accessed through the activation of a schema. Different devices also act to inhibit, activate, or otherwise control output in ways that one might predict given the extant literature.
The current chapter also explored the grammatical constraints that exist in the process of switching between languages. From a listener’s perspective, it appears as though code switching does not occur in a haphazard manner. Rather a listener perceives the concepts or semantics involved in mixed-language speech as fitting together nicely—making sense—despite the language changes that are involved. Though some would argue that there is no specific “grammar” for language switching (see e.g., MacSwan, 2000), it is the case that the motivation a speaker has to forge a switch is usually such that it assists in the communicative process. Ultimately, a speaker wants to be understood. Thus, logic would dictate that switches are somehow “programmed” such that they occur in instances that lead to a clear understanding of the concepts being described and communicated. Further research should examine the ways in which this kind of pragmatic nuance to language switching occurs across various languages as well as various linguistic situations.

It is quite clear, just from the point of view of a casual observer, that children code switch, too, particularly in cases in which they are being raised in a bilingual environment. Whether the bilingual environment is the home/family environment or a school or educationally-based program outside of the home, children who are exposed to more than one language tend to blend those languages in some way (Lanza, 1992). Children ultimately develop linguistic awareness of their two languages and of certain relationships between them allowing them to switch between the two languages in patterned ways. The development of code-switching behavior seems to be moderated not so much by experience doing so, as by an increase in general knowledge, linguistic or otherwise (Lederberg and Morales, 1985). Thus, could this ability be somehow governed by innate processes? Could a variant of Chomsky’s Language Acquisition Device (Chomsky, 1968) guide the development of code switching as it is touted to do for other language abilities? Future research should examine more closely the relationship between age and mode of acquisition and the frequency and nature of code-switching behavior across the lifespan.

Finally, the current chapter examined the ways in which empirical approaches have been designed to formalize the cost involved in switching between languages. The work of Allport and colleagues (e.g., Meuter and Allport, 1999; Thomas and Allport, 2000), for example, demonstrates the fact that “cost” in switching can be quantified in terms of milliseconds involved in responding. That cost in response is comprised of a host of processes that occur in terms of the access of language entries, the activation of those entries and suppression or inhibition of others, and the actual production of a response. Researchers have been able to capture those processes in terms of time and have developed clever paradigms to examine just what features of language representation moderate those costs. Clearly, switching takes time, and the nature and direction of those switches influences the amount of time involved in measurable ways.

While neurological approaches to code-switching represent an area that is out of the scope of the present chapter, many fine works are emerging that attempt to explore the ways in which the brain and patterns of activation within the brain change as different languages are accessed (see e.g., Ijalba, Obler, and Chennappa, 2004; Jackson et al., 2004; Muñoz, Marquandt, and Copeland, 1999; and Proverbio, Leoni, and Zani, 1999). Shanon (1991), for example, points to the issue of multilingualism and the representation of language in the case of polyglots. Thus, future research on code-switching and language-mixing should examine cases in which more than two languages are involved. How are costs distributed across switches that occur across different languages within an individual—languages that might
represent different levels of proficiency or fluency? Though these questions appear complex, it is certainly the case that increasing globalization will provide for more and more instances in which individuals do maneuver across several languages and do so successfully. How is this accomplished? Note as well that the case of interpreters and professional translators also poses an interesting population for further study (see de Groot and Christoffels, 2006). Clearly, any cognitive model that purports to explain how switching takes place and the variables that moderate those switches must not exclude the ability to switch across more than one language. Further, as with the more basic bilingual research in memory and general cognitive processing, it is important to investigate language switching across a variety of languages—those that share a similar etymology as well as those that arose from very different origins. How do different language origins play a role in moderating how easily switching can take place in a fluent speaker? These are some of the many interesting questions that can be pursued in this area of investigation. The current chapter, therefore, should serve as a starting point for many of these topics of inquiry.

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