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An electro-encephalography study on Dutch-Papiamento code-switching production

“*Een úniko studie*” or “*een studie úniko*”?

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Abstract

Intra-sentential code-switching in Dutch-Papiamento bilingualism may create a conflict within the determiner phrase, because in Dutch the **adjective** precedes the noun (1), whereas in Papiamento the **adjective** follows the noun (2).

1. Het **rode** huis [Dutch]
2. E kas **kòrá** [Papiamento]

   "The red house"

The Matrix Language Framework (MLF – Myers-Scotton, 1993) suggests that the matrix language will provide the grammatical frame and that the embedded language will supply some content elements. The matrix language will thus determine the word order in a code-switched determiner phrase. In the case of Dutch-Papiamento intra-sentential code-switching, the MLF will predict an [adjective-noun] order when the matrix language is Dutch, and the MLF will predict a [noun-adjective] order when the matrix language is Papiamento. However, the MLF does not make a prediction about the origin of the adjective or the noun. Thus, when the matrix language is Dutch, both combinations of [Dutch adjective-Papiamento noun] and [Papiamento adjective-Dutch noun] would be possible according to the MLF. The same principle applies for Papiamento as the matrix language, both language combinations [Papiamento noun-Dutch adjective] and [Dutch noun-Papiamento adjective] would be possible according to the MLF. The aim of the present study is to test the predictions of the MLF in Dutch-Papiamento code-switching production. The four code-switching patterns mentioned above were used as conditions that match the predictions of the MLF ("MLF+ conditions"). Another four conditions were created by reversing the order of the adjective and the noun in both matrix language paradigms, to create a violation of the predictions of the MLF ("MLF- conditions"). A total of eight conditions were used in this study.

The MLF predictions were tested by using an advanced psycholinguistic method, namely electro-encephalography (EEG). The integration of a psycholinguistic method in a code-switching experiment is an innovative way of testing the predictions of a theoretical model. In this study, an EEG signal was recorded while Dutch-Papiamento bilingual speakers conducted a modified picture naming task. The conditions were analysed by looking at naming latencies and by looking at the part of the EEG signal following target presentation.

Based on results of previous picture naming tasks (Christoffels, Firk & Schiller, 2007; Rodriguez-Fornells, Van Der Lugt, Rotte, Britti, Heinze & Münte, 2005; Misra, Guo, Bobb &

Kroll, 2012), I expected slower naming latencies and a more negative waveform for the conditions that violate the predictions of the MLF. The expected slower naming latencies were observed in two MLF- conditions: Papiamento adjective followed by a Dutch noun (Papiamento matrix language) and Papiamento noun followed by a Dutch adjective (Dutch matrix language). The expected negative waveform was observed in only one MLF- condition: Papiamento adjective followed by a Dutch noun (Papiamento matrix language). Furthermore, a P300 (with an early peak in the frontal/central area and a later peak in the occipital area) and a late positive component seem to be elicited in code-switching production. The amplitude of the P300 peak was higher in the conditions that contain a violation of the MLF, which could be explained by the higher complexity of the MLF- conditions. The occurrence of the P300 could be explained in terms of the context-updating theory (Donchin, 1981; Donchin & Coles, 1988) or the neural inhibition theory (Polich, 2007). On the whole, the results do not provide conclusive support for the predictions of the MLF.

Key words:

Code-switching, Intra-sentential, Dutch, Papiamento, Matrix Language Framework, Electro-encephalography

Abbreviations

These abbreviations are used in the example sentences. Other abbreviations will be explained in the running text.

A	adjective
ADV	adverb
AUX	auxiliary
DEF	definite
DET	determiner
FEM	feminine
FUT	future
INDEF	indefinite
MASC	masculine
MOD	modal
N	noun
NEG	negation
O	object
PL	plural
POSS	possessive
PRES	present
PRON	pronoun
PRT	particle
Q	question word
S	subject
SG	singular
TIME	time
V	verb

Contents

1. Introduction to code-switching

In the literature, there is no consensus about the definition of code-switching. Terms used in the literature are, among others, code-switching[1], code-mixing and language switching. However, language switching and code-switching do not refer to the same type of process and the results of a language switching experiment are often misinterpreted as evidence for code-switching. Costa and Santesteban (2004) conducted a language switching task with Spanish-Catalan bilinguals and Korean-Spanish bilinguals. Participants were instructed to choose the language of the response according to the color of the picture. As a result, participants focused on one language at a time and inhibited the response in another language. For these two groups switching from their second language to their first language was more difficult than vice versa (Costa & Santesteban, 2004; replication of the asymmetrical switching costs found in Meuter & Allport, 1999).

In contrast to language switching, code-switching is the integration of the grammars of both languages in the same conversation. According to Meisel (1994) code-switching is seen as "the ability to select the language according to the interlocutor, the situational context, the topic of the conversation, and so forth, and to change languages within an interactional sequence in accordance with sociolinguistic rules and without violating specific grammatical constraints" (Meisel, 1994: 415). Meisel's definition presumes that grammatical rules constraint code-switching. Myers-Scotton (1992) also presumes that code-switching is not random, however, she also suggests that the two languages should not be considered equal (Myers-Scotton, 1992). This asymmetry between the two languages will be explained in more detail in chapter 4, where the grammatical constraints of code-switching will be discussed.

The use of two languages by the same speaker within the same conversation is termed code-switching and can be divided into two main types: intra-sentential and inter-sentential code-switching. Code-switching at sentential boundaries is generally referred to as inter-sentential code-switching, while switching below sentential boundaries is called intra-sentential code-switching (MacSwan, 2000). (1) is an example of intra-sentential code-switching in Welsh-English (Deuchar, 2006) and (2) is an example of inter-sentential code-switching in English-Swahili (Myers-Scotton, 1993a).[2]

[1] Alternate spellings in the literature include codeswitching and code switching. In this study code-switching is used throughout, except in direct quotes from articles in which a different spelling is used.

[2] Two types of fonts (normal-**bolded**) are used in both the language pair and the example sentences, to illustrate which parts of the example sentences belong to which language of the language pair.

(1) Achos fod gen ti dy **silk** **handkerchief** yn dy
Because be to PRON.2SG your silk handkerchief in your

boced
pocket
"Because you have your silk handkerchief in your pocket"
(Welsh-**English**, Deuchar, 2006: 1995)

(2) That's too much. **Sina pesa**.
"That's too much. I have no money"
(English-**Swahili**, Myers-Scotton, 1993a: 41)

Sometimes a third type of code-switching is identified, referred to as extra-sentential switching (Poplack, 1980) or tag-switching (Cantone, 2007). This type of switching involves an utterance in one language and a tag or an interjection from another language, like the German '"weisst du" (3) or the Italian "capisci" (4) (Cantone, 2007).[3]

(3) Oggi Sara era al nuovo negozio, **weisst du**?
"Today Sara was at the new shop, you know?"
(Italian-**German**, Cantone, 2007: 58)

(4) I was happy about that, **capisci**?
"I was happy about that, do you understand?"
(English-**Italian**, Cantone, 2007: 58)

The focus of this study is on intra-sentential code-switching, and therefore, the examples that will be used, are examples of intra-sentential code-switching. The intra-sentential type of code-switching demonstrates how different grammars of two languages can interact within the same clause. The language pair Dutch-Papiamento will be studied, because the grammars of Dutch and Papiamento may create a conflict for intra-sentential code-switching. Thus, when not further specified, code-switching refers to intra-sentential code-switching. Some authors (such as Treffers-Daller, 1994) make this distinction by using the term code-mixing, while

[3] Bolded text in the example sentences is used to highlight the tag or interjection.

others use these terms interchangeably. I have chosen not to draw a distinction between the two. To avoid confusion, I will stick to one term: code-switching.

Now that I have explained the term code-switching, I will explain the point of views in which code-switching has been studied. Code-switching has mainly been studied from a linguistic and a sociolinguistic point of view (Backus, 2009). While linguists mainly focus on the structural aspects of code-switching and the formulation of constraints based on a theoretical model (e.g. Woolford, 1983), sociolinguists have mainly focused on the social motivations and social correlates of code-switching (e.g. Auer, 1988). Less research is done from a psycholinguistic point of view, in which researchers concern themselves with questions about how the linguistic system of a bilingual is stored and organized in the cognitive system, and how it is accessed in in language production and comprehension (Backus, 2009). Backus claims that "investigating usage patterns in corpora generates hypotheses about competence that should be tested, if possible, with psycholinguistic experiments" (Backus, 2009: 308) and he suggest that there should be more interdisciplinary approaches to code-switching. In this present study, I use an interdisciplinary approach to study Dutch-Papiamento code-switching production. A psycholinguistic method will be used to test the predictions of a theoretical model.

This study will have the following outline: in chapter 2 the grammars of both languages will be discussed, which will make the grammatical conflict more clear. The models of bilingual speech production will be discussed in chapter 3. The discussion of the bilingual speech production models will show how elements from multiple languages can be combined. The main focus will be on the Matrix Language Framework model. The aim of this study is to test the predictions of this Matrix Language Framework by using electro-encephalography. Background information about previous electro-encephalography studies will be provided in chapter 4. Subsequently, the methodology (chapter 5) and results (chapter 6) of this present study will be illustrated and there will be a discussion (chapter 7) and conclusion (chapter 8) of the findings at the end.

2. The language pair Dutch-Papiamento

In order to study code-switching between Dutch and Papiamento, the grammars of Dutch and Papiamento need to be explained first. The linguistic situation, the basic word order and word order of the determiner phrase of Dutch and Papiamento will be discussed in more detail below.

2.1. Dutch

Linguistic situation

Dutch is a west-Germanic language and is the official language of the Netherlands, Flanders, Suriname and the Leeward group of Islands of the Dutch Antilles (Janssens & Marynissen, 2005). However, these are not the only countries in which speakers of the Dutch language reside. Although Indonesia has been independent since 1948, there are still many older people who were educated in Dutch in the former Dutch East Indies and who still speak the language very well. Before Surinam was granted independency, many of the Creoles, Indians, Negroes, Javanese and Chinese chose to move to Holland and these people have also been linguistically integrated. In the 1950s, thousands of people left the Netherlands to settle in Canada, U.S.A., Australia, South Africa and New Zealand and so speakers of Dutch can be found across the world. In terms of number of speakers, Dutch is the third largest Germanic language after English and German (Donaldson, 1983). The Dutch language is considered to have originated from various Germanic dialects spoken in the northern part of the Netherlands, mostly of (low) Frankian origin. These dialects were mutually intelligible, but no standard form of speech existed. Due to important trade cities in the west, like Amsterdam and Antwerp, a standard form of the language began to develop. From the late Middle Ages on, this standard form started to evolve into the "standard Dutch" as we know it today (Shetter, 1994). Nowadays, Dutch has approximately 23 million speakers, most of them reside in the Netherlands (16 million), Flanders (6 million) and Suriname (400.000) (Janssens & Marynissen, 2005).

Basic word order

There is strong evidence that the basic word order in Dutch is subject-object-verb. The following examples show this word order in main clauses with modal (5a) and time auxiliaries (5b) and embedded sentences with finite verbs (6) (Jordens, 1988).

(5) a.

Karel	wil	Hans	een	boek	geven
Charles	AUX.MOD	Hans	DET.INDEF	book	give
S			O		V

"Charles wants to give Hans a book"

b.

Karel	heeft	Hans	een	boek	gegeven
Charles	AUX.TIME	Hans	DET.INDEF	book	given
S			O		V

"Charles has given Hans a book"

(Dutch, Jordens, 1988: 42)

(6)

Ik	zie	dat	Karel	Hans	een	boek	geeft
1.SG	see.1SG	ADV	Charles	Hans	DET.INDEF	book	give.3SG
S				O			V

"I see that Charles gives Hans a book"

(Dutch, Jordens, 1988: 43)

Dutch main clauses may be introduced by other elements than the subject. In that case, the finite verb precedes the subject and immediately follows the first constituent, as in the case of question words (7a,b) and adverbs (8a,b) (Zwart, 1993).

(7) a.

*Waarom	Jan	kust	Marie?
Q	Jan	kiss.3SG	Marie
	S	V	

b.

Waarom	kust	Jan	Marie?
Q	kiss.3SG	Jan	Marie
	V	S	

"Why does John kiss Mary?"

(Dutch, Zwart, 1993: 45)

(8) a.

*Weer	Jan	kust	Marie
ADV	Jan	kiss.3SG	Marie
	S	V	

b.	Weer	kust	Jan	Marie
	ADV	kiss.3SG	Jan	Marie
		V	S	
	"Again John kisses Mary"			

(Dutch, Zwart, 1993: 45)

The Dutch finite verb is always in the second position in the main clause. This phenomenon is called verb-second. Therefore the syntax of Dutch is referred to as subject-object-verb with verb-second (Zwart, 1993).

The determiner phrase

In the present study, the focus is on the determiner phrase, for which the word order is determined by the placement of an adjective and a noun. Dutch only allows for pre-nominal adjectives[4] (9a-b) (Zwart, 2011).

(9) a.	*Het	schip	snelle
	DET.DEF	ship	fast
		N	A
b.	Het	snelle	schip
	DET.DEF	fast	ship
		A	N
	"The fast ship"		

(Dutch, Zwart, 2011: 8)

2.2. Papiamento

Linguistic situation

Papiamento is a creole language that is spoken by the native inhabitants of Curaçao, Bonaire and Aruba. These three islands form the so-called Leeward Islands; together with the Dutch Windward Islands – Saint Martin, Saba and Statia – they form the Dutch Antilles. The Dutch Antilles are located in the Caribbean Sea off the Venezuelan coast (Kook & Narain, 1993). The

[4] In Dutch, a distinction can be made between predicative and attributive adjectives (Zwart, 2011). However, predicative adjectives are not part of the determiner phrase. In sentences with a predicative adjective ("*the ship is fast*"), there is a predicational relation between a determiner phrase and an adjective. Attributive adjectives are part of the determiner phrase, therefore, when I talk about adjectives, I am talking about attributive adjectives.

home languages of the six islands differ greatly. More than 80% of the population of the Dutch Windward Islands make use of an English-based creole as their home language, while more than 80% of the population of the Leeward Islands uses a creole with a mixed Portuguese and Spanish origin, namely Papiamento (Todd Dandaré, 1985). Papiamento has approximately 190.000 native speakers (de Palm, 1985). Although there are some differences in the types of Papiamento spoken on Curaçao, Bonaire and Aruba, people from these islands can still communicate with each other in this creole language. The language spoken in Aruba is referred to as Papiamento and the language spoken in Bonaire and Curaçao is referred to as Papiamentu. The differences can be seen in the intonation, the lexicon, but mainly in the orthography. Papiamentu from Curaçao and Bonaire has a more phonologically based orthography, while Papiamento from Aruba has a more etymologically based orthography (Kook & Narain, 1993). For the remainder of this study, the name Papiamento will be used to refer to the language spoken in Aruba, Bonaire and Curaçao.

The six islands are former Dutch colonies, therefore Dutch remains the official language. Nevertheless, most inhabitants of the Leeward Islands see Dutch as a foreign language. Most newspapers are written in Papiamento and most radio stations broadcast in Papiamento. Inhabitants use Dutch very little in their daily life, whereas the use of Dutch is vital in the Netherlands (Muysken, Kook & Vedder, 1996). There is great variety in the degree of bilingualism of the Dutch-Papiamento speakers.

Basic word order

Papiamento is considered a (creole) language with a very strict subject-verb-object word order, see examples (10) and (11) (Kook & Geert, 1988).

(10)	Mi	ta	un	hende
	1.SG	be.SG	DET.INDEF	person
	S	V	O	
	"I am a person"			

(Papiamento, Kook & Geert, 1988: 49)

(11)	Bo	ta	mi	amigo
	2.SG	be.2SG	POSS.1SG	friend
	S	V	O	

"You are my friend"

(Papiamento, Kook & Geert, 1988: 49)

The subject in Papiamento always precedes its predicate, even in question sentences (12), where Dutch would reverse the two, as was shown in example (7) (Muysken, Kook & Vedder, 1996).

(12)	Bo	ta	kere	ku	nan	lo	bai	bende	e	sapa
	2.SG		believe	ADV	3.PL	FUT	go	sell	DET.DEF	shoes
					S	V			O	
	aki	ei?								
	here	there								

"Do you believe that they will sell these shoes there?"

(Papiamento, Muysken, Kook & Vedder, 1996: 492)

The determiner phrase

With regard to the determiner phrase, Papiamento allows for post-nominal adjectives (13a,b) (Kook & Geert, 1988).

(13)	a.	Un	kas	limpi	
		DET.INDEF	house	clean	
			N	A	

"A clean house"

	b.	Un	sapatu		maron
		DET.INDEF	shoes	brown	
			N	A	

"*A brown pair of shoes*"

(Papiamento, Kook & Geert, 1988: 102)

Yet, there is a group of Papiamento adjectives that can appear either in pre-nominal position or in post-nominal position, depending on the meaning of the sentence. This group consists of the adjectives *bon* ('good'), *mal* ('bad'), *gran* ('big'), *dushi* ('attractive'), *nèchi* ('beautiful'), *bonita* ('beautiful') and *mahoso* ('ugly'). According to Kook and Geert (1988: 103), "if you put dushi, nèchi, bunita or mahos in pre-nominal position this will emphasize the dushi-nèchi/bunita/mahos-character of the noun". A few of these opposing positions are shown in Table 1 (Kook & Geert, 1988: 103).

Table 1. *Three Papiamento adjectives in pre-nominal and post-nominal position.*

Pre-nominal position			**Post-nominal position**		
Un	**bon**	hende	Un	hende	**bon**
DET.INDEF	good	person	DET.INDEF	person	good
"a good person"			*"a person with luck"*		
Un	**mal**	hende	Un	hende	**malu**
DET.INDEF	bad	person	DET.INDEF	person	bad
"a bad person"			*"a sick person"*		
Un	**gran**	hende	Un	hende	**grandu**
DET.INDEF	big	person	DET.INDEF	person	big
"a famous person"			*"a big person"*		

Post-nominal adjectives in Papiamento would lead to a phrase like "*biña còrá*" (lit. *wine red*), while Dutch speakers would say "*rode wijn*" (lit. *red wine*). Dutch-Papiamento is an interesting language pair to investigate within the context of the determiner phrase, because it creates a conflict site in code-switching. One language contains pre-nominal adjectives and the other language contains post-nominal adjectives, so it is unclear how a Dutch-Papiamento code switch may look like with such a conflicting word order. Now that the grammars of Dutch and Papiamento have been explained and the word order conflict has been made clear, I will explain the previous studies that have looked at Dutch-Papiamento code-switching.

2.3. Previous studies on Dutch-Papiamento bilingualism

Code-switching between Dutch and Papiamento has not been extensively studied yet. Previous code-switching research does include some studies on Dutch. Researchers have studied some language contact situations within the Netherlands (Dutch-Turkish - Backus, 1993; Dutch-Moroccan Arabic, Nortier, 1990) and outside the Netherlands, like Dutch-English in Australia (Clyne, 1978), Dutch-Malay bilingualism in Indonesia (Huwaë, 1992), Sarnami Hindustani-Dutch (Kishna, 1979) and French-Dutch bilingualism in Belgium (Treffers-Daller, 1994).

However, only a small number of studies have looked at code-switching in Dutch-Papiamento bilingualism (Muysken, Kook & Vedder, 1996; Vedder, Kook & Muysken, 1996; Gullberg, Indefrey & Muysken, 2009; Parafita Couto & Gullberg, 2015).

Two studies were done by Muysken, Kook and Vedder in 1996. In one study, Muysken et al. (1996) focussed on 1) the relationship between code-switching and language proficiency 2) the structural properties of code-switching and 3) the influence of borrowing on language change. They found that intra-sentential code-switching characterizes high proficiency in both languages and that insertional switches were the most common switches with Papiamento as the matrix language (Muysken et al., 1996). In the second study they looked at language choice and functional differentiation in bilingual reading (Vedder et al., 1996). Mothers were asked to read three picture books to their child: one in Dutch, one in Papiamento, and one without text. Results of their study showed that language choice was related to the text and contents of the book, as well as to restrictions imposed by the language proficiency in both languages of the mothers and children. The mothers categorized counting as school-related and tended to use Dutch to count (Vedder et al., 1996).

Muysken was also involved in a study on Dutch-Papiamento code-switching that used an adapted version of the Director-Matcher elicitation task[5] (Gullberg, Indefrey and Musyken, 2009), which was designed to elicit noun phrases consisting of determiners, color adjectives and nouns. Gullberg et al. (2009) used this task successfully in the Dutch-Papiamento bilingual community in the Netherlands. In order to get a complete picture of code-switching, an integration of corpus and naturalistic data, grammaticality judgments and neurolinguistic evidence is necessary (Gullberg et al., 2009). However, these three types of data are usually studied separately. For example, Parafita Couto and Gullberg (2015) have looked at corpora of three different bilingual communities to find the switching patterns in complex, modified noun phrases. The first corpus is the Dutch-Papiamento corpus, of which the data is collected in the Netherlands, and this corpus can now be accesses at The Max Planck Institute for Psycholinguistics[6]. The second corpus is the Welsh-English 'Bangor Siarad' corpus[7] (Deuchar, Davies, Herring, Parafita Couto & Carter, 2014), which includes data from speakers across Wales. The third corpus is the English-Spanish 'Bangor Miami' corpus[8], of which the data is collected in Miami, Florida (Deuchar et al., 2014). The latter two corpora are both available at

[5] This task is a referential communication task (Yule 1997) in which two speakers participates. The Director instructs the Matcher to do something.
[6] http://www.mpi.nl/resources/data/browsable-corpora-at-mpi
[7] http://bangortalk.org.uk/speakers.php?c=siarad
[8] http://bangortalk.org.uk/speakers.php?c=miami

the Centre for Research on Bilingualism at the Bangor University (links are provided in the footnotes). Results of their corpus study showed that the most frequent word order is determiner-adjective-noun[9] (Parafita Couto & Gullberg, 2015). Within a determiner-adjective-noun construction, the speakers tended to produce the determiner in one language and both the adjective and the noun in another language. In the case of Dutch-Papiamento, this resulted in a Papiamento determiner followed by a Dutch adjective and a Dutch noun. Switches between the adjective and the noun[10] (e.g. **Determiner-Adjective**-*Noun*, **Determiner**-*Noun*-**Adjective**, **Determiner-Noun**-*Adjective*) were also present in the Dutch-Papiamento corpus, but occurred less frequently (Parafita Couto & Gullberg, 2015). Three main patterns were observed: Papiamento-Dutch-Papiamento, Papiamento-Papiamento-Dutch and Papiamento-Dutch-Dutch. The first two patterns are patterns where the conflicting word order comes into play. If the adjective and the noun are from the same language, they will follow either the Dutch pre-nominal order or the Papiamento post-nominal order. But what happens when both word orders are available? Parafita Couto and Gullberg (2015) have provided some insight in which code-switching patterns emerge in naturalistic data, however, more evidence (from grammaticality judgement tasks and neurolinguistic experiments) is necessary in order to get a better understanding of code-switching. The present study is the next step in trying to integrate corpus data in a neurolinguistic experiment. This research builds on the results found by Parafita Couto and Gullberg (2015) and may provide neurolinguistic evidence for the switching patterns found in their corpus study. The focus will be on the code-switching patterns with a switch between the adjective and the noun, because that is where the grammars of Dutch and Papiamento may create a conflict. Now, I will look at previous studies regarding (similar) conflict sites within the determiner phrase.

