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RECOVERY TIME DURING THE PROCESSING OF CODE-SWITCHES IN BILINGUALS

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The central aim of the present paper is to investigate if the recognition of code-switched lexical items causes a processing delay. Soares and Grosjean (1984) found that in a phoneme-triggered lexical decision task, bilinguals took longer to access code-switched words when they were in a bilingual mode than they did to access base language words in a monolingual mode. Using a different language pair and another task, our study shows that there is no evidence of a processing delay in code-switch recognition. The results are discussed in terms of the stimuli and the experimental paradigm used.

Introduction[1]

Bilingual speech is similar to monolingual speech and at the same time more complex. Unlike monolingual speakers, bilinguals are not restricted to a choice between distinct varieties or styles of one and the same language: they can choose between two languages. Bilinguals may behave perfectly like monolinguals when they use only one language and deactivate the other one as much as possible. However, and in most bilinguals' everyday lives this is certainly much more the norm than the exception, they may use their two languages by mixing elements of both within one and the same utterance: this juxtaposition of elements belonging to two grammatical systems is referred to as *code-switching*.

The central aim of our study is to investigate how bilinguals process mixed language, in particular code-switched lexical items. In what follows, we will begin by describing the linguistic characteristics of bilingual speech. Grosjean (1995) argues that bilingual speech can be categorised along a situational continuum which induces two language modes: bilinguals are in

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a monolingual mode when behaving like monolinguals whereas they are in a bilingual mode when producing mixed speech. A bilingual, when in a bilingual mode, selects one of the two languages as the *base language* and inserts elements (phonetic, lexical, semantic or syntactic) from the other, less activated language (labelled *guest language*). The inserted elements from the guest language can be classified according to their level of integration into the base language. We will go on to deal with the psycholinguistic aspects of bilingualism. The central question here is whether code-switches are more costly to process than base language words. We will present and discuss three papers dealing with this subject. As we shall see, the issue is quite controversial: Macnamara and Kushnir (1971), for instance, claim to have found evidence for a *language switch*: they hypothesise that the on-line processing of mixed speech is more time-consuming due to the existence of a switch that blocks out the other language. Paradis (1980, 1989), on the other hand, argues strongly that switch mechanisms of this kind have no psychological reality whatsoever, simply because there is no difference between monolingual and bilingual language processing. Unfortunately, only very few researchers (such as Kolers 1966, Macnamara and Kushnir 1971, Soares and Grosjean 1984) have carried out research on this topic. At first sight, the experiments carried out by Kolers (1966) and Macnamara and Kushnir (1971) suggest that code-switch processing is indeed more time-consuming. However, these studies have problems: first, the sentences used in the tests are arranged at random, as if mixed speech were not subject to syntactic constraints but a chaotic gibberish; and second, the subjects were almost certainly not in a bilingual mode. Having recognised these short-comings, Soares and Grosjean (1984) control for the factors in question and still find evidence that code-switches are processed more slowly than base-language items. We conclude that Soares and Grosjean's findings need confirmation, and we propose that the «more time» hypothesis needs re-examination, preferably by using a different language pair and another task. What is clear now is that different factors can speed up or slow down the processing of code-switches (Grosjean 1997).

The main part of this paper will be taken up by a study which has two aims. The first is to investigate whether the recognition of code-switched words does indeed cause a processing delay, and the second, if such a delay is confirmed, is to measure how long it takes the listener to make up for it. We will present our experimental study in detail, illustrate and discuss

the results we obtained, and conclude with a general discussion of our findings.

Characteristics of bilingual speech

A central characteristic in the everyday life of bilingual communities is the fact that its members have a verbal repertoire that is far more extensive than that of monolingual communities. As opposed to the repertoire of a speaker who knows only one language, bilingual speech, by definition, involves two or more languages; whereas monolinguals are limited to dialects or sociolects from one language only, bilinguals, when in a bilingual setting, have the choice between language A or language B, and can mix elements of both languages if they wish to do so. As Grosjean (1982: 128) puts it:

> Not only can bilingual speakers, like their monolingual counterparts, choose among different varieties of a language but, when speaking to other bilinguals, they can also choose between two languages. Whereas a monolingual can only switch from one variety to another (colloquial to formal, for instance) in one language, a bilingual may change varieties in one language, change languages, or do both.

Grosjean (1995, 1997) suggests that the linguistic repertoire of bilinguals can be represented by a situational continuum which induces different language modes. Grosjean (1995: 261) writes:

> At one end of the continuum, bilinguals are in a totally monolingual language mode: they are speaking (or writing) to monolingual speakers of either language A or of language B. [...] At the other end of the continuum, they are with bilinguals who share their two languages (A and B) and with whom they normally mix languages (code-switch and borrow); they are here in a bilingual language mode. [...] Bilinguals differ among themselves as to the extent they travel along the continuum. Some rarely find themselves at the bilingual end (purists, language teachers, etc.) whereas others rarely leave this end (bilinguals who live in tight-knit bilingual communities where a form of mixed language is one of the language norms).

This means that, at one end point of the continuum, the bilingual speaker X selects language A as the base language and deactivates language B as much as possible. At the other end, however, the bilingual speaker Y finds himself in a bilingual language mode due to the fact that he is speaking with another bilingual a) who knows and uses the same two languages and b) who is used to Y mixing codes. Macnamara and Kushnir (1971) introduce the idea of a *base language*. They assume that a bilingual speaker, when in a bilingual mode, selects a base language to serve as the syntactic framework of the utterance; then he inserts elements of the guest

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language. The inserted elements can be taken from all levels of analysis and be by nature phonetic, lexical, semantic or syntactic. Grosjean (1997) points out that the inserted elements from the guest language can be classified according to their level of integration into the base language. He proposes the following classification:

1) *Code-switching*: a complete shift to the guest language for a word, a phrase or a sentence[2].
2) *Borrowing*: both the form and the content of a lexical item (or even of a whole expression) is borrowed from the less activated language (the guest language) and adapted to the morphonological system of the base language. Accordingly, the elements taken from the guest language are well integrated into the base language.
3) *Loanshift:* either the meaning of a word in the base language is extended to correspond to that of a word in the guest language, or words in the base language acquire a new meaning because they are rearranged along a pattern provided by the guest language.

The crucial question is therefore whether the inserted elements are integrated into the base language or not (and if they are, to what extent). As Grosjean (1997) points out, particular levels of activation of the two languages are reflected by the bilingual's language choice. If a bilingual is in a monolingual mode, he deactivates the other language as much as possible; consequently, it is not very likely that elements from the guest language are inserted into the utterance. When producing mixed speech, however, both languages are activated but one of them is activated more strongly than the other one in order to serve as the base language. Grosjean (1997: 5 in manuscript) writes:

> Different positions along the continuum correspond to different levels of activation of the two languages, but particularly of the guest language, as the base language probably never descends much below full activation.

Having identified and classified the various elements of bilingual speech, we are now in a position to make one step further, namely to discuss the psycholinguistic processes that underlie it. Grosjean and Soares (1986) state that psycholinguistic models proposed in order to shed light on bilingual language processing must account for the bilingual's *language modes*; and Grosjean (1995) points out that such a model not only faces the task of explaining if and how the language processing of bilinguals in a monolingual speech mode is distinct from that of their monolingual counterparts, but that it moreover has to account for the interaction of the two languages in on-line processing when the bilingual is in a bilingual speech mode. This means that bilinguals in a bilingual mode are faced with the complex task of decoding mixed speech that contains elements from two languages. The question we wish to address in our study is whether mixed speech is more costly to process: in other words, does it take bilingual listeners more time to access code-switched words than base language words?

2 The term *code-switching* will be used in the sense in which Gumperz (1982: 59) has defined it as «the juxtaposition within the same speech exchange of passages of speech belonging to two different grammatical systems or sub-systems».

Processing mixed speech

Kolers (1966) tested bilinguals for comprehension of texts presented in several linguistic forms. The subjects were asked to read passages which were prepared in each of six linguistic forms: in the *unilingual form*, the entire passage was either in English or in French; in the *alternating form*, alternate sentences were in English or French, in half of the sentences the first sentence in English and in the other half the first sentence in French; and in the *linguistically mixed form*, words were haphazardly in English or in French, half of the passages favouring English word-order and the other half favouring French. After reading the passages, the subjects answered questions concerning the content of the text. Kolers concluded that «the linguistic form of connected discourse has only a trivial effect upon comprehension of textual material» (p. 361). In a second experiment, subjects were to read aloud similarly arranged passages. Here Kolers' results differed significantly from those obtained in the first experiment: he found that the linguistic form of the passages had a great impact on the amount of time needed to read the passages. Subjects took longer to read aloud linguistically mixed material, while they read alternating texts in about the same time as the average of the two unilingual passages. Based on the measured reading times, Kolers computed a so-called phonological code-switching time, which he claimed to be between 0.3 and 0.5 sec. He concluded that «code-switching is inhibitory for production but irrelevant to comprehension» (p. 371).