2.4. Previous studies on conflict sites within the determiner phrase

Research on intra-sentential code-switching has shown that determiner phrases represent one of the most frequent switching points in bilingual speech (Poplack, 1980; Cantone, 2007). As stated in previous sections, intra-sentential code-switching may create a conflict site within the determiner phrase. In the case of Dutch-Papiamento bilingualism, the grammatical systems of the two languages differ in terms of word order, but other differences (and thus conflicts) can be found as well. For example, intra-sentential code-switching between a determiner and a noun

[9] Welsh and Spanish, like Papiamento, both contain post-nominal adjectives as well.
[10] Bolded text indicates Papiamento, italicized text indicates Dutch

with gender encoded languages may create a conflict in gender assignment. If the grammatical systems of both languages encode gender, then the bilingual speaker will encounter a conflict and has to cope with two options: 1) use the gender of the noun actually realized or 2) use the gender of the equivalent noun in the language of the determiner (Eichler, Hager & Müller, 2012). For the purpose of this study, I will not discuss other conflict sites in further detail and only focus on work that has been done on the word order conflict.

Parafita Couto, Deuchar and Fusser (2015) looked at Welsh-English bilingualism, which has a similar word order conflict in the determiner phrase. English, like Dutch, has pre-nominal adjectives (*red wine*), while Welsh, like Papiamento, has post-nominal adjectives (*gwin coch* – lit. *wine red*). In the field of code-switching research there have been two mainstream theoretical models that make predictions about the possible combinations of elements: the Minimalist Program (Chomsky, 1995) and the Matrix Language Framework (Myers-Scotton, 1993b). The principles and premises of these models will be discussed in more detail in the next chapter. Parafita Couto et al. (2015) used a multi-task approach, consisting of naturalistic corpus data, an elicitation task, and an auditory judgment task, to find out which theoretical model would make the best predictions regarding the word order conflict in code-switched determiner phrases. Data from the grammaticality judgment task showed that this type of task was not very useful in code-switching research Data from the naturalistic corpus and the elicitation task, however, were compatible with each other and both yielded support for the predictions of the Matrix Language Framework (Parafita Couto et al., 2015). Parafita Couto et al. (2015) suggest that neuroscientific evidence could make a useful contribution here and I am trying to follow that suggestion in this present study. Nevertheless, a clear understanding of the theoretical models is needed first. In the next chapter, I will discuss the principles and premises of the theoretical models in further detail and I will explain the language selection process during bilingual speech production.

3. Models of bilingual speech production

In the previous chapter, it was queried what a Dutch-Papiamento code-switch would look like and to what extent such a code-switch would be grammatical. The two mainstream theoretical models in the field of code-switching research have already been briefly mentioned in the previous chapter, namely the Minimalist Program (MP – Chomsky, 1995) and the Matrix Language Framework (MLF - Myers-Scotton, 1993b). For the purpose of this study, I will only focus on the predictions of the MLF, because testing the predictions of both models would be too difficult to accomplish in just one experiment. Besides, previous research has found more evidence in favour of the MLF (Parafita Couto et al., 2015) and therefore I decided to solely test the predictions of the MLF.

In short, the Minimalist Program assumes a so-called ‘null theory’. This null theory states that nothing but the requirements of both languages restricts code-switching. Considering the only requirement both language have is the order of the adjective and the noun, the Minimalist Programs suggest that the language of the adjective determines the word order (see Cantone & MacSwan, 2009). Jake, Myers-Scotton and Gross (2002) argue that the minimalist program on its own is not sufficient to explain what occurs in code-switching. From now on, the present study will only focus on the MLF and a detailed description of this model will now follow.

3.1. The Matrix Language Framework

According to Myers-Scotton (2006) the outcome of a bilingual speaker is not a result of equal participation of both language varieties. One language will provide the grammatical frame, called the matrix language, and the other language will supply some content elements, called the embedded language. This idea about an asymmetry between two participating languages was already risen in 1985 (Joshi, 1985). The prediction was that all items from closed classes, like determiners, prepositions, quantifiers, would come from the matrix language, while item from open classes, like nouns, verbs and adjectives, would come from either the matrix language or the embedded language (Joshi, 1985). To account for this asymmetry the MLF was proposed by Myers-Scotton (1993b).

The MLF has three main premises about the matrix and embedded language. The first premise is that there is an unequal participation of the matrix language and the embedded language in a constituent structure. The second premise yield that the matrix language and the embedded language do not provide all types of morphemes equally. The third and last premise entails that both languages of a bilingual speaker are always "on" during code-switching. This idea that both languages are always active in a bilingual's mind replaced the idea that there is a language switch, in which a bilingual speaker can switch off one language and switch on another language (Myers-Scotton, 2006). It has been argued by Kroll and Dijkstra (2002) that there is evidence for non-selective access to words in both languages, which means that there is activation in both languages when a bilingual speaker needs to select or produce a word in one language only. This was tested with Dutch-English bilinguals. The bilinguals had to name pictures in English (L2) with auditorily presented distractor words. When the distractor word was a word that sounded like the L1 name of the picture ("phono-translation"), the results showed interference in naming the picture. The results of the phono-translations revealed a different time course than the results for the phonologically related distractor words, which indicates that the translation equivalent is active through the stage of selecting an initial candidate, but one that is not yet phonologically specified (Kroll & Dijkstra, 2002).

Furthermore, the MLF yields two important principles that help to determine the matrix language of a (code-switching) clause. These principles are the morpheme order principle and the system morpheme principle. The morpheme order principle says that in a mixed language constituent the surface morpheme order should be that of the matrix language. The second principle, the system morpheme principle, claims that in mixed language constituents all system morphemes which have grammatical relations external to their head constituent will come from the matrix language (Myers-Scotton, 1993b, 2002). Example (14) illustrates the application of both MLF principles in a Welsh-English sentence (Deuchar, 2006).[11]

(14)	Mae	o-'n	reit	**camouflaged**	yn	dydi
	be.3SG.PRES	PRON.3SG-PRT	quite	camouflaged	PRT	NEG-be.3SG.PRES

"He's quite camouflaged isn't he?"

(Welsh-**English**, Deuchar, 2006: 1987)

According to the morpheme order principle the matrix language would be Welsh. The verb 'mae' is in clause-initial position, which reflects the verb-subject-object word order of Welsh. According to the system morpheme principle the matrix language is also Welsh, because the

[11] Two types of fonts (normal-**bolded**) are used in both the language pair and the example sentences, to illustrate which parts of the example sentences belong to which language of the language pair.

verb (with third person singular subject marking) and subject pronoun (third person masculine singular) also come from Welsh.

Example (14) contains a single occurring word as a code switch. Many researchers would call these single occurring words 'borrowings', whereas the MLF interprets such words as a code switched element in a mixed constituent (Myers-Scotton, 2006). A single-word switch is often referred to as a borrowing ("nonce borrowings" – Poplack, 1980), because some researchers claim there is a different mechanism at work. In the case of borrowing, only the integrity of the grammar of the recipient language was respected, while in code-switching the integrity of the grammar of both the donor and the recipient languages need to be respected. In most example sentences the word order, as far as the single occurring word is concerned, is the same for the two languages. In this present study, there is a conflict regarding word order. So, what word order do singly occurring embedded language forms follow? The MLF, especially the morpheme order principle, claims that the matrix language order determines the word order in such a conflict site. For example, English has a typical subject-verb-object word order and in Croatian the verb typically comes last in a clause. The position of the verb *supervise* occurs in the final position (15), demonstrating that Croatian provides the frame of the clause and is therefore the matrix language of that sentence (Myers-Scotton, 2006).[12]

(15)	Ne	on	radi	taj	posao	I	ja	njega	**supervise**
	no,	he	does	that	job	and	I	him	supervise

"No, he does the job and I supervise him"

(Croatian-**English**, Myers-Scotton, 2006: 256)

In Dutch and Papiamento there is a conflict between pre-nominal adjectives versus post-nominal adjectives. According to the morpheme order principle of the MLF the Papiamento-Dutch constructions with post-nominal adjectives, like "*biña rode*" and "*wijn còrá*", would only be possible if the matrix language is Papiamento; constructions with pre-nominal adjectives, like "*rode biña*" and "*còrá wijn*", would only be possible if the matrix language is Dutch.

Deuchar (2006) – among other researchers – has shown that the morpheme order principle and the system morpheme principle are supported in Welsh-English code-switching data. This

[12] Two types of fonts (normal-**bolded**) are used in both the language pair and the example sentences, to illustrate which parts of the example sentences belong to which language of the language pair

support proves that a code switch is not a random mix of language varieties, but that it has – contrary to the belief of many speakers – a principled basis (Myers-Scotton, 2006). All in all, the MLF emphasizes what happens on the abstract level of language production. However, there is still some discussion about one of the premises of the MLF, stating that both languages are active during production.

The early view was that the languages of a bilingual were not both activated at the same time. The idea of "turning on" one language and "turning off" the other language has been replaced by a general agreement that both language are always "on" to some extent (Myers-Scotton, 2006). According to Grosjean (1997), there is a continuum along which speakers can move, from a "bilingual mode" to a "monolingual mode". A bilingual's motivation to move from one mode to the other depends on language proficiency, task and situation (Grosjean, 1997). The presumption among researchers is that both languages are activated at some point whenever a bilingual speaks, even when they speak in one language (non-selective access – Kroll & Dijkstra, 2002). Exactly how does a bilingual speaker select the language of their choice? Imagine an adjective-noun code-switch, are adjectives from both languages activated and does one adjective need to be inhibited? Or is just one of the two adjectives considered for selection?

The literature provides no consensus regarding the manner and locus of language selection in bilingual speech. It has been argued that this lack of agreement is a result of the different experimental paradigms used in research on bilingual speech production (Hoshino & Thierry, 2014). Some theories on bilingual language access in speech production presuppose that the lexicon of both languages, the one in use and the one not in use, are activated through a common semantic system (Costa & Caramazza 1999). The question arises of how bilingual speakers select the proper lexical items when both lexicons are activated. Two models have been proposed in order to solve this issue: the language specific model and the language non-specific model. The next section will explain the two models.

3.2. Language specific versus language non-specific

The first model is the language non-specific model, which proposes that candidates from both the target and the non-target language compete for selection and that the activation of the non-target candidates needs to be inhibited (asymmetrical pattern of switching costs - Meuter & Allport, 1999). These so-called inhibitory models need a mechanism that inhibits the activation of the non-target language (Green, 1986; Meuter & Allport, 1999). A picture word interference experiment was conducted by Hermans, Bongaerts, De Bot and Schreuder (1998) to test the prediction of this model. Dutch-English bilinguals were instructed to name pictures in English while a Dutch distractor word appeared on the screen. The distractor words were either phonologically related, semantically related, unrelated or phonologically related to the Dutch name of the picture. The last type of distractor may interfere with the lemma selection process by activating the not-to-be-selected Dutch lemma, which would make it harder to select the English lemma. Their results demonstrated that during the initial stages of lexical access – accessing the English name of the picture – the Dutch picture name is also activated. Hermans et al. (1998) conclude that bilingual speakers can't prevent their first language from interfering with the production in their second language and explains this as evidence for the language non-specific model.

The second model is the language specific selection model, which claims that alternative candidates are active but only candidates from the intended languages are considered for selection. Costa, Miozzo and Caramazza (1999) have used the picture word interference paradigm to test whether the there is a language specific or a language non-specific lexical access in bilinguals. Participants were Catalan-Spanish bilinguals, who had to name pictures in Catalan with a distractor word in either Catalan (same language pairs) or Spanish (different language pairs). Distractors could either be the name of the picture or an unrelated name. A facilitation effect was found in the conditions where the distractor was the name of the picture, in both the same language pairs and the different language pairs. Though the facilitation effect was larger in the same language pairs. Costa et al. (1999) saw these outcomes as evidence for a language specific model, because only the words of the target language were considered for lexical selection.

In a later study by Costa and Caramazza (1999), they tried to replicate the facilitation effect found in Catalan-Spanish bilinguals with less balanced Spanish-English bilingual speakers and English-Spanish bilinguals speaking in their first and their second language respectively. Twenty-one Spanish-English bilinguals (experiment 1) and twenty-one English-Spanish bilinguals (experiment 2) took part in a picture word interference experiment. Costa and Caramazza (1999) used twenty-four pictures and six distractor words for each picture, three Spanish words and three English words. Results of both experiments showed that when the picture and the distractor corresponded to the same word, the naming latencies were faster than when the picture and the distractor referred to two different words. This facilitation effect occurred in the same-language pairs as well as in the different-language pairs, yet the effect was larger for the same-language pairs (Costa & Caramazza, 1999). Thus, the results are in line with the previous study with Catalan-Spanish bilinguals, but also expand the scope of this language specific model in three different components. First, the bilingual's ability to keep the two languages separate during lexical access in speech production is not affected by the similarity between the two languages. Catalan-Spanish bilinguals behave similar to Spanish-English bilinguals. Secondly, the language specific model also applies to proficient non-balanced bilingual speakers. Thirdly, the bilingual's ability to restrict lexical selection to only one lexicon also applies when speaking in a second (non-dominant) language (Costa & Caramazza, 1999).

To recapitulate, the linguistic situation, basic word order and the determiner phrase of Dutch and Papiamento have been discussed and the word order conflict within the determiner phrase has been made clear. There are two main theoretical models in the field of code-switching and I have chosen to study the predictions of the MLF, based on restrictions of the experiment (e.g. number of conditions) and results from previous studies. One premise of the MLF is that both language are activated during production and this activation process was discussed by looking at language specific versus language non-specific selection models. However, previous research has provided evidence for the language specific model (Costa et al., 1999; Costa & Caramazza, 1999) as well as the language non-specific model (Hermans et al., 1998), and thus, the literature provides no consensus regarding the language selection in bilingual speech production. In this present study, I want to study code-switching in a neurolinguistic/ psycholinguistic[13] manner, since that has been a suggestion for further research in many previous studies. However, it is not easy to incorporate a psycholinguistic method in an experiment that tests the predictions of a theoretical model. In the literature, there is no consensus on whether grammatical theories and language processing models (psycholinguistic models) describe separate cognitive systems, or whether they are accounts of different aspects of the same system (Lewis & Phillips, 2015). This present study can contribute to our understanding of the relationship between theoretical models and psycholinguistic models. I am going to use electro-encephalography (a psycholinguistic language processing method) to study the predictions of the MLF (a theoretical model) about Dutch-Papiamento code-

[13] In the literature, both terms (neurolinguistic and psycholinguistic) have been used to refer to the mechanisms in the human brain that control the comprehension, production, and acquisition of language. Therefore, I did not make a distinction between the two terms in this study as well. To avoid confusion, the term psycholinguistics will be used from now on.

switching. The theoretical MLF model and its predictions have already been discussed and the next step is to look at the method of electro-encephalography. The next chapter will review the previous electro-encephalography studies on bilingual speech production and code-switching.

4. Electro-encephalogram studies

Event-related potentials (hereafter ERP) are obtained from an electro-encephalography (hereafter EEG) signal. To subtract ERPs from EEG it is necessary to find the timeslot at which a certain stimuli or response (called 'events') has taken place. The idea behind ERPs is that "spontaneous activity produced by the brain over the scalp is not synchronized to events such as stimulus presentation or participant response unless it is related to it." (Hoshino & Thierry, 2014: 207). Therefore ERP signals reflect the cognitive process which is elicited by the stimulus. What if the stimulus can trigger a response in more than one language? What type of cognitive processes will be elicited by such a stimulus? ERP studies into bilingual speech production and their results will be reviewed in the next section.

4.1. ERP studies into bilingual speech production

Speech production is challenging to study by means of EEG, because activation of the muscles involved in speech articulation can contaminate the EEG signal and override the signal originating in the brain. However there is a small group of researchers that have found some techniques to overcome this difficulty. For example Rodriguez-Fornells, van der Lugt, Rotte, Britti, Heinze and Münte (2005) have made use of a go/no-go paradigm in combination with implicit picture naming. A go/no-go task implies that the participants have to make a button-press in one condition and withhold their response in another condition. Rodriguez-Fornells et al. (2005) asked their German-Spanish bilingual participants to press the button if the name of the picture starts with a consonant and to withhold their response if the picture started with a vowel. Though they manipulated their stimuli in a way that some pictures started with the same phoneme (consonant or vowel) in both languages and that some pictures started with different phonemes in the two languages. Rodriguez-Fornells et al. (2005) found an increased negativity from 300-600 ms (N200) for the go trials, but not for the no-go trials. This result was interpreted as an indication of activation and competition between candidates from both languages at a phonological level.

A similar design was executed by Misra, Guo, Bobb and Kroll (2012). Chinese-English bilinguals participated in a delayed picture naming task. Pictures had either a red frame, indicating that the picture had to be named in their first language, or a blue frame, indicating that the picture had to be named in their second language. Nevertheless it was not the color of the frame that was important, it was the time of picture naming. Participants were instructed to name pictures as soon as possible after three asterisks appeared inside the frame. Based on a study of Jackson, Swainson, Cunnington and Jackson (2001) these asterisks appeared either at 250 ms or 1,000 ms after the onset of the picture. Overall, the ERPs were more negative when naming in the first language (L1) followed naming in the second language (L2) (enhanced N200), while the ERPs were more positive when L2 naming followed L1 (Misra et al., 2012). The greater negativity of picture naming in the L1 after picture naming in the L2 suggests there is inhibition of the L1. Findings of both this study and the study of Rodriguez-Fornells et al. (2005) provide evidence for the language-nonspecific models of bilingual speech production.

Rodriguez-Fornells et al. (2005) and Misra et al. (2012) are one of the few researchers that have tried to use ERP to study bilingual speech production. In spite of this effort it is important to mention that the go/no-go task and the delayed picture naming task do not reflect the actual planning of speech. Participants had to withhold their response in certain conditions and this requires more cognitive control than immediate naming. There is a lack of knowledge about the relationship between motor inhibition and speech planning mechanisms (Hoshino & Thierry, 2014).

In the present study, I want to use a (modified) picture naming task, in which speakers do not withhold their response, but immediately have name the pictures. Strijkers, Costa and Thierry (2010) have shown that picture naming latencies can be affected by frequency of the stimuli, which is called the frequency effect, and by cognate status, which is called the cognate effect. The frequency effects refers to the observation that high-frequent words show faster naming latencies than low-frequent words (Strijkers et al., 2010). The cognate effect denotes that naming latencies for pictures who have a phonologically similar translation in both languages (e.g., the Spanish-English pair *guitarra – guitar*) are faster than for pictures whose translation is phonologically dissimilar in both languages (e.g., the Spanish-English pair *perro – dog*; e.g., Costa, Caramazza & Sebastián-Galles, 2000; Christoffels, Firk & Schiller 2007). Strijkers et al. (2010) tried to establish an electrophysiological index of lexical access in speech production by exploring the locus of the frequency and cognate effects during overt naming. In their study, a group of sixteen Spanish-Catalan bilingual participants and a group of sixteen Catalan-Spanish bilingual participants had to carry out a picture naming task in Spanish, respectively their L1 and L2. The pictures consisted of 64 line-drawings of familiar objects (e.g. body parts, buildings, animals). Results of both experiments revealed reliable and robust frequency and cognate effects, which are in line with results of previous studies (Christoffels et al., 2007). Besides these confirming results, they also found early ERP effects of frequency and cognate status in the mean amplitude of the P200, N300 and P300. From 150-200 ms until voice onset, ERPs in the high-frequency condition were significantly more negative than those elicited in the low-frequency condition and ERPs in the cognate condition were significantly more negative than those elicited in the non-cognate condition. Strijkers et al. (2010) estimate that lexical access occurs at approximately 180 ms after target presentation and that word frequency and cognate status influences phonological encoding as well as lexical access. The results of the study by Strijkers et al. (2010) has shown that frequency and cognate status affect both naming latencies and ERP data, therefore, I need to keep these factors in mind when I am creating stimuli for my own experiment.

The studies mentioned above are about bilingual production in general. So far, the most common result is an enhanced negativity (N200) for the critical conditions. The N200 component is hypothesized to reflect object recognition and categorization (Pritchard, Shappel & Brandt, 1991; Folstein & van Petten, 2008). The N200 and the P300 (the P300 was found in the study by Strijkers et al., 2010) appear to be closely associated with the cognitive processes of perception and selective attention (Patel and Azam, 2005). The P300 is commonly divided into two sub-components and each of these sub-components has their own scalp distribution and functional correlates. The first sub-component is the P3a, which is maximal over frontal areas and reflects the orienting of attention to unexpected or significant events in the environment. The second sub-component is the P3b, which is maximal over parietal areas and reflects the updating of the working memory (Donchin, 1981). The ERP components found in previous bilingual speech production research, all relate to perception and attention, but, crucially, there is no relation with grammaticality.