Macnamara & Kushnir (1971: 486) claimed that «code-switching runs counter to psychological 'inertia'»; they hypothesised that mixed speech was more costly to process and that the additional amount of time could be measured. In order to confirm their hypothesis, they used different

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strategies in order to test code-switch comprehension in the two modalities of reading and listening: first, like Kolers, they compared reading times of uni- and bilingual paragraphs; second, they presented uni- and bilingual sentences and asked bilinguals to judge their truth value; and third, they made subjects listen to tape recordings of sentences and again asked them to indicate if they were true or false. In the first experiment (silent reading), the authors found that language switching took an observable amount of time and calculated that the mean time per language switch amounted to .17 sec. Experiment II dealt with language switching in short sentences; subjects listened to English and French sentences as well as to mixed sentences that contained a number of switches. The mixed sentences contained either one switch (e.g. *le soleil boit* apples), two switches (*une pomme de terre* is *bleu*) or even three switches (*douze choses* make *une* dozen). The subjects then had to judge if the presented sentences were true or false. Macnamara and Kushnir found a) that the subjects were slower to respond to mixed sentences than to unilingual sentences, and b) that the response times increased with the number of code-switches. The authors claimed that mixed speech was more costly to process due to the fact that the two languages formed «psychologically distinct systems». They wrote:

> We have certain expectations for strings of words and one such expectation is that all the words should be in a single language. Our experiments all violated this expectation and as a result disrupted Ss' interpretative processes. (p. 485)

They then investigated the input switch proposed by Macnamara (1967), a two-switch model containing an input and an output switch. Macnamara hypothesised that the output switch is controlled by the perceptive system of the speaker and comes into effect during production; during comprehension, the input switch is assumed to be automatic and activated by the phonetic clues of the sound wave. Macnamara and Kushnir concluded that, due to the input switch, the processing of code-switches takes more time, and estimated that «a mean figure for language switching in input [is] close to .20 sec» (p. 486).

As Grosjean (1982) pointed out, researchers have repeatedly criticised the conclusions drawn from these studies as well as the assumptions from which the authors started. When mixed speech is the central characteristic in the everyday life of bilingual communities and code-switching is such an integral part of the bilingual's verbal repertoire, it simply does not make sense that switching should delay language processing. Grosjean (1982:

252) asked: «Could switching really delay the processing of language, when its very purpose in everyday life is precisely to ease the communication flow between bilinguals» ? A second point of criticism concerned the choice of subjects and the materials used by Kolers and Macnamara and his colleagues[3]. It seems that the authors were not themselves bilingual and did not ask native speakers of French for advice when preparing the materials. As a result, many of the sentences used in their experiments were ungrammatical in that they violated both monolingual rules and code-switching constraints. It is therefore reasonable to assume that the delay was caused by the random arrangement of the sentences rather than by the switches they contained. Grosjean (1982: 253) wrote:

> Listening to a haphazard mixture of languages certainly takes time, but whether natural code-switching actually takes time and makes language processing more difficult remains an open question. Many believe that it does not.

Soares and Grosjean (1984) investigated lexical access in Portuguese-English bilinguals and in English-speaking monolinguals during the on-line processing of spoken sentences. They controlled all the factors neglected in the studies by Kolers and Macnamara: they carefully selected the subjects, put them in a mono- and in a bilingual mode and used code-switched sentences that corresponded to mono- and bilingual syntax. They found that bilinguals can access words as rapidly as monolinguals: when in a monolingual mode, the bilinguals' lexical decision times were very similar to those of English monolinguals. However, Soares and Grosjean found that bilinguals in a monolingual mode were substantially slower than monolinguals at responding to nonwords: «when a nonword is presented, a complete search of the first lexicon is immediately followed by a (partial?) search of the other lexicon, before the stimulus is classified as a nonword» (p. 383). Another interesting point emerged when the subjects were tested in the bilingual mode: the subjects took longer to access code-switched words in the bilingual speech mode than base-language words in the monolingual speech modes. Interpreting their findings, Soares and Grosjean wrote:

[3] Kolers, for instance, describes his bilingual subjects as follows: «The Americans had lived in an French-speaking country for at least nine months and reported having a good knowledge of French. The Europeans had been in the U.S. for at least nine months [...] English was more actively used by the Europeans than French was by the Americans» (p. 360). Kolers did not test the subjects' degree of bilingualism, nor did he inquire with whom and how often they spoke the two languages separately or in mixed form.

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> We will make two assumptions. The first is that bilinguals always search both lexicons when confronted with a non-word, even in a bilingual speech mode, and the second is that whatever the task and the speech mode, bilinguals always search the base-language lexicon first. The first assumption explains the similar reaction times to nonwords in both the monolingual and the bilingual speech modes [...] The second assumption explains the difference in reaction times to base-language words in the monolingual speech modes and to code-switched words in the bilingual speech mode (p. 384).

In sum, Soares and Grosjean found evidence that code-switches are processed more slowly. However, they argued that a number of reasons affect the access time of code-switches, as we will see below.

Factors involved in the recognition of code-switches

In what follows, we will focus on code-switched elements, where there is a complete shift to the other language, rather than on borrowings and loan words that are more or less adapted to the morphological and phonological systems of the base language. Grosjean (1997) proposes that the factors involved in the recognition of guest words fall under at least three categories: the listener, the level of activation of the two languages, and the properties of the guest word[4]. As factors pertaining to the *listener*, Grosjean mentions the listener's fluency in the guest language, the language mode he is in when processing the guest word, the listener's attitude towards code-switching and borrowing in general, and the listener's expectations towards the presence of code-switches and borrowings (here it is assumed that the listener recognises a guest word more quickly when expecting a code-switch). As for *base and guest language activation*, Grosjean argues that the selected base language has a strong impact on language processing. He discusses this effect in terms of the base language effect (Grosjean and Soares 1986). Grosjean and Miller (1994: 201) define the base language effect as «a momentary dominance of base-language units (phonemes, syllables, words) at code-switch boundaries»; this effect «concerns the impact that the base language has on the guest language during the perception of code switches». This means, in other words, that even if in a bilingual mode, a listener does not always recognise a code-switch right from its onset, but rather works from the assumption that he has to activate and isolate a lexical item belonging to the base language. It has been shown repeatedly that the perception of guest language units can be delayed due to the base language effect (Soares and Grosjean 1984, Grosjean and Soares 1986, Grosjean 1988, Li 1996). As for guest language activation, there is now some evidence that guest word recognition is influenced by code-switch density. Grosjean (1997:18 in manuscript) writes that «the more code-switching there is, the more the guest language is activated and hence the more easily a code-switched word can be recognised». Leuenberger (1994) found a code-switch density effect: bilinguals recognised code-switches more rapidly when another code-switch preceded.

[4] Grosjean mentions a fourth category, code-switching constraints, but we will not discuss it here.

The third category concerns the *properties of guest words* that affect their recognition. A distinction needs to be made between the word's phonotactics (consonant sequences, syllables, etc.) and the actual phonetics of the word (language-specific sounds, prosody of guest language, phonological integration into base language, etc.). For example, Grosjean (1988) tested the recognition of three distinct types of words: Type 1 words, whose initial clusters marked them phonotactically as belonging to English; Type 2 words that were not marked phonotactically as belonging to English (but like Type 1 words, they did not have French counterparts); and Type 3 words, which were phonotactically similar to Type 2 words but, unlike Type 1 and 2 words, did in fact have French counterparts. These words were presented by means of the gating technique (Grosjean 1980), which means that the subjects heard series of segments of increasing duration. After each gate, French-English bilinguals were asked to guess the word being presented and to give a confidence rating. Two important insights emerge from this study: first, 76% of the words were isolated before their ending, but whereas 97% of Type 1 words and 90% of Type 2 words were isolated before their acoustic offset, only 43% of Type 3 words were isolated by then. This indicates clearly that bilingual listeners have difficulty in recognising words that are not phonotactically marked as belonging to one language and that have counterparts in the other language. Second, Grosjean found that the word-identification process depends on the pronunciation of the guest word. A guest word that is integrated into the morphonology of the base language (and pronounced as a borrowing) is more difficult to recognise than a code-switched item which involves a total change on the phonetic level.

Li (1996) carried out a very similar experiment with English-Chinese bilinguals and tested the three variables of language phonetics, phonotactic structure and context. His results support Grosjean's findings. First, Li found considerable evidence for the base language effect, namely that

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when the base language was Chinese, the subjects, during the first gates of the word to identify, proposed Chinese candidates more often than English ones for both borrowings and code-switches. Second, he confirmed that code-switches, when pronounced in their guest language phonetics, are identified much more easily than when they are pronounced as borrowings. Third, Li's results indicate that Chinese-English bilinguals can recognise code-switched words with the same amount of information as required by English monolinguals, particularly when the word is presented in a constraining context. In sum, every model proposed in order to explain the recognition of guest words in mixed speech must account for a number of factors, such as the listener, the degree of activation of base and guest language, the linguistic constraints governing code-switching and the phonotactic and phonetic properties of the guest words.

The aims of the present study

The central aim of the present study is to investigate how bilinguals process mixed language, in particular code-switches. Even though we have now a much better understanding of the factors that affect the perception of guest words, we need to pursue the question of whether recognising code-switches can cause a processing delay. Using a different language pair and a different task, we will investigate whether the results obtained by Soares and Grosjean (1984) are confirmed (aim 1). In addition, in case we find a delay, we wish to assess how long it takes the listener to make up for this delay (aim 2). The set-up of our experimental study was the following: Swiss German/English bilinguals listened to sentences followed by either a base language word or a code-switched word which in its turn was followed by four syllables (pa, ta, ka, sa). Except for one of the four syllables, the material was presented in one ear only. The subjects were asked to pay particular attention to the code-switched word since they were to indicate afterwards whether they had recognised it or not. They were also asked to repeat as quickly as possible the syllable that was presented in the other ear. The reaction times were then measured in order to find out whether the subjects' response after a code-switch was delayed or not. The first aim will be met if the first syllable «pa» takes significantly longer to repeat when following a code-switch than when it follows a base language word. If this is the case, the delay is probably due to a longer recognition process of the code-switch which carries over to the first syllable and slows down its

production. The second aim will be met by examining the time it takes to produce the second syllable «ta» and the third syllable «ka» in the two conditions (the code-switch condition and the base language condition). If it takes significantly longer to repeat the second syllable «ta» in the code-switch condition than in the base language condition, this would mean that the delay lasts at least two syllables. If the delay persists with the third syllable «ka», then it lasts at least three syllables. Of course, it might be that there is no extra delay starting with the second syllable which would show that listeners recuperate from the processing delay within one syllable.