After having discussed the studies about general bilingual production, it is also necessary to discuss what is already known about the combination of ERP and the determiner phrase and ERP and code-switching.

4.2. ERP studies and the determiner phrase

This study focuses on intra-sentential code-switching within the determiner phrase. As previously mentioned, the order in a determiner phrase of a given language may be fixed, like in English "*blue car*" or in Welsh "*car glas*" (lit. *car blue*), or it may vary, like in French "*voiture bleue*" (lit. *car blue*) versus "*belle voiture*" (lit. *beautiful car*) (Sanoudaki & Thierry, 2014). Bilingual speakers, who have learned both grammars in early childhood, will comprehend and produce sentences that are in concordance with the rules of the required grammar in that situation. Previous electrophysiological studies have focused on the bilinguals' sensitivity to syntactic violations and how this differs from monolingual sensitivity. These studies indicated two factors that play an important role in the way human brains process two languages, namely the age of acquisition and the level of proficiency (Sanoudaki & Thierry, 2014). The ERP responses of the bilingual brain resemble those of a monolingual brain more when the exposure to the second language starts earlier and the proficiency is higher (Sanoudaki &Thierry, 2014). Keep in mind that this statement is about bilingual language comprehension, and not on production.

Sanoudaki and Thierry (2014) combined the cross-language activation with bilingual syntactic access. Eighteen monolingual English speakers and sixteen highly proficient Welsh-English early bilinguals conducted a grammaticality judgment task with written English sentences. The sentences were either grammatical in English, with a pre-nominal adjective, or ungrammatical in English, with a post-nominal adjective (which is the Welsh order). An EEG-signal was elicited with a go/no-go design. In the pre-nominal adjective conditions, the no-go trials elicited a more negative N200 component than the go-trials. This was found for both the bilingual and monolingual participants. While in the post-nominal adjective conditions, the results of the bilingual participants exhibited the same changes in the N200 component as in the pre-nominal adjective conditions, though this was not the case for the monolingual participants. Results illustrated co-activation of Welsh syntax with English syntax in bilingual speakers. Regardless of the all-English context, the bilingual mind has spontaneous and implicit access to the grammars of both languages (Sanoudaki & Thierry, 2014).

4.3. ERP studies into code-switching

Parafita Couto, Boutonnet, Hoshino, Davies, Deuchar and Thierry (submitted) have used ERPs to investigate the acceptability of nominal constructions in Welsh-English code-switching. To account for the acceptability of nominal constructions Parafita Couto and her colleagues made use of the two mainstream theories on code-switching (as mentioned in chapter 3). The MLF predicts that a pre-nominal Welsh adjective in an English matrix sentence would be acceptable, but a pre-nominal English adjective in a Welsh matrix sentence would be seen as a violation of the theory. The predictions of the MP, which are solely based on the language of the adjective, are the exact opposite. Fifteen Welsh-English bilinguals participated in the experiment, all highly proficient in both languages. Parafita Couto et al. (submitted) found negative ERP variation between 280-340 ms in the condition predicted by the MLF to induce a violation. Negative ERPs in this timeframe are usually interpreted as syntactic violations. Therefore the findings of Parafita Couto et al. (submitted) were seen as a validation of the predictions of the MLF. No evidence for the predictions of the MP were found.

A similar ERP study for Dutch and Papiamento has been carried out as well (Schiller, Pablos, Sattaur & Parafita Couto, 2013). This study has focused on code-switching comprehension. Contrary to the Welsh-English study, an N400 was found in the condition violated by the MP (Schiller et al., 2013). New experiments are being carried out at the moment to find out which theoretical model makes the best predictions regarding code-switching within the determiner phrase. The present study is in line with the ongoing research on Dutch-Papiamento code-switching. Where Schiller et al. (2013) have focused on comprehension, this present study will focus on production. Will the ERP comprehension results be the same with respect to code-switching production? The objective of this study is to test the predictions of the MLF with Dutch-Papiamento bilingual speakers.

The present study

Certain conditions were set up in order to test the predicitons of the MLF. According to the MLF, the matrix language determines the word order in a code switch. In this case, the matrix language can be Dutch or Papiamento. So, when the matrix language is Dutch, the word order will be [adjective-noun]. However, the MLF does not make a prediction about the language of the adjective or the language of the noun. Therefore both combinations of [Dutch adjective-Papiamento noun] and [Papiamento adjective-Dutch noun] are possible, as long as the order of the two elements stays the same. For Papiamento, it will be the same principle, both language combinations [Papiamento noun-Dutch adjective] and [Dutch noun-Papiamento adjective] will be correct according to the MLF. This results in four conditions that match the predictions of the MLF:

- Matrix language Dutch - [Dutch adjective - Papiamento noun]
- Matrix language Dutch - [Papiamento adjective - Dutch noun]
- Matrix language Papiamento - [Papiamento noun - Dutch adjective]
- Matrix language Papiamento - [Dutch noun - Papiamento adjective]

Besides the four conditions that match the predicionts of the MLF, I have also used four conditions that violate the predictions of the MLF. The four conditions mentioned above were duplicated, but the order of the adjective and the noun were reversed to create a violation.

- Matrix language Dutch - [Papiamento noun - Dutch adjective]
- Matrix language Dutch - [Dutch noun - Papiamento adjective]
- Matrix language Papiamento - [Dutch adjective - Papiamento noun]
- Matrix language Papiamento - [Papiamento adjective - Dutch noun]

The first four conditions will be referred to as MLF+ conditions, since they match the MLF predictions, and the second four conditions will be referred to as MLF- conditions, since they violate the MLF predictions. Related to these eight conditions, there are three main research questions ("Q1, Q2, Q3") and I have stated my hypotheses ("H1, H2, H3") below each research question.

Q1. *Is there a difference in naming latencies between conditions that match the predictions of the MLF (MLF+) and conditions that violate the predictions of the MLF (MLF-)? In addition to this question, is there a difference in naming latencies with regard to the different types of code-switches (adjective versus noun / Dutch versus Papiamento)?*

H1. I expect to find a difference in naming latencies between MLF+ and MLF- conditions, with slower naming latencies for the MLF- conditions. In the MLF- conditions, the order of the adjective and the noun does not fit the morpho-syntactic frame presupposed by the matrix language. First, participants will need to process the mismatch between the word order presupposed by the matrix language and the word order they are presented with, and second, they will need to think about how to produce the "new" word order. This processing and reconfiguration of the production will take time. Somewhat related to this are the switching costs found in previous naming task studies. Christoffels et al. (2007) conducted a picture naming task with German-Dutch bilinguals. The color of the picture signalled the response language. The switch trials occurred unpredictably. Behavioural data showed that naming latencies were longer for switch trials than non-switch trials. On the switch trials participants have to inhibit one production, the word in one language, and come up with another production, the word in another language. Likewise, participants in the present study will have to inhibit the "correct MLF order" in the MLF- conditions and produce an order that matches the requirements of the MLF- condition.

Regarding the naming latency difference for the different code-switches patterns, the noun has been found to be the most frequently switched element by several researchers (Wentz, 1977; Timm, 1975). Therefore, I hypothesize that participants will respond faster when there is a noun inserted than when there is an adjective inserted. Cases where a Dutch noun is inserted in a sentence with Papiamento as the matrix language and cases where a Papiamento noun is inserted in a sentence with Dutch matrix language will elicit faster responses, because noun switches are much more common to the participants than adjective switches. My goal is to find participants that are highly proficient in both Dutch and Papiamento and therefore I don't expect to find a difference in naming latencies between a Dutch noun insertion and a Papiamento noun insertion.

Q2*. Is there a difference in neural activity between conditions that match the predictions of the MLF (MLF+) and conditions that violate the predictions of the MLF (MLF-)? In addition to this question, is there a difference in neural activity with regard to the different types of code-switches (adjective versus noun / Dutch versus Papiamento?*

H2. The hypothesis for the electrophysiological data is mainly based on results of previous picture naming task studies. Rodriguez-Fornells et al. (2005) has shown that there was an increased negativity when the names of the pictures in a picture naming paradigm do not match in both languages of a bilingual speaker. According to Misra et al. (2012) there was an increased negativity in pictures that are named in the first language following naming in the second language. In code-switching comprehension studies, an increased negativity was also found for the sentences that contained a code switch (Moreno, Federmeier & Kutas, 2002). So, when there is any kind of mismatch or a possibility of more than one solution ("production"), then I will expect an increased negativity. The participant will be asked to finish a sentence by describing a color (the adjective) and a picture (the noun). The order in which the picture are presented match the orders described above in the MLF+ and MLF- conditions. In the MLF- conditions the participants are presented with two possibilities, namely the adjective-noun order or the noun-adjective order. One of these possibilities is what they expect after recognizing the language of the lead-in sentence (which represents the matrix language) and the other order is given by them in the way the pictures are presented (left-right). This leads to a mismatch between the grammars of the two languages and consequently will elicit a more negative ERP signal.

With regard to the difference in neural acitivity between the different code-switches patterns, I expect to find the same pattern of results as in the naming latency analysis. The conditions with a switched noun will elicit a more positive ERP signal than conditions with a switched adjective, because nouns are switched more frequently (Wentz, 1977; Timm, 1975) and can thus be processed more easily. No difference is expected between the neural activity of a Dutch noun insertion and the neural activity of a Papiamento noun insertion.

Q3. *Do the results from the naming latency analysis and the results from the electrophysiological data analysis point in the same direction?*

H3. Yes, I expect the results of the naming latency analysis to point in the same direction as the results of the electrophysiological data analysis. The results found for Welsh-English code-switching in naturalistic corpus data and elicited data (Parafita Couto et al., 2015) also pointed in the same direction as the results from the electrophysiological data (Parafita Couto et al., submitted), both yielded support for the MLF. Even though, I am looking at naming latency data, the code-switching patterns used in this experiments are patterns that were found in Dutch-Papiamento naturalistic corpus data.

The methodology of the experiment will now be explained.

5. Methodology

5.1. Participants

Eighteen bilingual Dutch-Papiamento speakers participated in this study, eleven females and seven males. The participants were between 19 and 67 years old (mean age: 33.4; SD: 16.39). Fifteen of the participants had learned Papiamento before the age of 2, one participant had learned Papiamento before the age of 4 and two participants had learned Papiamento in elementary school. Seven of the participants had learned Dutch before the age of 2, two participants had learned Dutch before the age of 4, eight participants had learned Dutch in elementary school and one had learned Dutch in secondary school. The highest level of education reported ranged from high school to a Master's degree. The participants originated from all three Leeward islands of the Dutch Antilles, namely eight participants identified themselves as "Curaçaoan", one identified him/herself as "Bonairean", three identified themselves as "Aruban", one identified him/herself as "Antillean", one identified him/herself as "Dutch" and four participants filled in something else (e.g. "Caribbean", "Combination Aruban/Dutch", "World-citizen"). None of the participants had a reading or speaking disability. Participants did not receive a reward and participated on a voluntary basis.

Participants rated their proficiency in both languages on a scale from 1 (*knows a few words and expressions*) to 4 (c*onfidently able to express oneself in complex conversations*) (for the procedure see section 5.3.). Results of the self-rated proficiency are shown in Table 2. Thirteen participants (72.2%) feel confident expressing themselves in complex conversations in Papiamento and twelve participants (66.7%) feel confident expressing themselves in complex conversations in Dutch.

Table 2*. Participants' (N=18) self-rated proficiency of Papiamento and Dutch*

	Papiamento		**Dutch**	
Scale	***N***	***%***	***N***	***%***
1 – Knows of a few words and expressions	0	0	0	0
2 – Able to express oneself in a basic conversation	2	11.1	1	5.5
3 – Able to express oneself in more complex conversations	3	16.7	5	27.8
4 – Confidently able to express oneself in complex conversations	13	72.2	12	66.7
Total	*18*	*100*	*18*	*100*

5.2. Material

The matrix language was reflected by the language of the lead-in sentence. The order of adjective and noun can match the grammar of the matrix language (MLF+ conditions) or it can mismatch the grammar of the matrix language (MLF- conditions). In the case of the MLF+ conditions, a Dutch lead-in sentence was followed by a (Dutch/Papiamento) adjective and then a (Papiamento/Dutch) noun; a Papiamento lead-in sentence was followed by a (Dutch/Papiamento) noun and then a (Papiamento/Dutch) adjective. In the case of the MLF- conditions, a Dutch lead-in sentence was followed by a (Dutch/Papiamento) noun and then a (Dutch/Papiamento) adjective; a Papiamento lead-in sentence was followed by a (Dutch/Papiamento) adjective and then a (Dutch/Papiamento) noun.

To elicit the language switch between the adjective and the noun, a cue was used to tell the participants where to switch. A round frame indicated that the picture or color patch– either representing the adjective or the noun – needed to be produced in Papiamento and a square frame indicates that the picture or color patch needed to be produced in Dutch.

In total there are eight conditions (2 predictions x 2 languages x 2 frame positions), as shown in Table 3.

Table 3. *The experimental conditions.*

			Place on the screen			
	Condition	**Lead-in sentence**	**Left**	***Frame***	**Right**	***Frame***
1	MLF +	Dutch	Adjective	DUTCH (square)	Noun	PAP (round)
2	MLF +	Dutch	Adjective	PAP (round)	Noun	DUTCH (square)
3	MLF -	Dutch	Noun	PAP (round)	Adjective	DUTCH (square)
4	MLF -	Dutch	Noun	DUTCH (round)	Adjective	PAP (round)
5	MLF +	Papiamento	Noun	PAP (round)	Adjective	DUTCH (square)
6	MLF +	Papiamento	Noun	DUTCH (square)	Adjective	PAP (round)
7	MLF -	Papiamento	Adjective	DUTCH (square)	Noun	PAP (round)
8	MLF -	Papiamento	Adjective	PAP (round)	Noun	DUTCH (square)

Twenty pictures were selected from the Max Planck Institute for Psycholinguistics database and consisted of simple black and white line drawings (Appendix A). Four color patches were used to represent the adjectives. These color patches were created with the computer programme Paint. The colors red, green, white and grey were used (Appendix A). All of the picture and color names were non-cognates in Dutch and Papiamento. The Dutch and

Papiamento picture and color names were matched for number of phonemes and not for frequency, because lists of frequency do not exist for Papiamento. Word frequency (for Dutch) and length information is presented in Table 4. Each picture appeared once per condition; each color appeared five times per condition. Each picture had its own lead-in sentence.

The lead-in sentence consisted of a subject phrase, a transitive verb and an indefinite article, for example "*[De buurman] [ziet] [een] […]*" ("*[the neighbour] [sees] [a] […]*"). For each condition, half of the lead-in sentences had a subject phrase that consisted of one word and the other half had a subject phrase that consisted of two words. This division was made in order to create some diversity in the sentences. The transitive verbs[14] *zien/mira* ('to see'), *kopen/kumpra* ('to buy'), *verkopen/bènde* ('to sell'), *tekenen/tek* ('to draw') and *stelen/hòrta* ('to steal') were used. Each verb appeared four times per condition. For the complete overview of the Dutch and Papiamento lead-in sentences see Appendix B. All the words and sentences were checked by a native speaker of Papiamento.

Table 4. *Stimuli characteristics*

	Frequency (per 1 million words)		**Number of phonemes**	
	Mean	SD	Mean	SD
Names in Dutch	52.59	39.70	3.75	0.897
Names in Papiamento	-	-	4.96	1.301

Note. Frequencies were derived from the SUBTLEX-NL corpus (Keuleers, Brysbaert & New, 2010)

5.3. Procedure

The experiment took place in the EEG lab at the University of Leiden. After providing informed consent, the participants filled in an online ethno-linguistic background questionnaire via Qualtrics (web-based survey software[15]). They could choose the language of the questionnaire, there was one in Dutch (Appendix E) and one in Papiamento (Appendix F).

After filling in the background questionnaire, the participants were fitted with an electrode cap and seated in an armchair. The participants were tested individually in a soundproof room. The armchair was in front of a computer screen at a viewing distance of approximately 100 cm. The microphone was located under the computer screen. Before the experiment began,

[14] The verb in Dutch / the verb in Papiamento
[15] https://uleidenss.eu.qualtrics.com

participants were instructed to minimize movement and to minimize blinking of the eyes, which would disturb the EEG signal.

The participants first got acquainted with the pictures through a learning phase. They saw all twenty pictures and four color patches one by one for 2,000 ms, with their Dutch or Papiamento name below. After showing all the pictures, the participants saw one picture at a time and they had to say the corresponding Dutch or Papiamento name out loud. They received feedback on their responses. Half of the participants started the learning phase with the Dutch names and the other half started with the Papiamento names.

After the learning phase, there was a practice phase. There were eight practice sentences, one sentence of each condition. If the participant did not switch on all the practice trials, he or she had to do the practice block again, until all the responses were correct according to the conditions. After the practice block, the real experiment began. Each trial consisted of a 1,000 ms fixation cross, a 500 ms blank screen interval, a 500 ms subject-constituent, a 500 ms verb-constituent, a 500 ms determiner-constituent and, at last, a screen with a color and a picture. The participants were instructed to finish the sentence by describing the color and the picture. The screen with the color and the picture was shown until the participant responded (through a voice key) or, in case of no response, for 5,000 ms. After the voice-response of the participant there was an inter-trial-interval of 2,000 ms. The inter-trial-interval was used to code the voice-response of the participant. The experimenter pressed ‘0’ if there was no production, “1” if the participant’s production was completely Dutch, “2” if the participant’s production was completely Papiamento and pressed nothing when the production was a correct code switch. This way the correct trials - according the requested condition - can be easily extracted for analysis.

There were eight blocks of twenty trials. After each block there was a break, in which the participants could relax and blink their eyes. By pressing a button the participant could continue the experiment. The experiment took about an hour and a half.

5.4. EEG-recording and data analysis

The EEG-signal was recorded with a computer using ActiView software (BioSemi). Continuous EEG was recorded from 38 electrodes, each referred to the TMS electrode. Thirty-two electrodes (AF3, AF4, C3, C4, Cz, CP1, CP2, CP5, CP6, F3, F4, F7, F8, Fz, Fp1, Fp2, FC1, FC2, FC5, FC6, O1, O2, Oz, P3, P4, P6, P7, Pz, PO3, PO4, T7, T8) were placed in an electrode cap. Six additional electrodes were placed on the participants' head. Two bipolar electrodes were placed next to the left and the right eye to register horizontal eye movement, two bipolar electrodes were placed above and beneath the left eye to register vertical eye movement and two other electrodes were placed on the participants' left and right mastoid as offline reference channels. The EEG was continuously recorded and digitized at 512 Hz. The EEG-signals were analysed with the computer program BrainVision Analyzer.

First the EEG was segmented into 7,000 ms epochs prior to the marker '93', which was the marker for the correct code switch trials. This way only the correct code switched trials were segmented and the incorrect trials (indicated by the marker '90', '91'or '92', see section 5.3.) were excluded from the analysis. The 7,000 ms time limit was chosen, because the marker for the different conditions needed to be in that segment as well. Therefore the maximum time limit for the target presentation (5,000 ms) and the time the experimenter needed to code the responses (2,000 ms) needed to be taken into account. Second, the EEG signal was re-referenced to the average of the left and right mastoid. Thirdly, the EEG was processed through a high pass filter with a cut-off frequency of 0.05 Hz (24 dB setting). The contribution of ocular activity was corrected for and other artefacts were rejected at 25μV. Before a second segmentation the EEG was passed through a low-pass filter with a cut-off frequency of 10 Hz (24 dB setting). Higher low-pass filters resulted in too much alpha in the EEG signal. Then the EEG was segmented into 1,000 ms long epochs starting from the stimulus onset. The 1,000 ms long epochs were averaged in reference to the 200 ms pre-stimulus baseline. In total, ERP analyses were based on an average of 12 segments per condition (condition 1: 10 segments, condition 2: 12 segments, condition 3: 12 segments, condition 4: 12 segments, condition 5: 12 segments, condition 6: 13 segments, condition 7: 12 segments, condition 8: 13 segments). A minimum of 10 segments was maintained, so at least half the trials could be analysed.

The ERPs from the MLF+ conditions and the MLF- conditions were compared at each electrode by running 2-tailed paired t-tests at every sampling point (20 ms) starting from target presentation (0 ms) until 1,000 ms after target presentation to identify the latency at which the ERPs started to diverge significantly from one another. The same onset latency analysis was used to compare the ERPs from the conditions that contain the same matrix language, but a different word order.

Electrodes were clustered in nine groups as follows: left frontal (Fp1, AF3, F7, F3, FC5); fronto-central (Fz, FC1, FC2, Cz); right frontal (Fp2, AF4, F8, F4, FC6); left central (T7, C3, CP5); centro-parietal (CP1, CP2, Pz); right central (C4, T8, CP6); left parietal (P7, P3, PO3); occipital (O1, Oz, O2) and right parietal (P4, P8, PO4).

6. Results

Two participants were excluded from the analysis, due to excess (ocular) artefacts which resulted in a lack of usable segments. Therefore the analysis was based on sixteen participants. First the results of the ethno-linguistic background questionnaire will be discussed, then the behavioural data and at last the electrophysiological data.

6.1. Background questionnaire

Thirteen participants had filled in the background questionnaire in Dutch (Appendix E) and three participants had filled in the questionnaire in Papiamento (Appendix F). For the remainder of the questions, there will be no differentiation between answering in Dutch or in Papiamento. The results of all the participants will be grouped together. The background questionnaire consisted of twenty questions in total. The results of the questions concerning the participants' age, education, age of acquisition and language proficiency are already incorporated in the section about the participants (section 5.1.). The results of the remaining questions will be discussed in this section.

The participants had to judge the two languages on five characteristics on a five-point scale per characteristic. All five characteristics consisted of two opposite terms (e.g. old fashion-modern). The negatively loaded term was always on the left side of the scale and the positively loaded term was always in the right side of the scale. When a participant judged a characteristic exactly in the middle of the five-point scale, this was seen as a "neutral opinion". Tables 5 and 6 show the results for the Dutch and Papiamento language respectively.