Method

Subjects

48 Swiss German-English bilinguals, 28 female and 20 male, with no reported hearing or speech disorders, participated individually in a session lasting 30 minutes. All participants were students or assistants at the English Seminar of the University of Basle. All of them used both Swiss German and English regularly, most of them on a daily basis. A few of them reported both Swiss-German and English as their mother tongues and were considered simultaneous bilinguals. The vast majority of the participants, however, were native speakers of Swiss German and had learnt English at school; they used Swiss German as their language of communication with their families and friends, and spoke English extensively in their studies at University (lectures and seminars are held in English, seminar papers are written in English, etc.). All participants had travelled to English-speaking countries at least once and stayed there for a minimum of 2 months. After the test, the participants filled out a biographical questionnaire which provided additional information about their language history, their competence in each of the four skills (reading, writing, speaking, listening) in each language and the different functions of the languages in their lives (indicating which languages they used when, with whom and for what).

Materials

In order to select the stimuli, we composed two lists of words, one consisting in English words (henceforth English CS words), the other one

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in Swiss German words (SG words). All items were bisyllabic nouns and denoted concrete objects rather than abstract qualities. When composing the lists of potential stimuli, semantic priming was avoided as much as possible. In addition, the items had the following two characteristics: first, the uniqueness point (UP), the point in the left to right sequence of phonemes at which the word distinguishes itself from all other words (Marslen-Wilson 1984), occurred well before the offset of the stimulus, and second, the items became language-specific almost immediately after their beginning[5]. In order to establish the frequency of the words, we asked native speakers to give us a rating. We sent the list containing the English words to 25 English natives living in the region of Basle; the criterion was that they had grown up in an English-speaking country and, even though living in or near Basle, that they continued to use their mother tongue on a daily basis (with their families, at work etc.). They were asked to rate the frequency of the items on a scale ranging from 1 (very infrequent) to 7 (very frequent). To help them anchor their scales, examples of very infrequent and very frequent words were given. The frequency of the SG words was estimated in exactly the same way by 25 native speakers of Swiss German. We analysed the 50 answer sheets and calculated the average frequency for each word. We then selected 36 nouns, 18 SG and 18 English CS nouns, as the stimuli. In addition, we chose items to be used as fillers.

For the recording, we prepared a type-written version, containing a) several base (or carrier) sentences such as, «in letschter Ziit gsehn ich in dr Zittig immer hüffiger s'Wort ..», *lately I have seen in the newspaper more and more frequently the word* .., to which we added the SG word «Auto» (*auto*) as well as the four syllables «pa-ta-ka-sa»; and b) each of the 36 stimuli embedded in a short sentence («Ich gseh hüffig s'Wort ...», *I often see the word* ...). A bilingual Swiss German/English female speaker, with no apparent accent in either language, was then asked to read the sentences and, while reading, to insert a short pause between the sentence and the word «Auto» and another one between the latter and the following syllables. The recordings took place in a sound proof chamber and were digitised at a sampling rate of 20 kHz on a Macintosh II computer. The sentences as used in the test were composed in the following way: We

[5] The reason for this, of course, was that the subjects had to recognise the stimuli as code-switches right away and not undergo accessing difficulties by erroneously assuming that the lexical items in question were borrowings or loan words.

selected one version of the Swiss-German base sentence «in letschter Ziit gsehn ich in dr Zittig immer hüffiger s'Wort ..» (by analysing the speech wave and paying special attention to intonation), and added a pause of exactly 150 milliseconds after the offset of the plosive /t/. Then we isolated the experimental stimuli as accurately as possible by inspecting the speech wave and by using auditory feedback. After the pause, an isolated stimulus word was inserted, followed by another pause of 150 milliseconds. After the second pause came the syllable sequence «pa-ta-ka-sa», spoken in real time. The 36 stimuli plus the 12 words that were used as fillers were isolated, as well as the 12 words to be used in the pretest. The result was a sentence of the following kind:

Base sentence-------------stimulus-------------pa-ta-ka-sa
150 msec 150 msec

Then, the auditory channel of one of the four syllables was switched so that the subjects heard the base sentence, the stimulus and three of the four syllables in one ear. However, one of the four syllables — either «pa», «ta», «ka» or «sa» — was perceived in the other ear (e.g. the syllable «ta» in the example below). This means that, in our experiment, the subjects listened to sentences such as:

left ear:	base sentence	stimulus	pa		ka	sa
right ear:				ta		

We thus obtained 60 sentences: 12 for the pretest, and two series of 24 each for the test. The fillers (15 words in all) were only used in sentences where the ear change occurred on the syllable «sa»; these filler sentences were not considered in the final analysis. We then made 3 versions of each sentence (with the exception of the filler sentences): in each version, one of the three syllables «pa», «ta» or «ka» switched ears. The pretest was identical for all the participants: it contained 12 sentences, with 6 English CS and 6 SG stimuli. Each one of the four syllables was switched in three sentences. The test itself consisted in two series of 24 sentences. The total of 48 test sentences was split up in four groups; every ear-switched syllable occurred in 12 sentences, after 6 English CS and 6 SG stimuli. Three experimental

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tapes were made from these presentation sets. Each tape contained three pretests and three test series: in one of these series, the order of the two parts was reversed. The order of the filler and the test sentences was randomised; however, both parts of a series started with a filler sentence.

Procedure

The 48 subjects were run individually on one of the three experimental tapes. The subjects were first split into 3 groups of 16; this meant that the subjects heard each of the 36 stimuli, followed by either the syllable «pa», «ta» or «ka», plus the 12 fillers followed by the syllable «sa». Half of the subjects were run first on part one, then on part two of the series, whereas the other half began with part two and ended with part one. These 6 subgroups of 8 were again divided in half because 4 subjects heard part one in the left and part two in the right ear, whereas the other 4 heard part one in the right and part two in the left ear. All in all, the 48 subjects were split into 12 groups of 4. Great care was taken to make the groups as homogeneous as possible. The sessions were conducted in Swiss German (the usual language of communication between the experimenter and the subjects) and the instructions were written in German. For all recordings, we used a reaction time button box and a Marantz CP 230 tape recorder. The subjects were told that they were going to hear over headphones the base sentence, followed by either a Swiss German or an English word and that one out of the following four syllables would be switched, i.e. that either «pa», «ta», «ka» or «sa» would be presented in the other ear. The subjects were then asked to listen to the presentations and to do two things: first, to listen carefully to the stimulus because, after each series, they had to identify on a separate sheet the stimuli they had heard; and second, to repeat the ear-switched syllable as rapidly as possible. The subjects were given a pause of three seconds between each presentation. After both series, we tested if the participants had recognised the stimuli or not: they were given identification sheets containing twelve stimuli they had heard (six SG and six English CS ones), plus two SG and two English CS words that were not presented. They were asked to look at the 16 words and to put a cross beside those they remembered.

Data analysis

First, we evaluated the response sheets of the recognition test in order to find out whether the subjects had recognised the code-switches or not.

Second, we prepared the measured reaction times in the following way: when there was no response to a switched syllable, it was not replaced immediately (but see below). The extreme values (both extremely high and low) were replaced by less extreme ones; we obtained these by adding to the mean (Ø) or taking away from it twice the standard deviation (the upper extreme value was thus replaced by applying the formula Ø + 2SD, the lower one by Ø - 2SD). After having replaced the extreme values, we calculated the new mean; in cases where there was no response, we put in the mean obtained this way. After having cleaned the data, we did two kinds of analysis: one by items and one by subjects. The reaction times were entered in two distinct matrices: one with all the measured times of one particular subject, and another one in which all of the subjects' reaction times to one particular stimulus were registered. We calculated the average reaction time to each syllable after a SG and after an English CS stimulus. Then we conducted two analyses of variance (ANOVA) on the data, one with participants as the random variable (F1), and the other one with items as the random variable (F2).

Results and discussion

Recognition rate

An examination of the stimulus recognition sheets provided clear evidence that the subjects paid attention to the stimuli. Of the 16 words on the identification sheet, only 12 had figured in the preceding part. This means that 4 words had not been used and were simply introduced in order to test the subjects' attention. Consequently, when indicating the words the participants believed they had heard, there were two possible sources of error: first, not identifying a correct stimulus, i.e. a stimulus that had been used in the test; and second, identifying a false candidate, i.e. indicating a stimulus that had not been used. Figure 1 (next page) shows the percentage of SG and English CS stimuli that were presented in the test and recognised by the participants. The majority of stimuli (84,9% of English CS and 81,8% of Swiss German words) were identified correctly by the participants.