The majority of the participants had a neutral opinion about whether the Dutch language is beautiful (N=9), inspiring (N=8), influential (N=7) and friendly (N=6). In the case of Papiamento, the majority had a neutral opinion about whether the language is beautiful (N=9), inspiring (N=7) and influential (N=5). Seven participants also had a neutral opinion about whether Dutch is useful, but seven participants also completely agreed Dutch is useful. Whereas for Papiamento six participants had a neutral opinion about usefulness and only four participants completely agreed Papiamento is useful. Five participants had a neutral opinion about whether Dutch is modern, but six participants completely agreed Dutch is modern. For Papiamento, six participants had a neutral opinion and only five participants completely agreed Papiamento is modern. In the case of friendliness of the Papiamento language, five participants had a neutral opinion, six participants somewhat agreed Papiamento is friendly and five participants completely agree Papiamento is friendly.

Table 5. *The participants' opinion (N=16) on five characteristics of the Dutch language.*

THE DUTCH LANGUAGE

	Five-point scale ←→					
Ugly	0	1	9	6	0	Beautiful
Useless	0	0	7	2	7	Useful
Uninspiring	0	4	8	1	3	Inspiring
Non-influential	0	2	7	4	3	Influential
Unfriendly	1	1	6	4	4	Friendly
Old fashion	0	0	5	5	6	Modern

Table 6. *The participants' opinion (N=16) on five characteristics of the Papiamento language.*

THE PAPIAMENTO LANGUAGE

	Five-point scale ←→					
Ugly	0	0	9	3	4	Beautiful
Useless	0	1	6	5	4	Useful
Uninspiring	0	1	7	4	4	Inspiring
Non-influential	1	5	5	1	4	Influential
Unfriendly	0	0	5	6	5	Friendly
Old fashion	0	1	6	4	5	Modern

Next, the participants were presented with two statements, on which they had to rate their agreement on a five-point scale ranging from 'strongly disagree' to 'strongly agree'. The first statement is about their attitude towards code-switching; the second statement is about their own production of code switches. Figures 1 and 2 show the results of the ratings.

Six participants (37.5%) had a negative attitude towards code-switching, four participants (25%) had a neutral opinion and six participants (37.5%) had a positive attitude towards code-switching. Nine participants (56.25%) claimed to switch in every day conversations, three participants (18.75%) had a neutral opinion and four participants (25%) claimed to keep the languages separate in every day conversations.

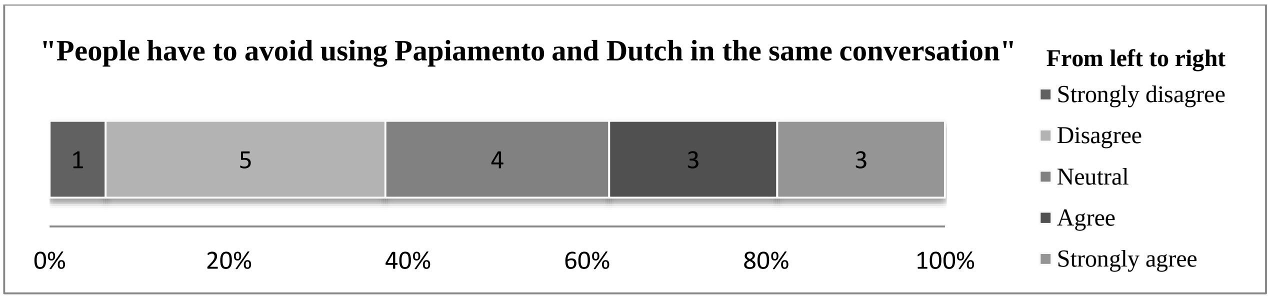

Figure 1. *The participants' opinion (N=16) on the statement "People should avoid using Papiamento and Dutch in the same conversation".*

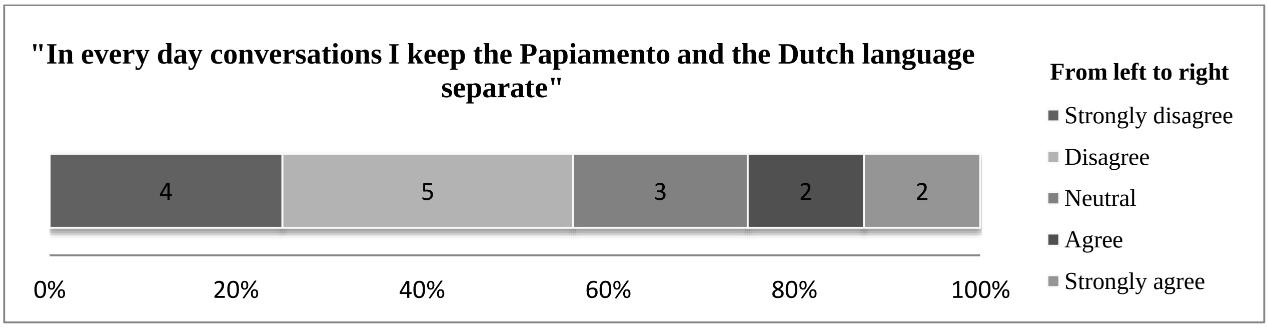

Figure 2. *The participants' opinion (N=16) on the statement "In everyday conversations I keep the Papiamento and the Dutch language separate".*

The participants also had to write down which language(s) they speak with their mother, father and caretaker (if applicable). Three participants indicated to speak solely Dutch with their father and only one participant indicated to speak solely Dutch with his/her mother. Seven participants indicated to speak solely Papiamento with their father and seven participants indicated to speak solely Papiamento with their mother. Two participants indicated to speak both languages with their father and two participants indicated to speak both languages with their mother. Figure 3 summarizes these results.

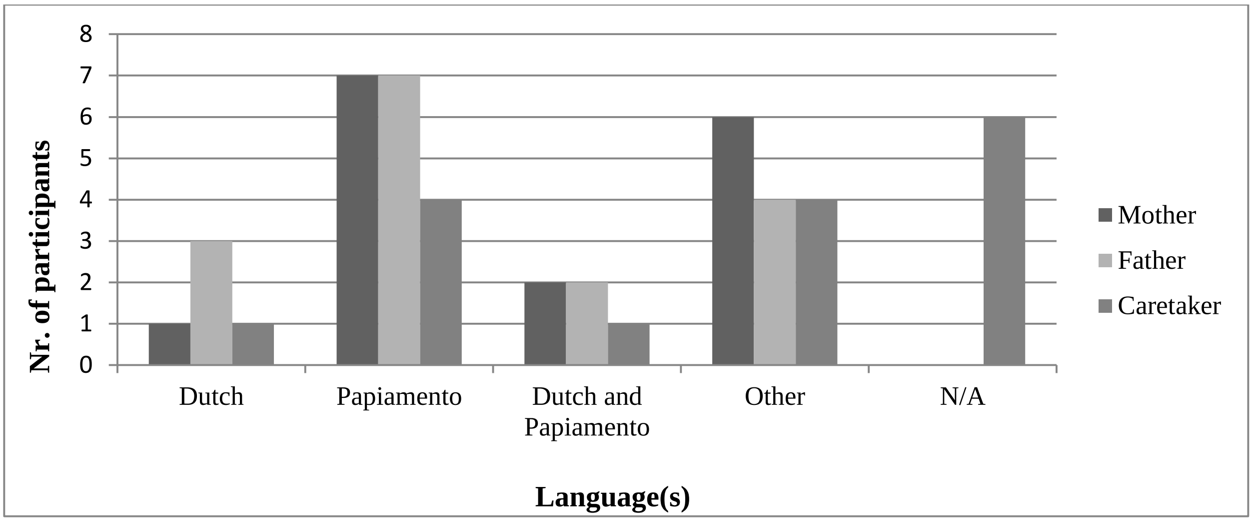

Figure 3. *The language(s) spoken by the participants (N=16) with their mother, father and caretaker (if applicable).*

In the last question participants had to write down five names of people (or their relation) with whom they converse the most on an everyday basis and then indicate which language they use: Dutch, Papiamento or both. Most participants indicated to speak Dutch (56%), Papiamento (38%) or both languages (57%) with their friends. Besides their friends, Dutch was most often spoken with colleagues (18%), Papiamento was most spoken with their partner (19%), parents (19%) or siblings (19%), and both languages were most spoken with their parents (19%). The results were illustrated separately for Dutch, Papiamento and both Dutch/Papiamento in Figure 4.

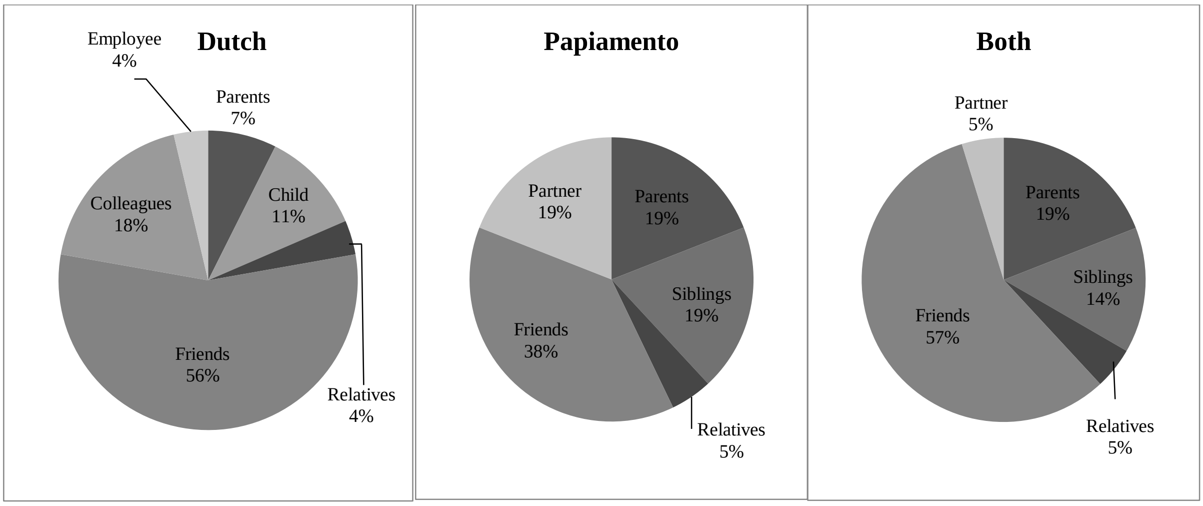

Figure 4. *Three circle diagrams for the relation between the conversational partners and the languages used. The most left diagram is about the use of the Dutch language, the middle diagram is about the use of the Papiamento language and the most right diagram is about the use of both Dutch and Papiamento.*

6.2. Behavioural results

Both the behavioural data and the electrophysiological data has been split up into two analyses. The first analysis deals with the predictions of the MLF; the second analysis deals with the different types of code-switches. For all analysis a significance level of α = .05 was used.

6.2.1. Analysis of MLF predictions

The main goal of this study was to test the predictions of the MLF. In order to do so, I need to compare conditions that match the predictions of the MLF (MLF+) with conditions that contain a violation of the MLF (MLF-). I divided the eight experimental conditions into four pairs of one MLF+ condition and one MLF- condition each. The two conditions of each pair contain the same code-switching pattern, but in one condition, the MLF predicts the code-switching pattern to be acceptable and in the other condition, the code-switching pattern will not be acceptable according to the MLF. The analyses were based on the following pairs:

- Condition 1 *versus* condition 7
  [MLF+ / ML=Dutch / Adj Dutch-Noun Pap] *versus* [MLF- / ML=Pap / Adj Dutch-Noun Pap]
- Condition 2 *versus* condition 8
  [MLF+ / ML=Dutch / Adj Pap-Noun Dutch] *versus* [MLF- / ML=Pap / Adj Pap-Noun Dutch]
- Condition 5 *versus* condition 3
  [MLF+/ ML=Pap / Noun Pap-Adj Dutch] *versus* [MLF-/ ML=Dutch / Noun Pap-Adj Dutch]
- Condition 6 *versus* condition 4
  [MLF+/ ML=Pap / Noun Dutch-Adj Pap] *versus* [MLF-/ ML=Pap / Noun Dutch- Adj Pap]

The naming latency analysis revealed faster average responses in the MLF+ conditions than in the MLF- conditions. The average naming latency difference of 16 ms was not significant, $t(3) = -0.489$, $p = .658$. A paired sample t-test showed a significant difference in picture naming when the Papiamento adjective was on the left and the Dutch noun was on the right. Participants were significantly faster in the MLF+ condition (ML=Dutch) than in the MLF- condition (ML=Pap), $t(319) = -3.061$, $p = .002$. Paired sample t-tests for other orders of adjective and noun did not show significant naming latency differences between the MLF+ and MLF- conditions: Adj Dutch – Noun Pap: $t(319) = 1.367$, $p = .173$, Noun Pap – Adj Dutch: $t(319) = -0.665$, $p = .506$, Noun Dutch – Adj Pap: $t(319) = 0.455$, $p = .649$. Table 7 summarizes the mean naming latencies of the eight experimental conditions, the significant difference mentioned above is indicated with an 'a' in superscript.

6.2.2. Analysis of code-switching patterns

The second analysis is a small sidestep from the analysis of the MLF predictions. Even though the MLF does not make any predictions about the origin of the adjective and the noun, I think an analysis of the code-switching patterns might provide useful information for our understanding of code-switching. I wanted to study the code-switching pattern more closely to see whether a switched adjective elicits different behavioural (and electrophysiological) results than a switched noun. Also to see whether switching within a sentence with Dutch as the matrix language entails different results than switching within a sentence with Papiamento as the matrix language. The conditions in each comparison contain the same prediction of the MLF (+ or -), the same matrix language (Dutch or Papiamento), the same word order (adjective-noun or noun-adjective), but a different type of switch (adjective switch or noun switch). The analysis was based on the following pairs:

- Condition 1 *versus* condition 2
  [MLF+/ ML=Dutch/ Adj Dutch-Noun Pap] *versus* [MLF+/ ML=Dutch/ Adj Pap-Noun Dutch]
- Condition 3 versus condition 4
  [MLF-/ ML=Dutch/ Noun Pap-Adj Dutch] *versus* [MLF-/ ML=Dutch/ Noun Dutch- Adj Pap]
- Condition 5 versus condition 6
  [MLF+/ ML=Pap/ Noun Pap-Adj Dutch] *versus* [MLF+/ ML=Pap/ Noun Dutch-Adj Pap]
- Condition 7 *versus* condition 8
  [MLF-/ ML=Pap/ Adj Dutch-Noun Pap] *versus* [MLF-/ ML=Pap/ Adj Pap-Noun Dutch]

Results of a paired t-test of the naming latencies within the same matrix language paradigm – but keeping MLF+ and MLF- conditions apart – revealed that participants responded significantly faster in the MLF- condition with a Papiamento matrix language when there was a Dutch adjective inserted than when a Dutch noun was inserted, $t(319) = -4.038$, $p = < .001$. Other comparisons were not significant: MLF + / ML=Dutch: $t(319) = 0.771$, $p = .441$, MLF + / ML=Pap: $t(319) = -0.819$, $p = .413$, MLF- / ML=Dutch: $t(319) = 0.297$, $p = .767$. The significant difference is highlighted with a 'b' in superscript in Table 7.

Table 7. *Mean naming latencies (ms) in the 8 experimental conditions, divided into MLF+ and MLF- conditions. Significant differences are indicated with superscript. ML = Matrix Language.*

	MLF +		**MLF –**	
Adj Dutch – Noun Pap	1155 (649)	[1; ML = Dutch]	1104 (604)^{b}	[7; ML = Pap]
Adj Pap – Noun Dutch	1130 (575)^{a}	[2; ML = Dutch]	1231 (678)^{a,b}	[8; ML = Pap]
Noun Pap – Adj Dutch	1174 (653)	[5; ML = Pap]	1203 (688)	[3; ML = Dutch]
Noun Dutch – Adj Pap	1207 (628)	[6; ML = Pap]	1192 (577)	[4; ML = Dutch]
Average	*1166.5*		*1182.5*	

Note. Standard deviations are in parentheses. ^{a} $p < .001$ ^{b} $p < .001$

A two-way ANOVA was conducted that examined the effect of matrix language and noun-adjective order on naming latency. There was not a statistically significant interaction between the effects of matrix language and noun-adjective order on naming latency, $F(1,2556) = 0.413$, $p = .520$. No main effects for the matrix language ($p = .716$) nor the noun-adjective order ($p = .118$) were found. Figure 5 shows the interaction between the matrix language and the noun-adjective order. On the whole, participants reacted faster in conditions with an adjective-noun word order than in conditions with a noun-adjective order. However, in the case of adjective-noun word order, participants reacted faster when Dutch was the matrix language then when Papiamento was the matrix language. In the case of noun-adjective word order, participants reacted faster when Papiamento was the matrix language then when Dutch was the matrix language.

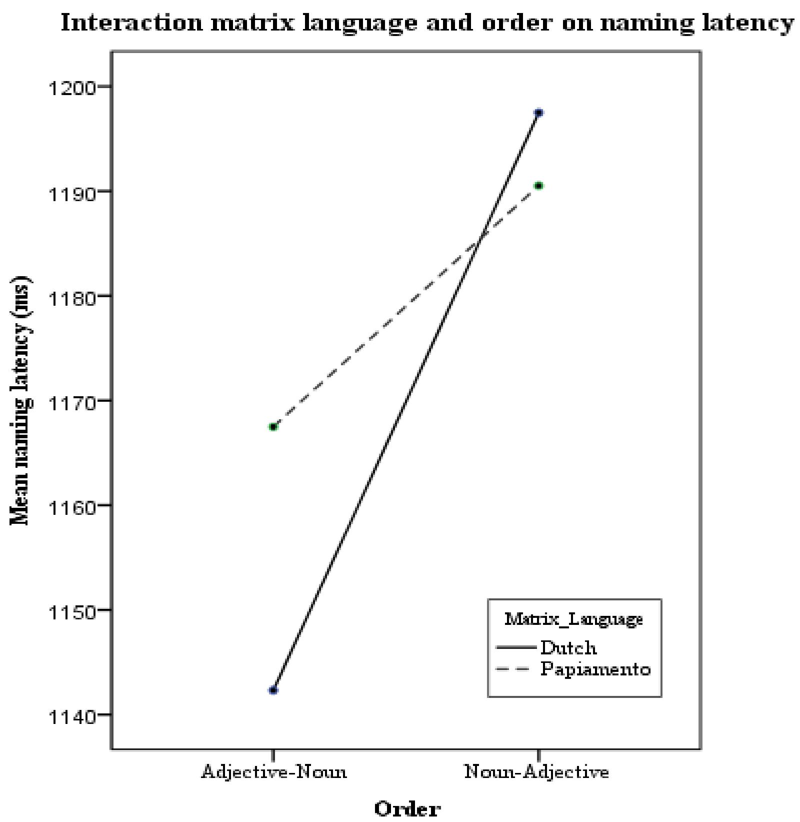

Figure 5. *A line graph of the interaction of matrix language and word order on naming latency*.

6.3. Electrophysiological results

6.3.1. Analysis of MLF predictions

The conditions that were compared to each other to test the predictions of the MLF are repeated below:

- Condition 1 *versus* condition 7
  [MLF+ / ML=Dutch / Adj Dutch-Noun Pap] *versus* [MLF- / ML=Pap / Adj Dutch-Noun Pap]
- Condition 2 *versus* condition 8
  [MLF+ / ML=Dutch / Adj Pap-Noun Dutch] *versus* [MLF- / ML=Pap / Adj Pap-Noun Dutch]
- Condition 5 *versus* condition 3
  [MLF+/ ML=Pap / Noun Pap-Adj Dutch] *versus* [MLF-/ ML=Dutch / Noun Pap-Adj Dutch]
- Condition 6 *versus* condition 4
  [MLF+/ ML=Pap / Noun Dutch-Adj Pap] *versus* [MLF-/ ML=Pap / Noun Dutch- Adj Pap]

The ERPs of the Grand Averages are shown in Figures 6 to 9 (twelve representative electrodes, based on the depicted representative electrodes in Misra et al., 2012). All conditions revealed a similar pattern, beginning with a small negative peak at approximately 50 ms after target presentation, mostly visible in the occipital area. A second negative peak, maximal between 80-140 ms was also observed. These negative peaks were followed by a positive peak, maximal between 150-220 ms in the frontal and central area and between 220-300 ms in the occipital area. This positive peak was the most prominent peak in the signal. A subsequent positive peak was observed between 320-420 ms, though this peak was less clear than the first positive peak. From 600 ms onwards, there seems to be a sustained positivity for the MLF+ condition in Figure 8 (condition 1 vs. 7) and 9 (condition 2 vs. 8), most noticeable in the frontal and central areas. Whereas in Figure 10 (condition 5 vs. 3) and 11 (condition 6 vs. 4) a sustained positivity for the MLF- condition was observed.