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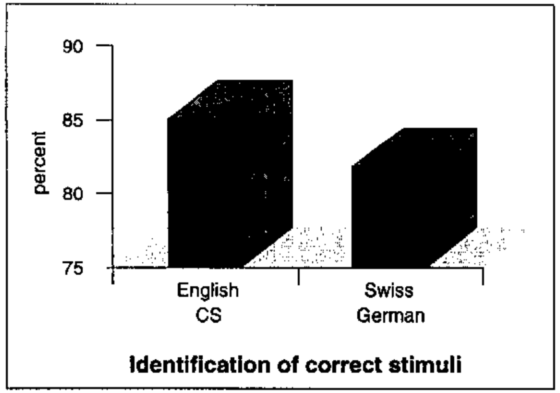

Figure 1: Percentage of stimuli (English CS and Swiss German) that were presented in the test and recognised correctly by the subjects

We thus have clear evidence that the subjects recognised the stimuli, code-switched or not. This becomes even more obvious when we analyse the identification of false stimuli, i.e. the stimuli that had not been presented in the test but were nevertheless indicated by the subjects. In Figure 2, we see that only about 5,5% of wrong candidates were proposed. Again, the subjects paid the same amount of attention to English CS and to Swiss German stimuli: whereas only 4,7% of wrong English words were indicated, the percentage of wrong Swiss German candidates amounts to 6,3%.

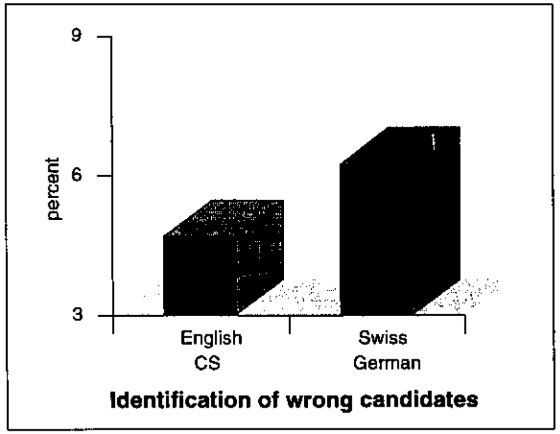

Figure 2: Percentage of stimuli that were recognised but had not been used in the test

A combination of the findings illustrated in figures 1 and 2 therefore puts us in a position to claim that the participants did indeed pay attention to the

stimuli and that they consequently recognised if the word following the base sentence was Swiss German or code-switched.

Syllable perception

The question here is whether syllables switched after an English CS word obtained a higher percentage of errors than those switched after a Swiss German stimulus. In other words, did the lexical status of the stimulus exert an influence on the repetition of the following syllable(s)? Figure 3 reveals several interesting points; first, only about 8% of all the syllables were not repeated correctly. Second, when a false response was given, the syllable to be repeated was replaced by the immediately following syllable in more than 90 percent of the cases: most mistakes were made by saying «ta» when the perceived syllable was «pa», or by saying «ka» when the syllable to repeat was «ta». Third, the second syllable was the most difficult one to repeat: the syllable «ta» replaced by «ka» alone accounted

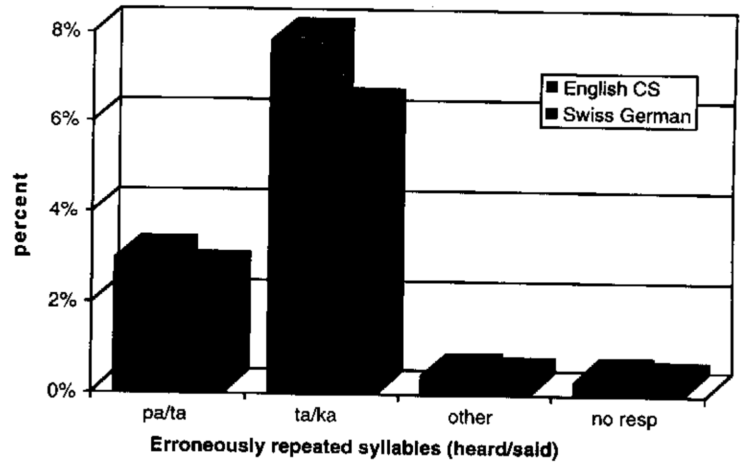

Figure 3: Percentage of erroneously repeated syllables; the first bar represents the syllable heard, and the second the syllable the subjects actually repeated.

for 60% of all the mistakes made. And fourth, the most important point for the present study, the subjects made about the same amount of repetition mistakes after English CS stimuli and after Swiss German ones (2,95% versus 2,6% for the syllable «pa» and 7,81% versus 6,25% for «ta»). In sum, most of the stimuli were recognised and identified by the subjects (as illustrated in Figures 1 and 2). Moreover, the language status of the stimulus did not have an impact on the repetition of the syllable to be repeated afterwards. We conclude that mistakes in syllable repetition were made irrespective of the stimuli's status (as seen in Figure 3).

Reaction times

Having established that the subjects could do the tasks asked of them — recognise code-switches and repeat the syllables without too many errors — we can now go back to the two aims we set ourselves. The first aim was to re-examine Soares and Grosjean's (1984) findings that recognising code-switched words could cause a processing delay; we stated that the aim would be met if the first syllable «pa» took significantly longer to repeat when following a code-switch than when following a base-language word.