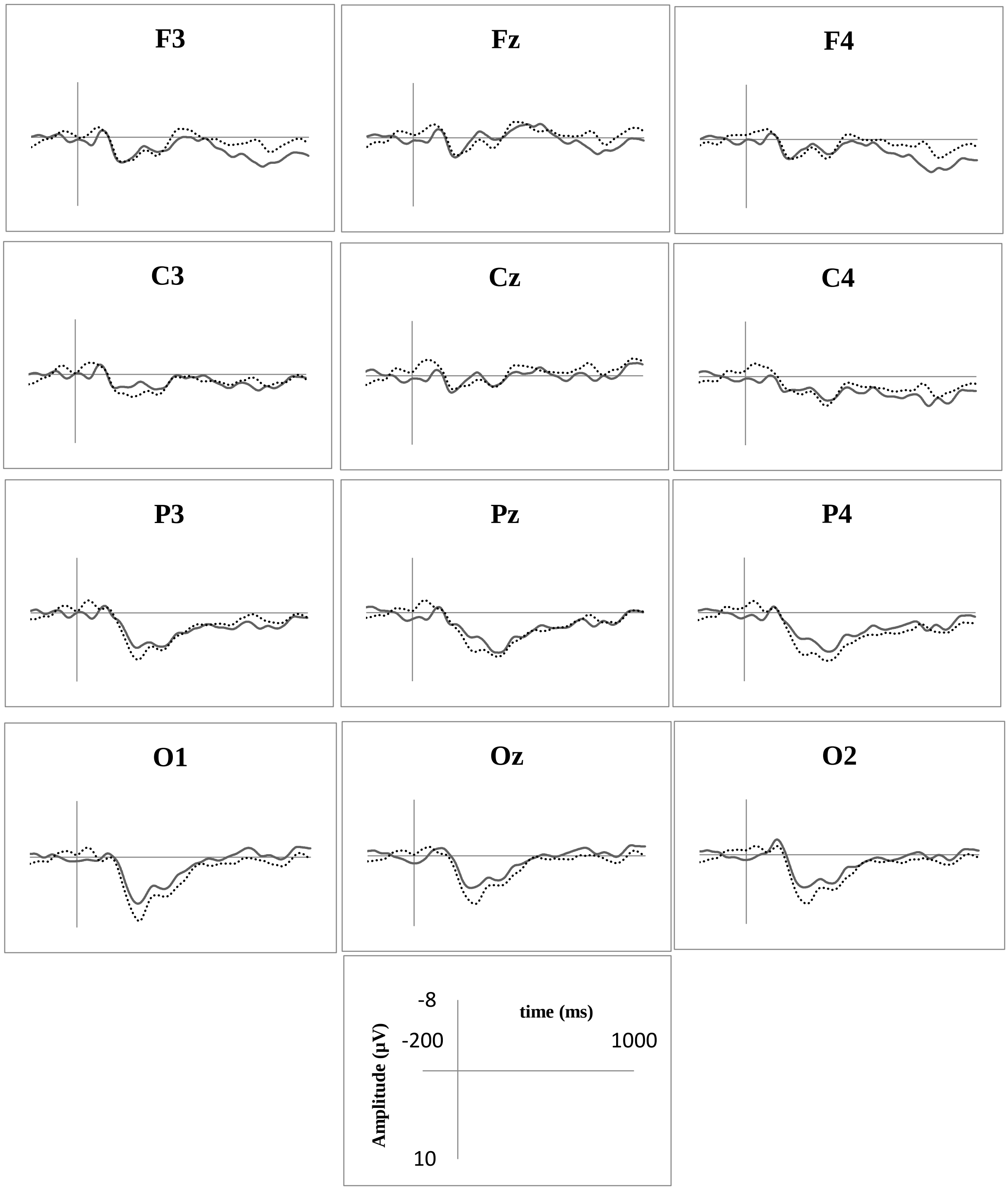

Figure 6. *Grand Average waveforms of twelve representative electrode sites for the MLF violation (dotted line) and its correct counterpart (solid line) of condition 1 (MLF+ / ML=Dutch / Adj Dutch-Noun Pap) versus condition 7 (MLF- / ML=Pap / Adj Dutch-Noun Pap). Zero on the time axis marks the onset of the picture and color presentation. Electrodes are arrayed from most anterior (top) to most posterior (bottom) and from left to right as they were positioned on the scalp. Negativity is plotted up.*

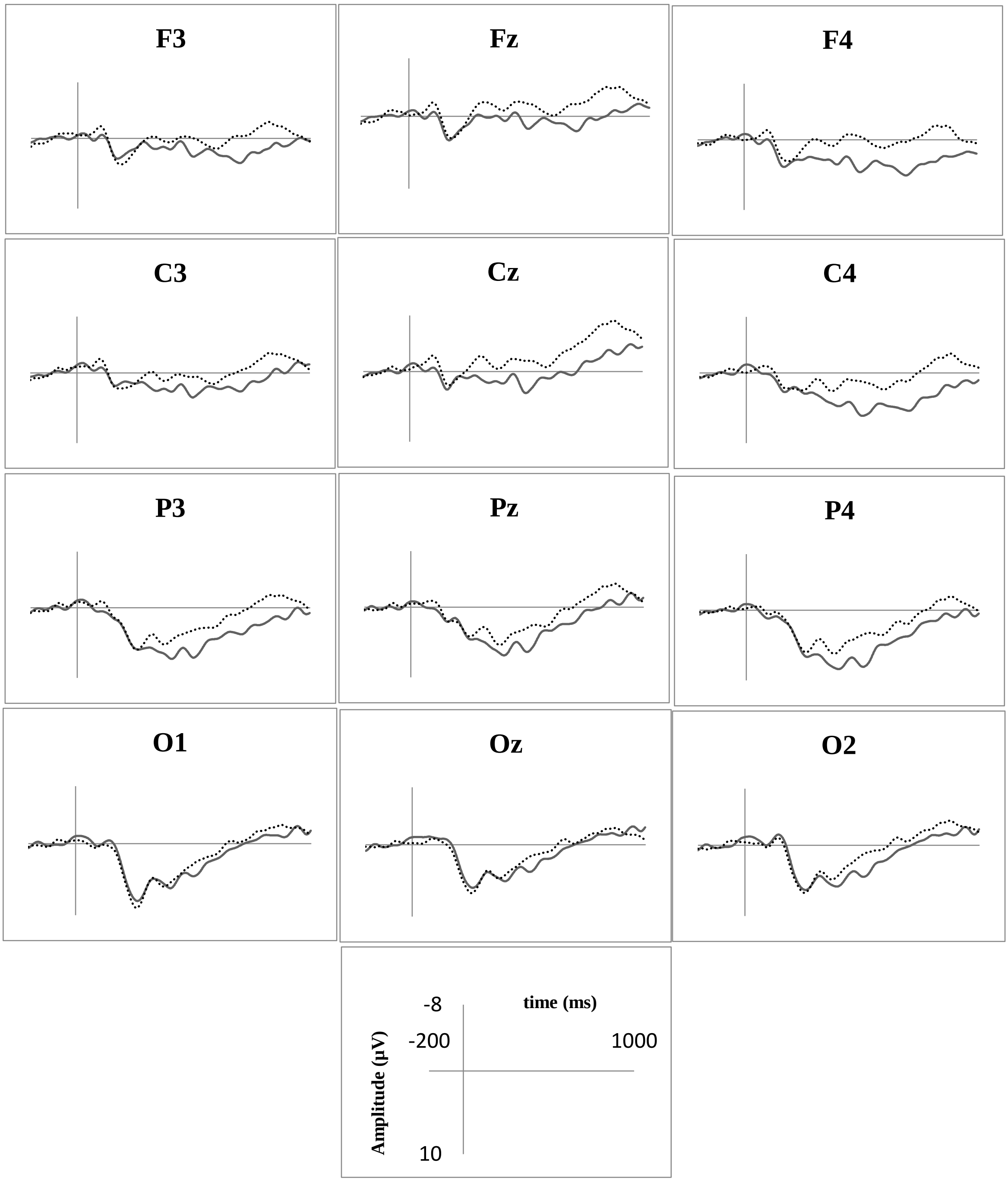

Figure 7. *Grand Average waveforms of twelve representative electrode sites for the MLF violation (dotted line) and its correct counterpart (solid line) of condition 2 (MLF+ / ML=Dutch / Adj Pap-Noun Dutch) versus condition 8 (MLF- / ML=Pap / Adj Pap-Noun Dutch). Zero on the time axis marks the onset of the picture and color presentation. Electrodes are arrayed from most anterior (top) to most posterior (bottom) and from left to right as they were positioned on the scalp. Negativity is plotted up.*

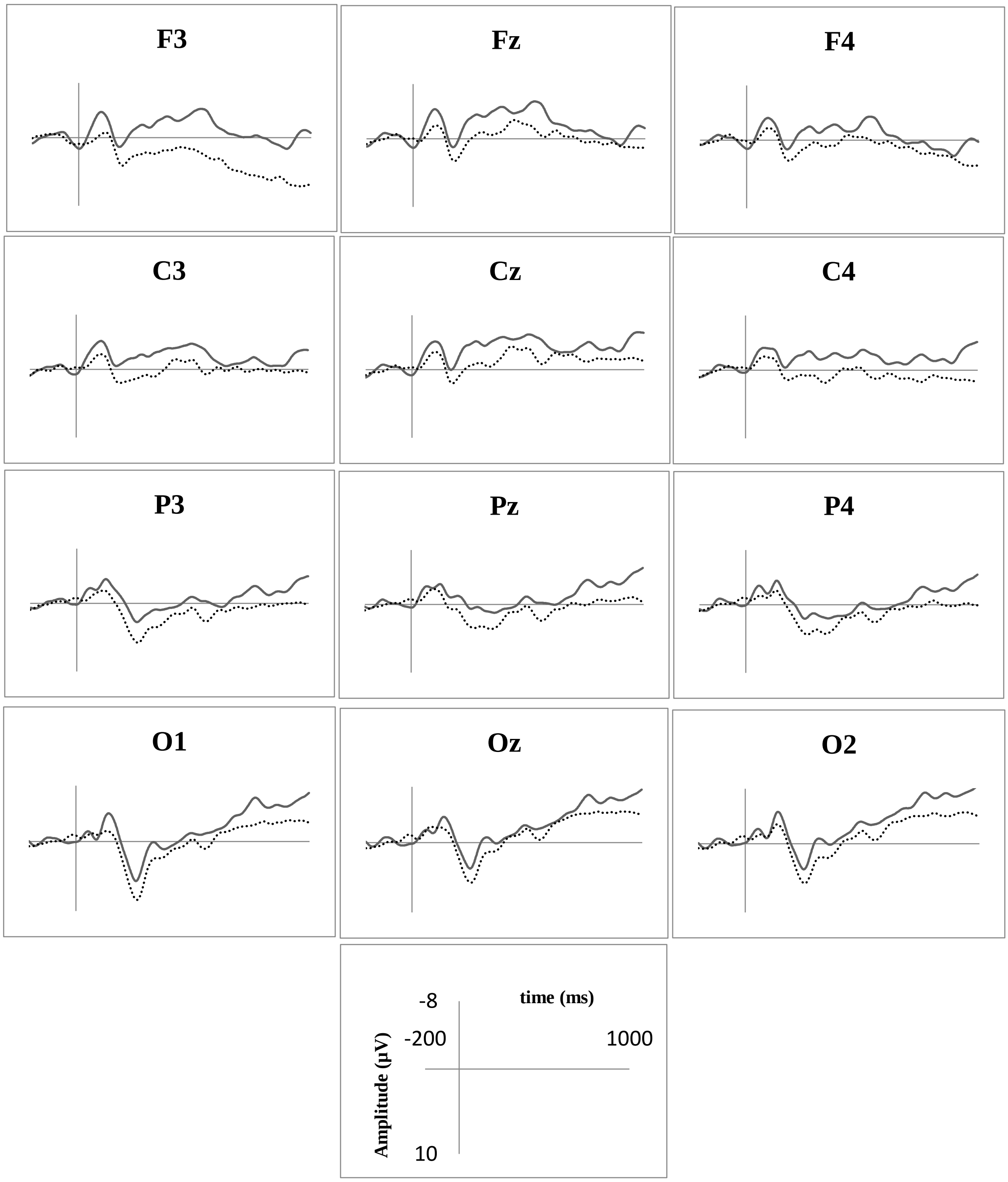

Figure 8. *Grand Average waveforms of twelve representative electrode sites for the MLF violation (dotted line) and its correct counterpart (solid line) of condition 5 (MLF+/ ML=Pap / Noun Pap-Adj Dutch) versus condition 3 (MLF-/ ML=Dutch / Noun Pap-Adj Dutch). Zero on the time axis marks the onset of the picture and color presentation. Electrodes are arrayed from most anterior (top) to most posterior (bottom) and from left to right as they were positioned on the scalp. Negativity is plotted up.*

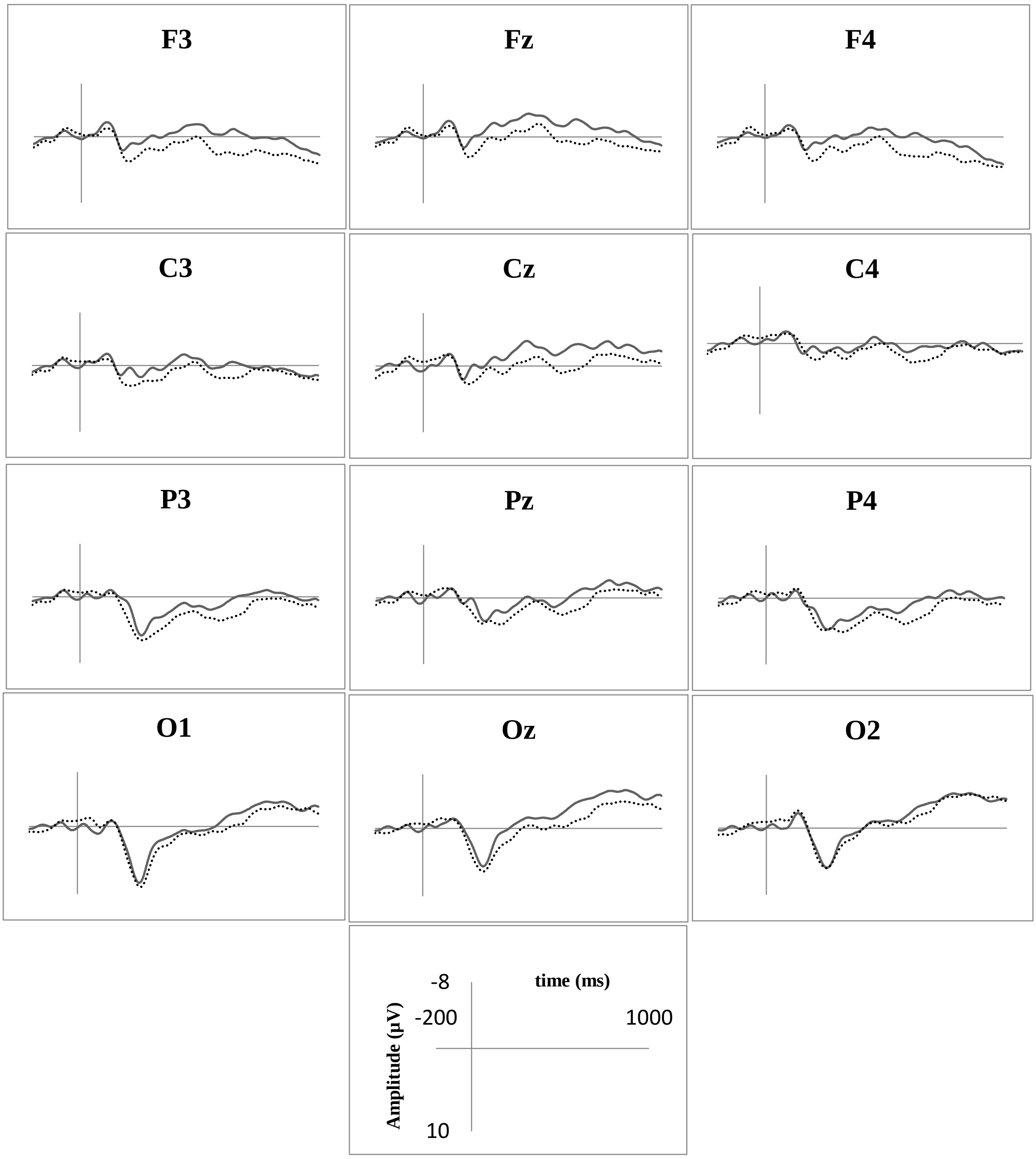

Figure 9. *Grand Average waveforms of twelve representative electrode sites for the MLF violation (dotted line) and its correct counterpart (solid line) of condition 6 (MLF+/ ML=Pap / Noun Dutch – Adj Pap) versus condition 4 (MLF-/ ML=Dutch / Noun Dutch – Adj Pap). Zero on the time axis marks the onset of the picture and color presentation. Electrodes are arrayed from most anterior (top) to most posterior (bottom) and from left to right as they were positioned on the scalp. Negativity is plotted up.*

Onset latency analysis

Condition 1 versus condition 7 (adjective Dutch – noun Papiamento)

t-tests at each sampling rate indicated that the MLF- (ML=Pap) ERPs and the MLF+ (ML=Dutch) ERPs diverge significantly from one another in the occipital, parietal and right central areas between 0-60 ms after target onset (MLF+/ ML=Dutch condition more positive). The ERPs also diverge significantly from one another between 240-280 ms, in the occipital and parietal areas (MLF-/ ML= Papiamento condition more positive).

Condition 2 versus condition 8 (adjective Papiamento – noun Dutch)

t-tests at each sampling rate has shown that the MLF- (ML=Pap) ERPs and the MLF+ (ML=Dutch) ERPs diverge significantly from one another between 300-940 ms in all skeletal areas (MLF+/ ML=Dutch condition more positive).

Condition 5 versus condition 3 (noun Papiamento – adjective Dutch)

t-tests at each sampling rate indicated that the MLF- (ML=Dutch) ERPs and the MLF+ (ML=Pap) ERPs do not diverge significantly from one another (overall MLF-/ ML=Papiamento condition more positive).

Condition 6 versus condition 4 (noun Dutch – adjective Papiamento)

t-tests at each sampling rate indicated that the MLF- (ML=Dutch) ERPs started to diverge significantly from MLF+ (ML=Pap) ERPs 180-240 ms after target onset, in the left and right frontal area, the left central area and the fronto-central area (MLF-/ ML=Dutch condition more positive).

Time window analysis

On the basis of visual inspection of the Grand Averages, five time windows were selected for statistical analyses. The first time window is from 150-220 ms after target presentation, the second time window from 220-320 ms, the third time window is from 320-420 ms, the fourth time window is 420-600 ms and the fifth window is 600-900 ms. The first and the second time window mainly cover the peaks of the P300. The fifth time window covers the sustained positivity.

Time window analyses were conducted to explore possible interactions between matrix language, adjective-noun order and clustered electrodes. A 2 x 4 x 9 repeated measures ANOVA was conducted with Matrix Language (Dutch vs. Papiamento), Order (Dutch Adj - Pap Noun vs. Pap Adj – Dutch Noun vs. Pap Noun – Dutch Adj vs. Dutch Noun – Pap Adj) and Electrode cluster (9 electrode clusters: see above) as independent variables. Mauchley's Test of Sphericity indicated that the assumption of sphericity had been violated[16] in all time windows (all $p < .001$). Therefore a Greenhouse-Geisser correction was used. Reported degrees of freedom are uncorrected, but p-values are corrected.

150-220 time window

There was no main effect of Matrix Language, $F(1,15) = 1.351$, $p = .263$, Order, $F(3,45) = 1.234$, $p = .292$ or Electrode cluster, $F(8,120) = 1.025$, $p = .358$. There were no significant interactions ($p > .053$).

220-320 time window

There was no main effect of Matrix Language, $F(1,15) = 2.199$, $p = .159$, or Order, $F(3,45) = 1.613$, $p = .223$. There was a main effect of Electrode cluster, $F(8,120) = 14.973$, $p < .001$. There were no significant interactions ($p > .097$). The 150-220 and 220-320 time windows also covered the peaks of the P300. Mean amplitudes were greater for the MLF- conditions than MLF+ conditions, 4.18μV versus 3.21μV, $t(3) = -1.391$, $p = .258$.

320-420 time window

There was no main effect of Matrix Language, $F(1,15) = 2.057$, $p = 0.172$, or Order, $F(3,45) = 3.502$, $p = .057$. There was a significant main effect of Electrode cluster, $F(8,120) = 7.956$, p =

[16] Mauchley's Test of Sphericity tests the null-hypothesis that the variances of the differences are equal. If this is significant we can reject the null-hypothesis and accept the alternative hypothesis that that the variances of the differences are not equal.

.001. There was a significant interaction between Order and Electrode cluster, $F(24,360) = 2.456$, $p = .046$. Other interactions were not significant ($p > .088$).

420-600 time window

There was no main effect of Matrix Language, $F(1,15) = 1.971$, $p = 0.181$, or Order, $F(3,45) = 2.092$, $p = .147$. There was a significant main effect of Electrode cluster, $F(8,120) = 5.073$, $p = .011$. There was a significant interaction between Matrix Language and Electrode cluster, $F(8,120) = 3.394$, $p = .042$. Other interactions were not significant ($p > .269$).

600-900 time window

There was no main effect of Matrix Language, $F(1,15) = 3.297$, $p = .089$, or Order, $F(3,45) = 0.754$, $p = .461$. There was a significant main effect of Electrode cluster, $F(8,120) = 11.875$, $p < .001$. There was a significant interaction between Matrix Language and Electrode cluster, $F(8,120) = 4.259$, $p = .015$. And there was a significant interaction between Order and Electrode cluster, $F(24,360) = 3.560$, $p = .007$. Other interactions were not significant ($p > .452$).

Interim conclusion

The results from the onset latency analysis and the time window analysis do not seem to provide conclusive support for the predictions of the MLF. The MLF only looks at the syntactic structures of both languages and does not take any extra-linguistic variables into account. However, an explanation for these inconclusive results can be sought in the way this study was designed or in the group of participants that were used. An example of an extra-linguistic variable, that might have had an influence, is the age of the group of participants. The participants ranged from 19 to 67 years old and it could very well be that older people have different opinions about code-switching or have different code-switching manners than younger people. The participants of this study can be classified into ‘young participants’ (<30; N=12) and ‘older participants’ (>30; N=4). If I look at the answers that were given on the two statements about code-switching, I see that three out of the six participants that said that people have to avoid using Dutch and Papiamento in the same conversation were older than thirty and three out of the four people that said they keep the language separate were over thirty. So, the older participants had a more negative attitude towards code-switching and more often claimed they keep the two languages separate in every day conversations. It is only possible to make strong claims about the results when there is no influence of other (extra-linguistic) variables and the group of participants is as homogenous as possible. In a second analysis, the four older participants were excluded to see if a reduced age range would make a difference in the results. Though, it might be the case that the smaller group (the four older participants) is the group that shows different results than the results from the first onset latency and time window analysis, but a group of four people is too small to do a statistical analysis on. Therefore, the second analysis was based on the twelve younger participants. The Grand Average waveforms for this second analysis can be found in Appendix E.

The waveforms illustrate a similar pattern than the waveforms of all sixteen participants. It begins with a negative peak, maximal between 50-150 ms. This negative peak was followed by a positive peak, maximal between 150-220 ms in the frontal and central area, and maximal between 220-320 ms in the occipital area. After the positive peak, the waveform goes into a negative direction until 450 ms and into a more positive direction from 450 ms until 1,000 ms after target onset.

Repeated onset latency analysis

Condition 1 versus condition 7 (adjective Dutch – noun Papiamento)

t-tests at each sampling rate indicated that the MLF- (ML=Pap) ERPs do not divergence significantly from the MLF+ (ML=Dutch) ERPs. There were three time windows in which only one electrode showed a significant difference, namely the PO3 electrode between 40-60 ms ($p = .035$) and the Fp1 electrode between 540-560 ms ($p = .022$) and 560-580 ms ($p = .024$). Between 40-60 ms, the MLF-/ ML=Dutch condition was more positive, and between 540-580 ms, the MLF-/ ML= Papiamento condition was more positive.

Condition 2 versus condition 8 (adjective Papiamento – noun Dutch)

t-tests at each sampling rate indicated that the MLF- (ML=Pap) ERPs and the MLF+ (ML=Dutch) ERPs diverge significantly form one another between 300-900 ms in all skeletal areas (MLF+/ ML=Dutch condition more positive).

Condition 5 versus condition 3 (noun Papiamento – adjective Dutch)

t-tests at each sampling rate has shown that the MLF- (ML=Dutch) ERPs and the MLF+ (ML=Pap) ERPs diverge significantly from one another between 0-20 ms, in the left frontal, fronto-central, left parietal and centro-parietal areas (MLF+/ ML= Papiamento condition more positive).

Condition 6 versus condition 4 (noun Dutch – adjective Papiamento)

t-tests at each sampling rate indicated that the MLF- (ML=Dutch) ERPs started to diverge significantly from the MLF+ (Pap) ERPs between 180-240 ms after target onset, in the left and right frontal area, the left and right central area, the fronto-centro area and the centro-parietal area (MLF-/ ML=Dutch condition more positive).

Repeated time window analysis

The same five time windows and repeated measures ANOVA with a Greenhouse-Geisser correction were used as the first analysis. Reported degrees of freedom are uncorrected, but p-values are corrected.

150-220 time window

There was no main effect of Matrix Language, $F(1,11) = 1.864$, $p = .199$, or Order, $F(3,33) = 2.153$, $p = .165$ or Electrode cluster, $F(8,88) = 0.609$, $p = .547$. There was a significant interaction between Matrix Language and Electrode cluster, $F(8,88) = 3.331$, $p = .037$. Other interactions were not significant ($p > .185$).

220-320 time window

There was no main effect of Matrix Language, $F(1,11) = 2.246$, $p = .162$ or Order, $F(3,33) = 3.064$, $p = .095$. There was a main effect of Electrode cluster, $F(8,88) = 16.336$, $p <.001$. There were no significant interactions ($p > .148$). The 150-220 and 220-320 time windows also covered the peak(s) of the P300. Mean amplitudes were greater for the MLF- conditions than MLF+ conditions, 4.30μV versus 3.07μV, $t(3) = -0.961$, $p = .408$.

320-420 time window

There was no main effect of Matrix Language, $F(1,11) = 3.195$, $p = .101$. There was a main effect of Order, $F(3,33) = 5.531$, $p = .019$[17] and a main effect of Electrode cluster, $F(8,88) = 19.874$, $p < .001$. There were no significant interactions ($p > .061$).

420-600 time window

There was no main effect of Matrix Language, $F(1,11) = 3.255$, $p = .099$, or Order, $F(3,33) = 3.401$, $p = .057$. There was a main effect of Electrode cluster, $F(8,88) = 12.130$, $p <.001$. There were no significant interactions ($p > .090$).

600-900 time window

There was no main effect of Matrix Language, $F(1,11) = 3.415$, $p = .092$, or Order, $F(3,33) = 1.421$, $p = .264$. There was a main effect of Electrode cluster, $F(8,88) = 6.651$, $p = .004$. There were no significant interactions. There were no significant interactions ($p > .050$).

Table 8 gives an overview of the results of the first and second onset latency analysis and Table 9 gives an overview of the results of the first and second time window analysis. The significant divergences in the occipital and parietal areas, in the condition of a Dutch adjective followed by a Papiamento noun, were replaced by significant divergences of single electrodes.

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[17] A Bonferroni post-hoc test was performed, showing that there was a linear effect ($p = .007$) and a cubic effect ($p = .047$). However, the numbers of the factor "Order" are merely representations of a certain word order (1 = Dutch Adj – Pap Noun, 2= Pap Adj – Dutch Noun, 3 = Pap Noun – Dutch Adj, 4 = Dutch Noun – Pap Adj) and thus cannot be perceived as something linear or cubic.

The condition, in which a Papiamento noun is followed by a Dutch adjective, illustrated a significant divergence in the second onset latency analysis, which did not emerge in the first onset latency analysis.

Table 8. *An overview of the results of the first and second onset latency analysis. Only the time windows in which a significant ("sign.") divergence was found are mentioned. Between brackets it says which MLF condition had a more positive ("pos.") waveform in that particular time window.*

Conditions	First onset latency analysis	Second onset latency analysis
Adj Dutch- Noun Pap	- Sign. divergence between 0-60 ms (MLF+ more pos.) - Sign. divergence between 240-280 ms (MLF- more pos.)	- Sign. divergence between 40-60 ms (only the PO3 / MLF+ more pos.) - Sign. divergence between 540-560 ms (only the Fp1 / MLF- more pos.) - Sign. divergence between 560-580 (only the Fp1 / MLF- more pos.)
Adj Pap – Noun Dutch	- Sign. divergence between 300-940 ms (MLF+ more pos.)	- Sign. divergence between 300-900 ms (MLF+ more pos.)
Noun Pap –Adj Dutch	- No sign. divergence (overall MLF- more pos.)	- Sign. divergence between 0-20 ms (MLF+ more pos.)
Noun Dutch – Adj Pap	- Sign. divergence between 180-240 ms (MLF- more pos.)	- Sign. divergence between 180-240 ms (MLF- more pos.)

Table 9. *An overview of the results of the first and second time window analysis. ML= Matrix Language.*

Time windows	First time window analysis	Second time window analysis
150-220 ms	- Nothing is significant	- Sign. interaction ML and Cluster
220-320 ms	- Main effect of Cluster	- Main effect of Cluster
320-420 ms	- Main effect of Cluster - Sign. interaction Order and Cluster	- Main effect of Order - Main effect of Cluster
420-600 ms	- Main effect of Cluster - Sign. interaction ML and Cluster	- Main effect of Cluster
600-900 ms	- Main effect of Cluster - Sign. interaction ML and Cluster - Sign. interaction Order an Cluster	- Main effect of Cluster

6.3.2. Analysis of code-switching patterns

The conditions that were compared to each other to analyse the code-switching patterns are repeated below:

- Condition 1 *versus* condition 2
  [MLF+/ ML=Dutch/ Adj Dutch-Noun Pap] *versus* [MLF+/ ML=Dutch/ Adj Pap-Noun Dutch]
- Condition 3 versus condition 4
  [MLF-/ ML=Dutch/ Noun Pap-Adj Dutch] *versus* [MLF-/ ML=Dutch/ Noun Dutch- Adj Pap]
- Condition 5 versus condition 6
  [MLF+/ ML=Pap/ Noun Pap-Adj Dutch] *versus* [MLF+/ ML=Pap/ Noun Dutch-Adj Pap]
- Condition 7 *versus* condition 8
  [MLF-/ ML=Pap/ Adj Dutch-Noun Pap] *versus* [MLF-/ ML=Pap/ Adj Pap-Noun Dutch]

The ERPs of the Grand Averages are shown in Figures 10 to 13 (twelve representative electrodes, based on the depicted representative electrodes in Misra et al., 2012).

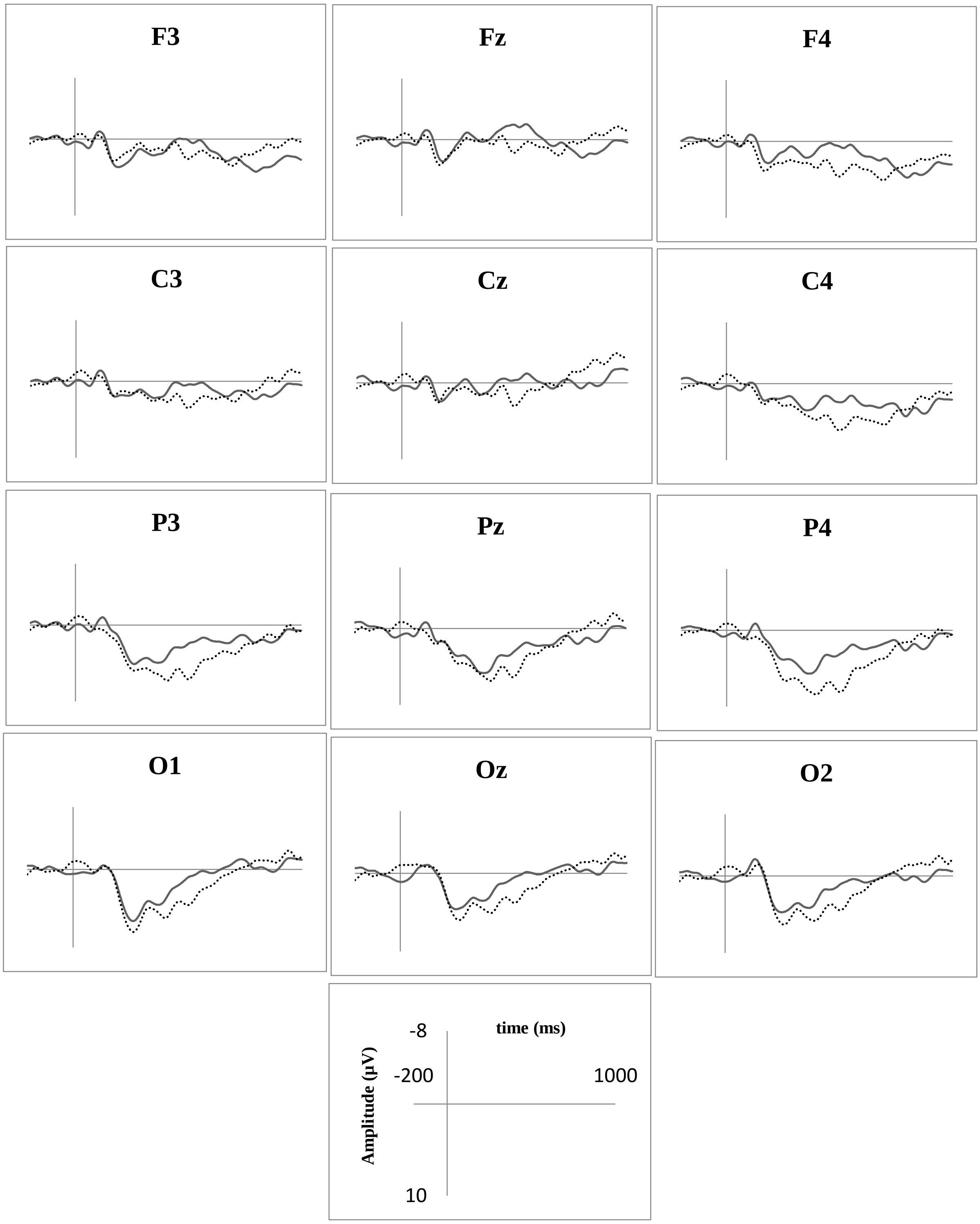

Figure 10. *Grand Average waveforms of twelve representative electrode sites for the MLF+ / Matrix Language = Dutch condition with a Papiamento adjective inserted (dotted line) and the Papiamento noun inserted (solid line). Zero on the time axis marks the onset of the picture and color presentation. Electrodes are arrayed from most anterior (top) to most posterior (bottom) and from left to right as they were positioned on the scalp. Negativity is plotted up.*

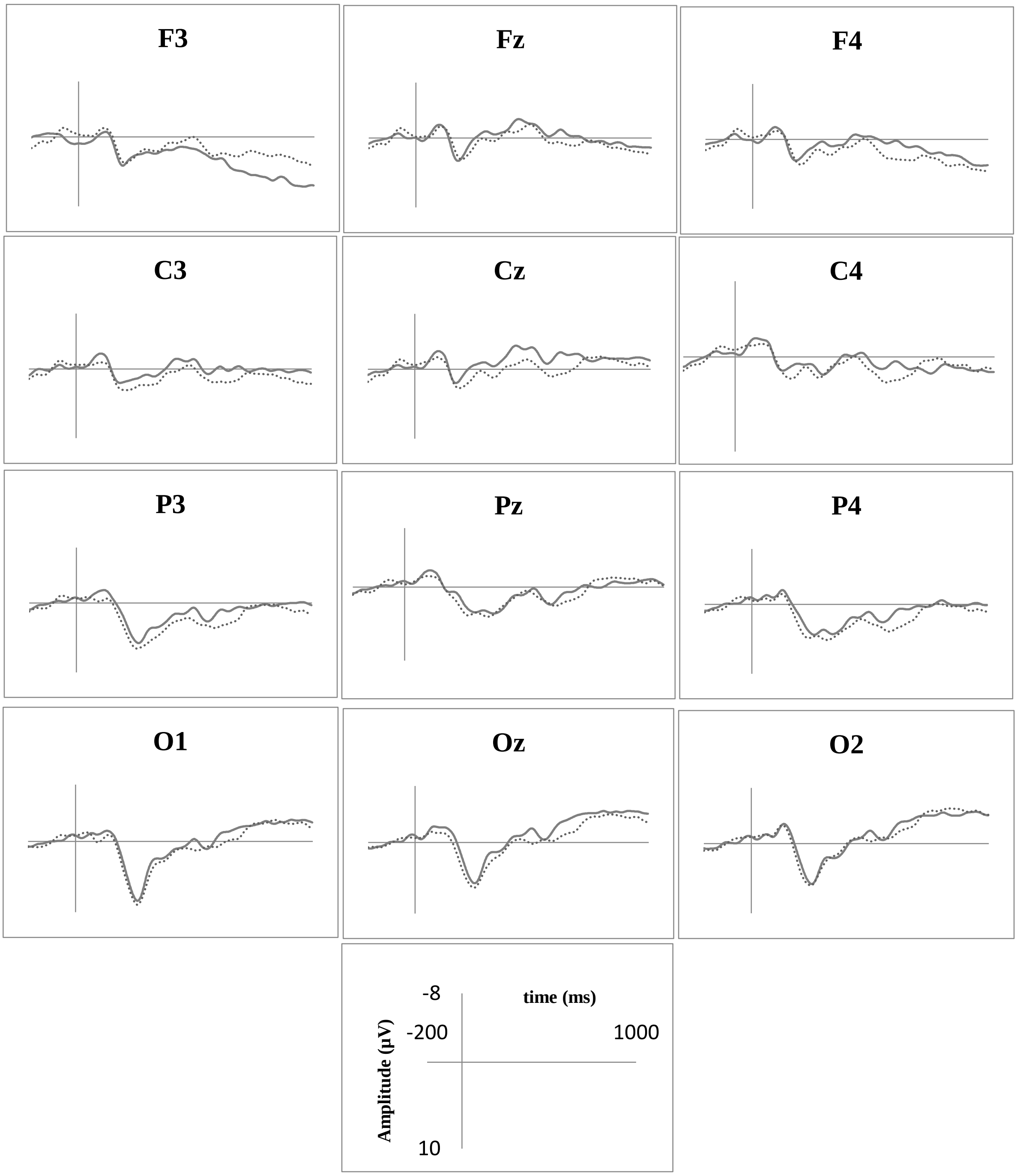

Figure 11. *Grand Average waveforms of twelve representative electrode sites for the MLF- / Matrix Language = Dutch condition with a Papiamento adjective inserted (dotted line) and the Papiamento noun inserted (solid line). Zero on the time axis marks the onset of the picture and color presentation. Electrodes are arrayed from most anterior (top) to most posterior (bottom) and from left to right as they were positioned on the scalp. Negativity is plotted up.*

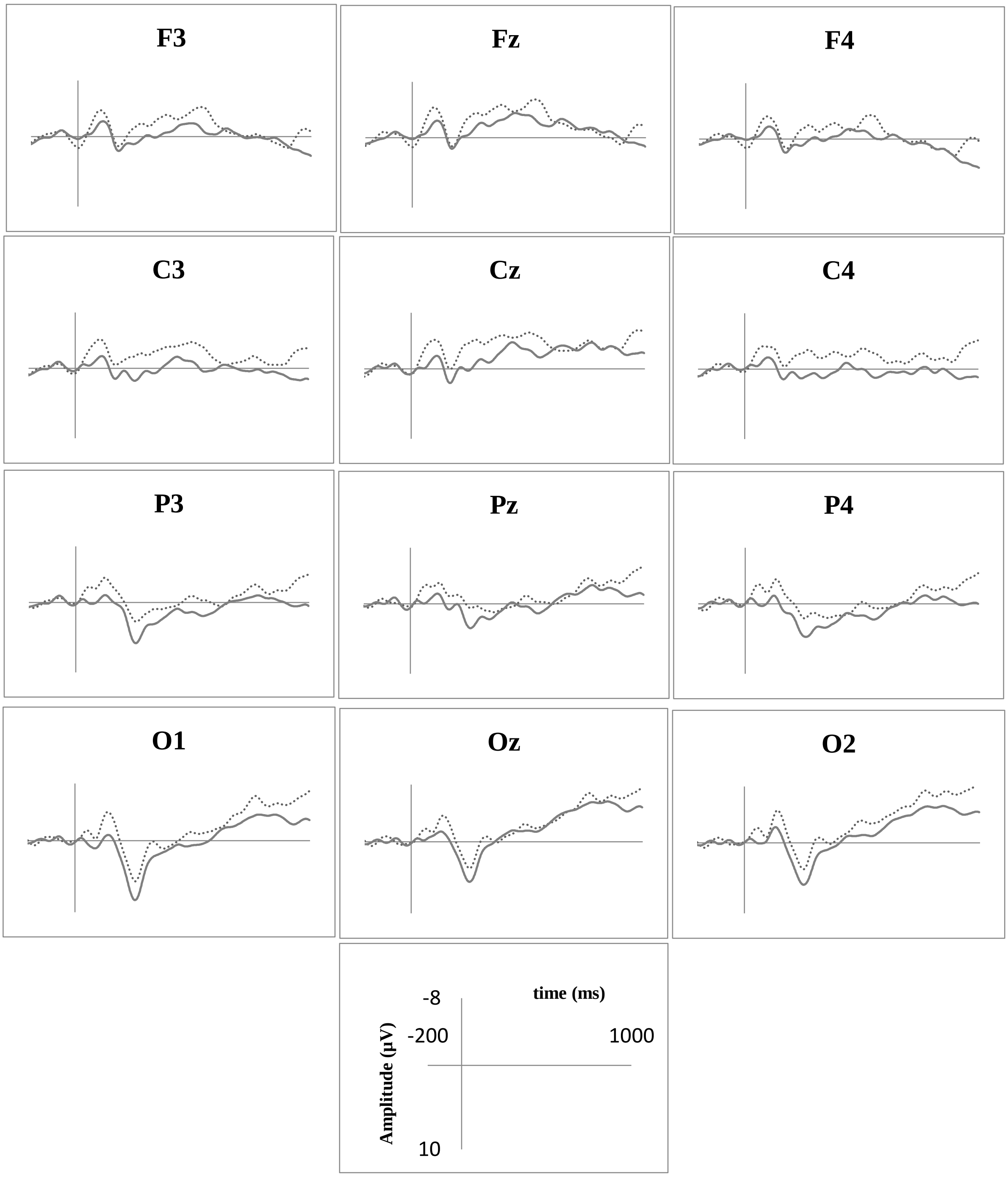

Figure 12. *Grand Average waveforms of twelve representative electrode sites for the MLF+/ Matrix Language = Papiamento condition with Dutch adjective inserted (dotted line) and the Dutch noun inserted (solid line). Zero on the time axis marks the onset of the picture and color presentation. Electrodes are arrayed from most anterior (top) to most posterior (bottom) and from left to right as they were positioned on the scalp. Negativity is plotted up.*

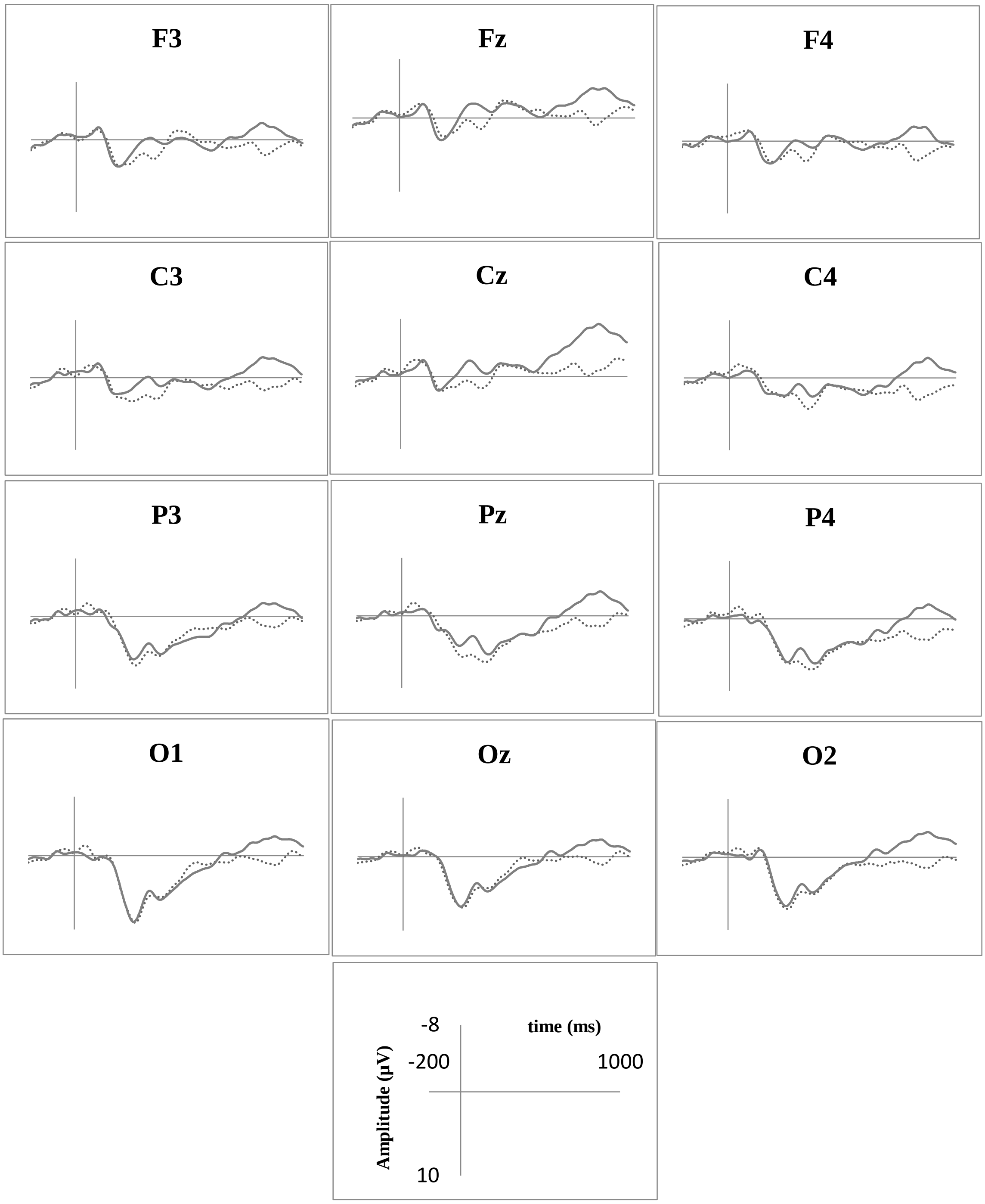

Figure 13. *Grand Average waveforms of twelve representative electrode sites for the MLF-/ Matrix Language = Papiamento condition with Dutch adjective inserted (dotted line) and the Dutch noun inserted (solid line). Zero on the time axis marks the onset of the picture and color presentation. Electrodes are arrayed from most anterior (top) to most posterior (bottom) and from left to right as they were positioned on the scalp. Negativity is plotted*

Onset latency analysis

Condition 1 versus condition 2 (MLF+ / Matrix Language=Dutch)

t-tests at each sampling rate has shown that the Dutch adjective-Papiamento noun ERPs and the Papiamento adjective-Dutch noun ERPs diverge significantly from one another between 0-40 ms, in the occipital, left and right parietal areas (Papiamento noun insertion more positive), between 120-140 ms, in the right parietal and right central areas (Papiamento adjective insertion more positive), between 240-280 ms, in the right parietal and right central area (Papiamento adjective insertion more positive) and between 360-500 ms, in the occipital, parietal, right central and right frontal areas (Papiamento adjective insertion more positive).