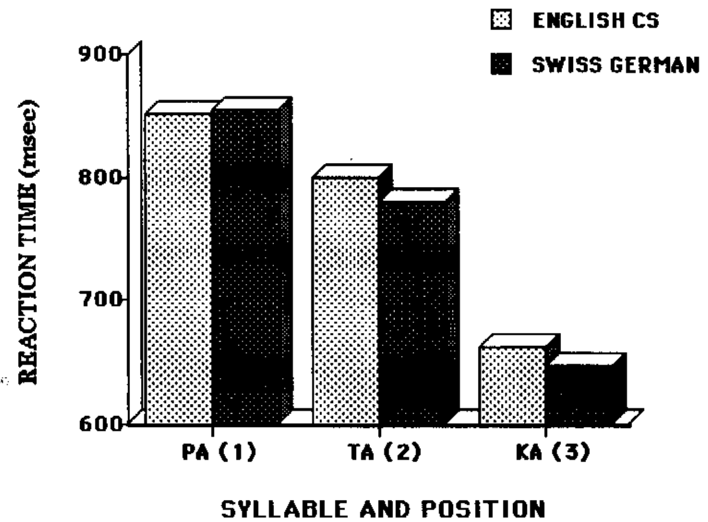

Figure 4: Mean reaction times for the three syllables «pa», «ta» and «ka» after English CS and SG words

As can be seen in Figure 4, which presents reaction time as a function of syllable and type of stimulus word (CS and SG), the reaction times to «pa» are practically identical for the two conditions (852 and 855 msec respectively). We conclude from this that, based on the first syllable «pa», our results show no evidence of a processing delay. The time it took the subjects to repeat the syllable was not influenced by the language status of the preceding word.

The second aim was to find out how long it took the listener to make up for this delay. As can be seen in Figure 4, the mean reaction time for «ta» and «ka» syllable repetition was again practically identical both after the English CS and after the Swiss German stimulus (800 ms vs. 779 ms for «ta», and 662 ms vs. 647 ms for «ka»). The results obtained for the syllables in position 2 and 3 provide further evidence that the recognition of code-switched words in our experiment did not cause a processing delay. In fact, a two-way analysis of variance shows no base language code-switching difference whatsoever. By subjects, the type of stimulus (CS, SG) effect is not significant ($F(1.47) = 2.38$, NS) nor is it in the by items analysis ($F(1.34) = 1.90$, NS). However, we have a large syllable effect — as one moves from «pa» to «ta» to «ka», it takes less time to produce the syllable. This is reflected in the by subjects ($F(2.94) = 62.02$, $p < 0.001$) and the by items anovas ($F(2.68) = 136.29$, $p < 0.001$). We should note, though, that there is no interaction either by subjects or by items. To explain the syllable effect, we suggest that the syllable «ka» is repeated more quickly than «pa» due to a more focused expectation on the part of the listener. It is paramount that the subjects are instructed that one of the four syllables is switched, but that they are not told which will be the one to be perceived in the other ear. At the onset of the syllable sequence, the chances for the first syllable to be repeated is therefore 1 in 4, i.e. 25%. However, if «pa» is perceived in the same ear as the base sentence, there remain only three syllables; the chances for «ta» increase and are 33%. The same process goes for the third syllable in case the syllables in position 1 and 2 are not switched: now the chances for «ka» to be the syllable to produce increase to 50%. As a consequence, the later the switched syllable occurs, the more it is anticipated by the listener.

General discussion

Our results suggest that processing code-switches does not cause a processing delay. Soares and Grosjean (1984), however, found a code-switch effect in the recognition of mixed speech. The question now is why Soares and Grosjean's results and the findings obtained in our study are in such obvious contradiction. Two reasons come to mind. The first concerns the characteristics of the stimuli used in our experiment. The uniqueness point of both types of words occurred quite early and the words themselves were quite long (2 syllables); moreover, additional time was given by the 150 msec pause before the syllable sequence. There is no question that the

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tapping into lexical decision mechanisms occurred before the stimulus' offset; this means that recognition had taken place by the time the first syllable «pa» arrived. Consequently, the subjects were probably given too much time between the moment they heard the stimulus word and the moment they had to repeat the syllable. As a result, we found no delay because tapping into the recognition process probably occurred too late. The conclusion is that, if there is a delay, it is very short-term and cannot be shown in our experiment because the stimuli and the following pause were too long.

The second point considers the nature of our task. Perhaps the task used in our experiment does not tap into the word recognition process after all and hence cannot show the delay (if there is one). It is theoretically possible that the process of monitoring and repeating syllables is not sensitive to word recognition processes involved in identifying code-switches and base language words. In case the two operations take place independently, it is plausible that the delay in word recognition cannot be shown by syllable production. In sum, we are unfortunately not in a position to argue that our findings offer consistent proof that there exists or that there does not exist a processing delay in code-switch recognition. Further studies, perhaps using a similar task with monosyllabic or short bisyllabic stimuli and shorter (or no) pauses should be carried out in order to explain whether code-switches are indeed more costly to process or not.

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