Condition 3 versus condition 4 (MLF- / Matrix Language=Dutch)

t-tests at each sampling rate indicated that the Dutch noun-Papiamento adjective ERPs do not diverge significantly from the Papiamento noun-Dutch adjective ERPs (overall Papiamento adjective insertion more positive). There were several time windows in which just one electrode showed a significant divergence, namely CP5 between 100-120 ms ($p = .047$), Cz between 400-420 ($p = .044$), Cz between 420-440 ms ($p = .027$), Cz between 440-460 ms ($p = .040$), Oz between 480-500 ms ($p = .048$), Oz between 500-520 ms ($p = .048$) and CP5 between 600-620 ms ($p = .038$).

Condition 5 versus condition 6 (MLF+ / Matrix Language =Papiamento)

t-tests at each sampling rate indicated that the Papiamento noun-Dutch adjective ERPs and the Dutch noun-Papiamento adjective ERPs do not diverge significantly from one another (overall Dutch noun insertion more positive). The F7 electrode showed a significant divergence between 180-200 ms ($p = .029$) and between 200-220 ms ($p = .047$).

Condition 7 versus condition 8 (MLF- / Matrix Language =Papiamento)

t-tests at each sampling rate indicated that the Dutch adjective-Papiamento noun ERPs diverged significantly from the Papiamento adjective-Dutch noun ERPs between 320-360 ms in the frontal areas (Dutch adjective insertion more positive). The two ERPs also diverge significantly from one another between 800-920 ms, in all skeletal areas (Dutch adjective insertion more positive). In addition, the Fp1 electrode showed a divergence between 640-800 ms ($p < .039$).

No second age-related analysis was done for the code-switching pattern data, because establishing the behavioural and electrophysiological differences among the different code-switching patterns was not the main goal of this study. The main goal was to test the predictions of the MLF and therefore the MLF data was analysed in more detail.

6.4. Summary of the results

From the behavioural data it is clear that the participants responded faster when the matrix language was Dutch then when the matrix language was Papiamento. Within the Dutch matrix language paradigm, participants responded faster to adjective-noun constructions than to noun-adjective constructions; this was even the case in the Papiamento matrix language paradigm. Participants responded significantly faster in MLF-/ ML=Dutch conditions with a switched Papiamento adjective than in MLF-/ ML=Dutch conditions with a switched Papiamento noun. Significant faster responses were also found for the Papiamento adjective- Dutch noun order in the MLF+ condition (ML=Dutch) in comparison to the MLF- condition (ML=Papiamento).

In the onset latency and time window analysis with the electrophysiological data, there were significant differences in various time windows and skeletal regions. Nonetheless, it became visible that MLF+ conditions had a more positive waveform in the first 60 ms, which, in most conditions, was followed by a more positive waveform for the MLF- conditions. A positive peak was found, with a maximum between 150-220 ms in the frontal and central area and a maximum between 220-320 ms in the occipital area. This was seen as a P300, with a higher amplitude in the MLF- conditions.

A second onset latency and time window analysis was done to test the possible influence of an extra-linguistic variable, namely age of participants, on the inconclusive results. Though, the results of this second age-related analysis did not show major effects.

7. Discussion

Behavioural data

The first research question addressed a theoretical question and the behavioural data was used to answer this question: *"Is there a difference in naming latencies between conditions that match the predictions of the MLF (MLF+) and conditions that violate the predictions of the MLF (MLF-)? In addition to this question, is there a difference in naming latencies with regard to the different types of code-switches (adjective versus noun / Dutch versus Papiamento)?"* The behavioural data showed that the average naming latencies were slower for the MLF- conditions than for the MLF+ conditions. However, if I look at each comparison of conditions individually, it is not always the case that participants responded slower in the MLF- condition. Participants responded faster in the MLF+ conditions in the case of a Papiamento adjective followed by a Dutch noun (ML=Dutch) and in the case of a Papiamento noun followed by a Dutch adjective (ML=Pap). The results of these two conditions would confirm my hypothesis about slower naming latencies for conditions that violate the predictions of the MLF. Nonetheless, participants responded faster in the MLF- condition in the case of a Dutch adjective followed by a Papiamento noun (ML=Pap) and in the case of a Dutch noun followed by a Papiamento adjective (ML=Dutch). In these two conditions, the order of the adjective and the noun does not fit into the morpho-syntactic frame provided by the matrix language, but it seems to follow the order of the language of the adjective. That is more in line with the predictions of the Minimalist Program (MP – Cantone & MacSwan, 2009). In both cases of faster responses in the MLF+ and faster responses in the MLF- conditions, there is a condition that has Dutch as a matrix language and a condition that has Papiamento as the matrix language. Consequently, no claim about the relationship between naming latencies and the matrix language can be made yet. A two-way ANOVA also showed no significant interaction between the matrix language and adjective-noun order on naming latency. The behavioural data does not seem to support the predictions of the MLF completely, because the naming latency analysis shows inconsistent results.

A comparison of the naming latencies within the same matrix language paradigm showed that participants responded faster when an adjective was inserted than when a noun was inserted, regardless of matrix language or MLF predictions. This faster naming response was even significant in the case of the MLF- condition with Papiamento as the matrix language. This response time pattern suggests that adjectives that come from a different language than the matrix language trigger faster responses than nouns that come from a different language than the matrix language. The results of this code-switching pattern analysis do not confirm my hypothesis about faster production in conditions with a noun insertion.

Electrophysiological data

The second research question addressed the same theoretical question as the first research question, only now the electrophysiological data was used to answer this question: *"Is there a difference in neural activity between conditions that match the predictions of the MLF (MLF+) and conditions that violate the predictions of the MLF (MLF-)? In addition to this question, is there a difference in neural activity with regard to the different types of code-switches (adjective versus noun / Dutch versus Papiamento?* The grand average waveforms of all conditions show a similar pattern. From visual inspection it is clear that the MLF- conditions show a more positive waveform than the MLF+ conditions, except the pair with the Papiamento adjective first and the Dutch noun second, in which the waveform for the MLF- condition (ML=Pap) is more negative than the waveform of the MLF+ condition (ML=Dutch). The positive waveform of the other three MLF- conditions was not the trend I expected.

Onset latency analysis revealed significant differences between the MLF+ waveforms and the MLF- waveforms in various time windows and skeletal regions. Only the comparison between condition 5 and condition 3 (Papiamento noun-Dutch adjective), did not show a significant divergence between the waveforms of the MLF+ condition (ML=Pap) and the MLF- condition (ML=Dutch). Early ERP components reflect automatic processing, while late ERP components reflect (more) deep processing. There were two comparisons of conditions that showed an early effect, namely the comparison of condition 1 versus condition 7, Dutch adjective followed by a Papiamento noun, and the comparison of condition 6 versus condition 4, a Dutch noun followed by a Papiamento adjective. In the comparison of condition 1 versus condition 7, the MLF+ (ML=Dutch) waveform was more positive, while in the comparison of condition 6 versus condition 4, the MLF- (ML=Dutch) waveform was more positive. This could indicate that processing the order of a Dutch adjective followed by a Papiamento noun in a sentence with Dutch matrix language (condition 1) and a Dutch noun followed by a Papiamento adjective in a sentence with Dutch matrix language (condition 4) are the "easiest" out of all language-order combinations. Looking at the first condition, encountering a Dutch adjective first is not uncommon (Dutch adjectives always precede the noun) and subsequently encountering a Papiamento noun is possible, because participants are expecting a noun after a Dutch adjective. Looking at the fourth condition, when participants encounter a Dutch noun, they are fine, because adjectives are optional, and when this noun is followed by a Papiamento adjective, they are still fine, because in Papiamento adjectives are always post-nominal. Perhaps those combinations can be processed more automatically, because the grammars of Dutch and Papiamento allow for, respectively, pre-nominal and post-nominal adjectives. Whereas, a pre-nominal Papiamento adjective (condition 2 versus 8) or a post-nominal Dutch adjective (condition 5 versus 3) could be more difficult to process, because these orders are not consistent with the Dutch and Papiamento grammar.

However, the comparison of condition 1 versus 7 (Dutch adjective-Papiamento noun) may confirm the predictions of the MLF, the other comparison of condition 6 versus 4 (Dutch noun-Papiamento adjective) does not. The order of a Dutch noun followed by a Papiamento adjective might be explainable, though it is not the order presupposed by the matrix language, which in this case is Dutch. Instead, the order resembles the word order presupposed by the language of the adjective and this effect would go with the predictions of the MP (Cantone & MacSwan, 2009). Now, similar to the behavioural data, there is a comparison of conditions that seems to validate the predictions of the MLF and there is a comparison of conditions that might be explained by the predictions of the MP.

Results of a second analysis, which only included the participants under thirty, were quite similar to the first. The early effect in the comparison of condition 6 and condition 4 (Dutch noun followed by a Papiamento adjective) remains, though the very early effect in the comparison of condition 1 and condition 7 (Dutch adjective followed by a Papiamento noun) is no longer visible. Surprisingly, the waveform of condition 5 (Papiamento noun followed by a Dutch adjective with Papiamento as the matrix language) was significantly more positive than the waveform of condition 3 (Papiamento noun followed by a Dutch adjective with Dutch as the matrix language), between 0-20 ms. This result (more positivity for a Papiamento noun followed by a Dutch adjective in a sentence with Papiamento as the matrix language) provides support for the predictions of the MLF. While comparing the results of the first and second onset latency analysis, it became clear that the waveforms of the MLF+ conditions seems to be significantly more positive in very early time windows (between 0 and 60 ms). However, this significant positive direction stops after maximally 60 ms. Significant divergences in later time windows show a more positive waveform for the MLF- conditions. So, in very early time windows the MLF+ conditions follow the expected pattern, but these time window might be too early to draw any real conclusions from. To sum up, reducing the age variability does not seem to have a major effect on the electrophysiological data. Data of more participants (preferably in the same age range) is needed to draw any conclusions about the influence of an extra-linguistic variable, like age of participants. The overall predictions of the MLF need further research as well.

Apart from the MLF predictions, do the results show any differences regarding the different code-switching patterns? The grand average waveforms of the code-switching pattern analysis do not show one universal trend. Within the Dutch matrix language paradigm, the waveform of a Papiamento adjective insertion is more positive than the waveform of a Papiamento noun insertion, in both the MLF+ and MLF- condition. As for the Papiamento matrix language paradigm, the waveform of a Dutch adjective insertion is more positive in the MLF- conditions, while the waveform of a Dutch noun insertion is more positive in the MLF+ conditions. The latter confirms my hypothesis about a more positive waveform for noun insertions. The hypotheses about the code-switching patterns (slower naming latencies and a more negative waveform for adjective insertions) were confirmed by one of the four comparisons of conditions in the electrophysiological data analysis, while it was not confirmed at all in the naming latency analysis.

Perhaps the differences in the results, between conditions with an adjective insertion and conditions with a noun insertion, are a result of the design of the experiment. The stimuli consisted of twenty pictures (nouns) and only four colors (adjectives). In the case of a color, participants had to decide whether it was 'red', 'green', 'white' or 'grey' and then decide in which language they have to produce it in. In the case of a picture, it could be a 'house', 'tree', 'shoe', 'dog', 'dress', et cetera, resulting in a lot more options for the participant. Besides, each color appeared five times per condition, while the pictures appeared once per condition and so participants encountered the colors more often than the pictures. The frequent encounters and the lesser options could have led to a faster recognition. Conditions with an inserted adjective could seem easier to process for the participants than condition with an inserted noun. This could lead to a more positive waveform for conditions with an adjective insertion.

Bringing the data together

The third research question was *"Do the results from the naming latency analysis and the results from the electrophysiological data analysis point in the same direction?".* Table 10 gives an overview of the conditions and the results from the behavioural data analysis and the electrophysiological data analysis.

Table 10. *The results of the behavioural data analysis and the electrophysiological data analysis for each experimental condition. ✓ = support, x = no support.*

	Condition			*Type of data*	
	MLF	**ML**	**Word order**	**Behavioural data**	**EEG data**
1	MLF+	Dutch	Adj Dutch – Noun Pap	x	x
2	MLF+	Dutch	Adj Pap – Noun Dutch	✓	✓
3	MLF-	Dutch	Noun Pap – Adj Dutch	✓	x
4	MLF-	Dutch	Noun Dutch – Adj Pap	x	x
5	MLF+	Papiamento	Noun Pap – Adj Dutch	✓	x
6	MLF+	Papiamento	Noun Dutch – Adj Pap	x	x
7	MLF-	Papiamento	Adj Dutch – Noun Pap	x	x
8	MLF-	Papiamento	Adj Pap – Noun Dutch	✓	✓

The electrophysiological data does point in a similar direction as the behavioural data. The condition in which a Papiamento adjective is followed by a Dutch noun is the only condition that illustrated the expected pattern, namely slower naming latencies in the MLF- condition (ML=Pap) and a more negative waveform for the MLF- condition (ML=Pap). The condition, in which a Papiamento noun is followed by a Dutch adjective, also shows the expected pattern in the behavioural data, but not in the electrophysiological data.

The elicited ERP components

Previous studies on bilingual production (although not specifically on code-switching production) mostly reported on the P200, N200 and P300 ERP components. In the present study it seems that there is a P300 component, which is maximal between 150-220 ms in the frontal and central areas and between 220-320 ms in the occipital areas. The amplitude of the P300 was higher in the MLF- conditions than in the MLF+ conditions. The P300 is usually addressed in experiments using an "oddball paradigm", in which participants are presented with sequences of repetitive stimuli that are infrequently interrupted by a deviant stimulus. Previous studies have shown that a larger P300 is elicited by the events representing the low-probability category (Donchin and Coles, 1988) and that the P300 also increases as the complexity of the stimuli and task increases (Johnson, 1986). I expected the task to be most complex in the MLF- conditions, because in these conditions the order of the adjective and the noun does not match the order presupposed by the grammar of the matrix language. The task of naming the color and the picture is then more difficult for the participants. The larger P300 peak found in the MLF- conditions could be explained by the higher complexity of the MLF- conditions.

The amplitude of the P300 can be explained, but the question remains of why a P300 occurs? There is yet no clear understanding of how and why the brain produces a P300 and several theories have been proposed in the literature (for an overview see Polich, 2012). One suggested theory is the context-updating theory (Donchin 1981; Donchin & Coles, 1988), in which the P300 component indexes brain activities underlying revision of the mental representation induced by incoming stimuli. Attentional processes govern a change or an "update" of the stimulus representation when a new stimulus is detected. It could be the case that the participants consistently had to update their stimulus representations, because the representations in the MLF- conditions are new to the participants, i.e. the stimuli participants encounter are unlike the Dutch pre-nominal adjective representation and Papiamento post-nominal adjective representation that are familiar to the brain. These representations need to be changed or "updated" into something that fits the requirements of the MLF- condition.

Another proposed theory is the neural inhibition theory (Polich, 2007), where it has been hypothesized that the P300 reflects neural inhibition of on-going activity to facilitate transmission of task/stimulus information from frontal (P3a) to temporal-parietal (P3b) locations. The obtained frontal peak could reflect the P3a cub-component and the obtained occipital peak could reflect the P3b sub-component, although this peak is in the occipital area rather than the parietal area. One of the premises of the MLF is that both languages of a bilingual speaker are always "on" during code-switching. In the Dutch-Papiamento word order conflict, participants have to inhibit activation from one grammar to retrieve information from the other and vice versa. For example, activation of the Papiamento grammar needs to be inhibited in order to retrieve the Dutch pre-nominal order, but then the activation of the Dutch grammar needs to be inhibited, because the lexical adjective needs to be retrieved from the Papiamento grammar. This will lead to a Papiamento pre-nominal adjective, an example of an MLF-construction.

Apart from the apparent P300, there is a sustained positivity visible in the grand average waveforms. In the comparisons between conditions 1 versus 7 (Dutch adjective-Papiamento noun) and conditions 2 versus 8 (Papiamento adjective-Dutch noun), there is a sustained positivity for the MLF+ conditions (ML=Dutch), while in the comparisons between conditions 5 versus 3 (Papiamento noun-Dutch adjective) and the conditions 6 versus 4 (Dutch noun-Papiamento adjective) there is a sustained positivity for the MLF- conditions (ML=Dutch). The late positive component could reflect deep processing and reanalysing of the stimuli (related to the P600 component found in sentence comprehension studies that reflects syntactic reanalysis – Kaan, Harris, Gibson & Holcomb, 2000; Frisch, Schlesewsky, Saddy & Alpermann, 2002).

Though, this does not explain the distinction between sustained positivity for two MLF+ conditions and sustained positivity for two MLF- conditions. All four conditions, that showed a sustained positivity, have Dutch as the matrix language. As a result, it seems that conditions with Dutch as the matrix language, MLF+ or MLF-, are the conditions that need the most deep processing and re-analysing. However, the analysis of the behavioural data nor the analysis of the electrophysiological data reveal a particular difficulty with sentences that have Dutch as the matrix language. This late positive component does not confirm neither rejects the hypothesis about the predictions of the MLF.

All in all, the apparent P300 seems to fit into the context-updating and the neural inhibition theory. Nevertheless, more research is necessary to confirm the appearance of a P300 component in code-switching production and to explain the apparent late positive component. Further research is also necessary to discover which methods are most suitable for studying code-switching production. In this study I tried to incorporate a methodological innovation to test the predictions of a theoretical model. A (re)new(ed) methodology comes with new methodological challenges.

Methodological challenges

This study has shown that it is not easy to study code-switching production with EEG. First of all, people from the Dutch Antilles have a hairstyle that is not most suitable for EEG recordings. Some people have frizzy hair or braids and so the electrodes can't always make contact to the scalp. That leads to a less clean signal. That was one of the reasons why I had set the minimum of segments to 10, because otherwise I could not have included a lot of participants. Secondly, it was difficult to get one universal way of spelling the stimuli, because there is a variety of Papiamento spoken in Aruba (Papiamento) and a variety spoken in Bonaire and Curaçao (Papiamentu) and these varieties mainly differ in orthography. Nevertheless, the focus of this study is on production and not on spelling and thus one spelling variety was chosen and a native speaker of Papiamento had checked the spelling for me.

During the experiments, participants did not seem to mind the spelling, whether it was correct or incorrect according to their variety. The type of words seem to mind more. Some participants told me that when they speak (on a daily basis) they don't use some of the Papiamento words themselves, but would use the Dutch equivalent. For example, they would say the Dutch word *beer* ("bear") instead of the Papiamento word *oso* ("bear"). Even though there was a learning phase at the beginning of the experiment, participants mentioned they sometimes had more trouble remembering the Papiamento word than thinking about the order in which they had to produce it. This study was not designed to be a memory task. It might be the case that the word *oso* is a borrowing from Spanish and perhaps not all Papiamento speakers use or know this borrowing. The Papiamento language has a lot of influences of Portuguese, Spanish and Dutch and this could result in borrowings or words that are phonologically similar (cognates). Especially the amount of Papiamento-Dutch cognates made it very difficult to find proper Papiamento nouns and enough Papiamento adjectives that could be used for this study. The most challenging part of this study was to work with the variety of the Papiamento language. So, there is a fine line between enough stimuli (keeping frequency, number of phonemes, cognate effect, et cetera in mind) and maintaining the goal of the experiment.

8. Conclusion

In this study I have tested the predictions of a theoretical model in an innovative way, namely by using a psycholinguistic method. In the field of code-switching, there are two prominent theoretical models with each their own approach to code-switching. An electrophysiological method was used to test the predictions of one of these models, namely the Matrix Language Framework. However, the results of this study do not provide any conclusive support for the predictions of the Matrix Language Framework. The explanation for some results might be found within the Minimalist Program, however, this study was not designed to test the predictions of the Minimalist Program and so this is merely a suggestion. From this study it is not clear whether the Dutch-Papiamento code switches are governed by an asymmetry between two languages (as proposed by the Matrix Language Framework) or by the grammars of both languages (as proposed by the Minimalist Program). A study in code-switching production thus remains exploratory in this field and I can only pose suggestions for explanations and suggestions for further research. Data of more participants and data from language pairs with a similar conflict in code-switching would benefit the results. Nevertheless, this study was a first step in trying to incorporate methods and models from different fields of expertise and this line of study needs to be continued to get a better understanding of code-switching and the syntactic and psycholinguistic models. Further research should continue to look at code-switching production and thereby keep the methodological challenges (e.g. language variety, type of participants, number of stimuli) in mind.

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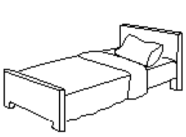
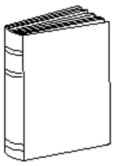
Appendices

Appendix A – The pictures (Dutch name / Papiamento name)

Practice pictures

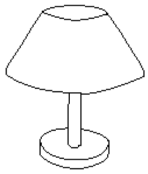


Bed / Kama

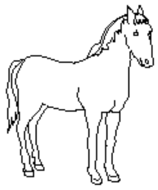


Boek/ Buki

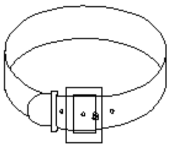
Huis / Kas



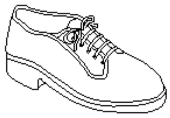
Lamp / Lampi



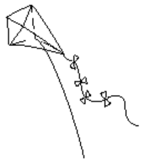
Paard Kabai



Riem / Faha



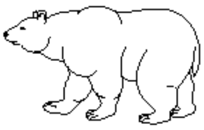
Schoen / Sapato



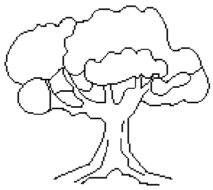
Vlieger / Fli

Experiment pictures

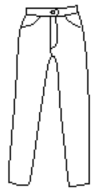
Aap / Makako



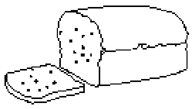
Beer / Oso



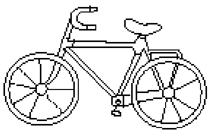
Boom / Palu



Broek / Karson

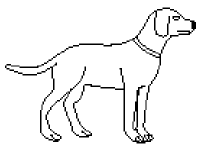


Brood / Pan



Fiets / Baiskel

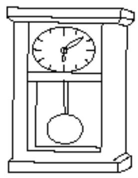
Hoed / Sombré



Hond / Kachó

Jas / Mantel

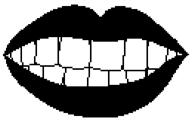
Jurk / Bistí



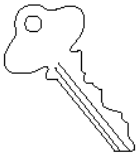
Klok / Oloshi

Koffer / Falis

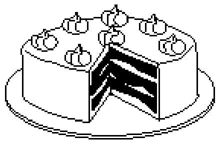
Mes / Kuchú



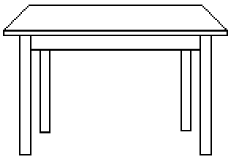
Mond / Boka



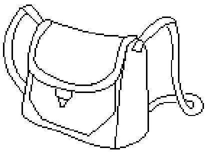
Sleutel / Yabi



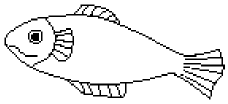
Taart / Bolo



Tafel / Mesa



Tas / Monton



Vis / Piská

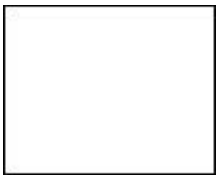
Vogel / Para

The color patches

Groen / Bèrdè

Grijs / Shinishi

Rood / Kòrá



Wit / Blanku

Appendix B – The experimental sentences

	Lead-in sentence (Dutch)			MLF+ /Dutch/ Adj-N		MLF - /Dutch/ N-Adj	
	Subject	**Verb**	**Determiner**	**Adj Dutch - N Pap (11)**	**Adj Pap - N Dutch (22)**	**N Dutch - Adj Pap (33)**	**N Pap - Adj Dutch (44)**
1	De man	ziet	een	Grijze makako	Shinishi aap	Aap shinishi	Makako grijs
2	Wij	zien	een	Grijze kachó	Shisnihi hond	Hond shinishi	Kachó grijs
3	Mijn broer	ziet	een	Grijze para	Shinishi vogel	Vogel shinishi	Para grijs
4	Maaike	tekent	een	Grijs kuchú	Shinishi mes	Mes shinishi	Kuchú grijs
5	Kees	verkoopt	een	Grijze mesa	Shinishi tafel	Tafel shinishi	Mesa grijs
6	Mijn vriend	verkoopt	een	Groene karson	Bèrde broek	Broek bèrde	Karson groen
7	De jongen	steelt	een	Groene sombré	Bèrde hoed	Hoed bèrde	Sombré groen
8	De man	steelt	een	Groene monton	Bèrde tas	Tas bèrde	Monton groen
9	Zij	verkoopt	een	Groene mantel	Bèrde jas	Jas bèrde	Mantel groen
10	Het kind	tekent	een	Groen yabi	Bèrde sleutel	Sleutel bèrde	Yabi groen
11	Wij	kopen	een	Witte piská	Blanku vis	Vis blanku	Piská wit
12	De buurman	ziet	een	Witte oso	Blanku beer	Beer blanku	Oso wit
13	Peter	koopt	een	Wit pan	Blanku brood	Brood blanku	Pan wit
14	Joost	tekent	een	Witte palu	Blanku boom	Boom blanku	Palo wit
15	Mijn ouders	verkopen	een	Witte oloshi	Blanku klok	Klok blanku	Oloshi wit
16	Mijn opa	koopt	een	Rode bisikleta	Còrá fiets	Fiets còrá	Bisikleta rood
17	Mijn vriendin	steelt	een	Rode falis	Còrá koffer	Koffer còrá	Falis rood
18	Mijn zus	koopt	een	Rode bolo	Còrá taart	Taart còrá	Bolo rood
19	Zij	tekent	een	Rode boka	Còrá mond	Mond còrá	Boka rood
20	Lola	steelt	een	Rode bistí	Còrá jurk	Jurk còrá	Bistí rood

	Lead-in sentence (Pap)			**MLF + / Pap / N-Adj**		**MLF - / Pap / Adj-N**	
	Subject	**Verb**	**Determiner**	**N Pap - Adj Dutch (55)**	**N Dutch - Adj Pap (66)**	**Adj Dutch - N Pap (77)**	**Adj Pap - N Dutch (88)**
1	E hòmber	ta mira	un	Makako grijs	Aap shinishi	Grijze makako	Shinishi aap
2	Nos	ta mira	un	Kachó grijs	Hond shinishi	Grijze kachó	Shinishi hond
3	Mi ruman	ta mira	un	Para grijs	Vogel shinishi	Grijze para	Shinishi vogel
4	Maaike	ta tek	un	Kuchú grijs	Mes shinishi	Grijze kuchú	Shinishi mes
5	Kees	ta kumpra	un	Mesa grijs	Tafel shinishi	Grijze mesa	Shinishi tafel
6	Mi amigu	ta bènde	un	Karson groen	Broek bèrde	Groene karson	Bèrde broek
7	E hòmber	ta hòrta	un	Sombré groen	Hoed bèrde	Groene sombré	Bèrde hoed
8	E hòmber	ta hòrta	un	Monton groen	Tas bèrde	Groene monton	Bèrde tas
9	E	ta bènde	un	Mantel groen	Jas bèrde	Groene mantel	Bèrde jas
10	E mucha	ta tek	un	Yabi groen	Sleutel bèrde	Groene yabi	Bèrde sleutel
11	Nos	ta tuma	un	Piská wit	Vis blanku	Witte piská	Blanku vis
12	E bisiña	ta bènde	un	Oso wit	Beer blanku	Witte oso	Blanku beer
13	Peter	ta kumpra	un	Pan wit	Brood blanku	Witte pan	Blanku brood
14	Joost	ta tek	un	Palo wit	Boom blanku	Witte palo	Blanku boom
15	Mi mayonan	ta bènde	un	Oloshi wit	Klok blanku	Witte oloshi	Blanku klok
16	Mi padú	ta bènde	un	Bisikleta rood	Fiets còrá	Rode bisikleta	Còrá fiets
17	Mi amiga	ta hòrta	un	Falis rood	Koffer còrá	Rode falis	Còrá koffer
18	Mi ruman	ta kumpra	un	Bolo rood	Taart còrá	Rode bolo	Còrá taart
19	E	ta tek	un	Boka rood	Mond còrá	Rode boka	Còrá mond
20	Lola	ta hòrta	un	Bistí rood	Jurk còrá	Rode bistí	Còrá jurk

Appendix C – The information form (in Dutch)

Leiden University Centre for Linguistics

Begeleider: Dr. M. Carmen Parafita Couto
Onderzoeker: Myrthe Wildeboer

Titel van het onderzoek: EEG-onderzoek naar tweetaligheid

Universiteit Leiden

Beste deelnemer,

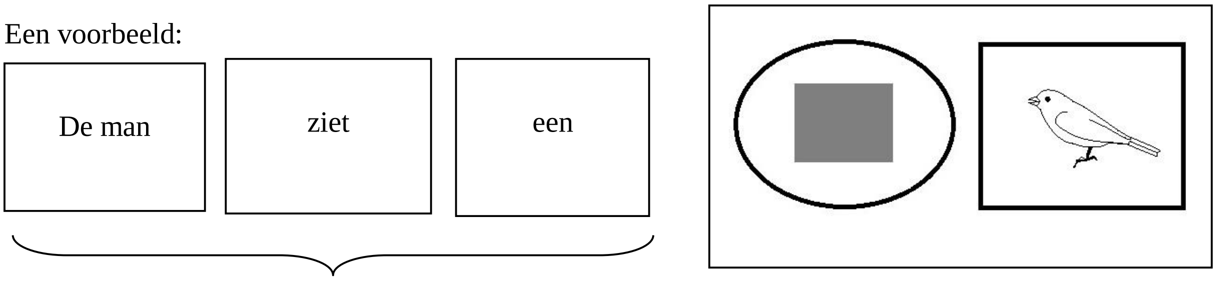
We vragen u deel te nemen aan een onderzoek waarmee we hopen meer te weten te komen over tweetaligheid. We doen dit door naar de activiteit van de hersenen te kijken tijdens het lezen en spreken.

Inhoud van het onderzoek

Het experiment bestaat uit drie onderdelen: een leerblok, een oefenblok en het experiment. Tijdens het leerblok verschijnt er één voor één een afbeelding met een naam in beeld. Aan u de taak om de juiste naam bij de juiste afbeelding te onthouden. Nadat u alle afbeeldingen en bijbehorende namen eenmaal gezien heeft, zult u de afbeeldingen zelf moeten gaan benoemen. Er komt elke keer één afbeelding tegelijk in beeld. Aan u de taak om de juiste naam **hardop** te zeggen. U krijgt hier feedback, zodat u kunt zien of u de juiste naam heeft genoemd of niet. Probeer meteen de naam te zeggen en geen "ehh" of andere aarzelingen te gebruiken. Dit doet u één keer met Nederlandse namen en één keer met Papiamento namen.

Tijdens het echte experiment zult u stukje voor stukje een deel van een zin te zien krijgen. Dit deel van de zin hoeft u **niet** hardop voor te lezen of te benoemen, maar kunt u voor uzelf lezen. Daarna zult u tegelijkertijd een afbeelding en een kleur te zien krijgen. Aan u de taak om de zin af te maken door de zowel de afbeelding als de kleur **hardop** te benoemen. U moet beide afbeeldingen benoemen. Probeer meteen de afbeeldingen te benoemen en geen "ehh" of andere aarzelingen te gebruiken.
LET OP: om zowel de kleur als de afbeelding staat een frame. Een **vierkant** frame betekent dat u die afbeelding of kleur in het **Nederlands** moet benoemen. Een **rond** frame betekent dat u die afbeelding of kleur in het **Papiaments** moet benoemen. Er zal altijd één vierkant frame zijn en één rond frame, u wisselt hier dus van taal. Voordat het experiment begint, kunt u wennen aan de taak door middel van een oefenblok.

Een voorbeeld:



Dit gedeelte leest u in uw hoofd

Hier zegt u: SHINISHI VOGEL

Voordat we het experiment kunnen beginnen zullen we het EEG materiaal aansluiten. U krijgt hierbij een cap op uw hoofd, waar 32 elektroden in worden geplaatst. Daarnaast komen er nog 6 elektroden op uw gezicht: één op beide slapen, één boven het linkeroog, één onder het linkeroog en één achter elk oor. Het is een veilige methode en u zult er geen schade aan overhouden. Het aansluiten van het materiaal zal ongeveer een half uur duren. Na het experiment heeft u de mogelijkheid om uw haar te wassen.

We vragen u ook een vragenlijst in te vullen voor achtergrondinformatie. Deze informatie is puur en alleen voor dit onderzoek bedoeld en zal niet aan derden worden verstrekt.

Het is belangrijk dat u het gehele experiment zo geconcentreerd mogelijk blijft. Probeer zo min mogelijk te knipperen, dit kan namelijk storingen veroorzaken in het signaal. Gelieve ook zo stil mogelijk te zitten. Alle geluiden en bewegingen (slikken, smakken, zuchten, tanden knarsen, etc) kunnen storingen opleveren, waardoor het signaal moeilijker te analyseren wordt. Er zullen voldoende pauzes zijn waarin u kunt ontspannen en even kunt knipperen, waardoor u daarna weer geconcentreerd verder kunt met het experiment.

Vrijwilligheid van deelname

Deelname aan dit onderzoek is geheel vrijwillig en vrijblijvend. Dit betekent dat u te allen tijde, zonder opgaaf van reden, kunt besluiten om uw deelname aan het onderzoek te beëindigen.

Vertrouwelijkheid van informatie

Alle informatie die in het kader van dit onderzoek wordt verzameld, wordt als strikt vertrouwelijk behandeld. Alle gegevens worden in anonieme vorm verwerkt en bewaard. Er zal voor worden gezorgd dat onbevoegden er geen inzage in krijgen en ook dat de gegevens niet tot personen zijn terug te leiden. Dit onderzoek wordt gecoördineerd door Myrthe Wildeboer (m.wildeboer.2@umail.leidenuniv.nl). Indien u vragen heeft over dit onderzoek kunt u dat met haar bespreken.

Klachten

Indien u vindt dat u onjuist bent geïnformeerd over dit onderzoek, of klachten heeft over de uitvoering of bejegening tijdens dit onderzoek, verdient het aanbeveling dit te bespreken met de onderzoeker of met de coördinator van het onderzoek. Indien u dat niet wilt, of indien dat geen oplossing geeft, kunt u ook een klacht indienen bij bestuur van het instituut LUCL. Onderaan vindt u de contactgegevens.

Toestemmingsverklaring

Voor deelname aan het onderzoek hebben wij vanzelfsprekend uw toestemming nodig. Als u bereid bent om mee te doen, kunt u dit op het hier bijgevoegde toestemmingsformulier aangeven.

Contact informatie

Onderzoeker: Myrthe Wildeboer
E-mail: m.wildeboer.2@umail.leidenuniv.nl

Leiden University Centre for Linguistics (LUCL):
Adres: P. N. van Eyckhof 3, NL-2311 BV, Leiden, Nederland
Telefoon: 071-5271662 (Gea Hakker, Instituut Manager)
E-mail: lucl@hum.leidenuniv.n

Appendix D – The consent form (in Dutch)

Leiden University Centre for Linguistics

Universiteit Leiden

Begeleider: Dr. M. Carmen Parafita Couto

Onderzoeker: Myrthe Wildeboer

Titel van het onderzoek: EEG-onderzoek naar tweetaligheid

Toestemmingsverklaring

Door dit formulier te ondertekenen geeft u te kennen de proefpersoneninformatie te hebben gelezen en dat u deze heeft begrepen. Verder geeft u door dit formulier te ondertekenen aan dat u akkoord gaat met de in het informatieformulier beschreven procedures.

U heeft het informatieformulier gelezen en begrepen en geef toestemming voor deelname aan het onderzoek.

Datum: …………………………. Plaats: …………………

Naam: …………………………… Handtekening: ………..

Appendix E - The background questionnaire in Dutch

Vragenlijst Deelnemer nr. ....

We zouden u erg dankbaar zijn als u ons de volgende achtergrond informatie wilt geven om ons te helpen met ons onderzoek.

1. Bent u: Man ☐ Vrouw ☐? **2. Leeftijd**:……………………………

3. Wat is op dit moment uw beroep (of als u met pensioen bent of werkloos, wat was het laatste beroep dat u hebt beoefend voordat u met pensioen bent gegaan of werkloos bent geworden)?

....

4. Geef alstublieft aan waar u voor langere perioden hebt gewoond:

v.b.: Plaats: *Willemstad, Curaçao* Data: *1982-1993*
Plaats: *Kralendijk, Bonaire* Data: *1993-1999*
Plaats: *Tilburg, Nederland* Data: *1999-2002 +*

Plaats: *Leiden, Nederland* Data: *2002-2005*

Plaats: ………………………………………… Data: ……………………………

Plaats: ………………………………………… Data: ……………………………

Plaats: ………………………………………… Data: ……………………………

Plaats: ………………………………………… Data: ……………………………

Plaats: ………………………………………… Data: ……………………………

Plaats: ………………………………………… Data: ……………………………

5. Vind u uzelf voornamelijk**…?**

☐ Curaçaoënaar
☐ Bonaireaan
☐ Arubaan
☐ Antilliaans
☐ Nederlandse
☐ Anders (geef a.u.b. aan wat):……………………………

6. Hoe zou u Papiamento als taal op een schaal van 1 tot 5 rangschikken volgens de volgende eigenschappen? Omcirkel één nummer in elke regel.

	←			→		
ouderwets	1	2	3	4	5	modern
onvriendelijk	1	2	3	4	5	vriendelijk
zonder invloed	1	2	3	4	5	invloedrijk
niet inspirerend	1	2	3	4	5	inspirerend
nutteloos	1	2	3	4	5	bruikbaar
lelijk	1	2	3	4	5	mooi

7. Hoe zou u Nederlands als taal op een schaal van 1 tot 5 rangschikken volgens de volgende eigenschappen? Omcirkel één nummer in elke regel.

	←			→		
ouderwets	1	2	3	4	5	modern
onvriendelijk	1	2	3	4	5	vriendelijk
zonder invloed	1	2	3	4	5	invloedrijk
niet inspirerend	1	2	3	4	5	inspirerend
nutteloos	1	2	3	4	5	bruikbaar
lelijk	1	2	3	4	5	mooi

8. In hoeverre bent u het eens met de volgende stelling:
"In alledaagse gesprekken houd ik de talen Papiamento en Nederlands gescheiden."

☐ **1** Geheel mee oneens
☐ **2** Oneens
☐ **3** Niet eens of oneens
☐ **4** Eens
☐ **5** Geheel mee eens

9. In hoeverre bent u het eens met de volgende stelling:
"Mensen moeten het vermijden om Papiamento en Nederlands met elkaar te mengen in hetzelfde gesprek."

☐ **1** Geheel mee oneens
☐ **2** Oneens
☐ **3** Niet eens of oneens
☐ **4** Eens
☐ **5** Geheel mee eens

10. Wat is uw hoogst genoten opleiding?
☐ Basisonderwijs
☐ MAVO/VMBO
☐ MBO
☐ HAVO
☐ VWO
☐ HBO
☐ Universitair – Bachelor

☐ Universitair – Master
☐ Geen

11. Vanaf wanneer kunt u Papiamento spreken?
☐ Vanaf dat ik 2 jaar of jonger was
☐ Vanaf dat ik 4 jaar of jonger was
☐ Vanaf de basisschool
☐ Vanaf de middelbare school
☐ Ik heb Papiamento leren spreken als volwassene

12. Vanaf wanneer kunt u Nederlands spreken?
☐ Vanaf dat ik 2 jaar of jonger was
☐ Vanaf dat ik 4 jaar of jonger was
☐ Vanaf de basisschool
☐ Vanaf de middelbare school
☐ Ik heb Nederlands leren spreken als volwassene

13. Op een schaal van 1 tot 4, hoe goed vind u dat u Papiamento kunt spreken?
☐ **1** Ik ken alleen een paar woorden en uitdrukkingen
☐ **2** Ik kan me met vertrouwen uiten in een basisgesprek
☐ **3** Ik kan me met wat vertrouwen uiten in uitgebreide gesprekken
☐ **4** Ik kan me met volle vertrouwen uiten in uitgebreide gesprekken

14. Op een schaal van 1 tot 4, hoe goed vind u dat u Nederlands kunt spreken?
☐ **1** Ik ken alleen een paar woorden en uitdrukkingen
☐ **2** Ik kan me met vertrouwen uiten in een basisgesprek
☐ **3** Ik kan me met wat vertrouwen uiten in uitgebreide gesprekken
☐ **4** Ik kan me met volle vertrouwen uiten in uitgebreide gesprekken

15. Welke taal (of talen) heeft uw moeder met u gesproken wanneer u aan het opgroeien was (indien van toepassing)?
☐ Papiamento
☐ Nederlands
☐ Papiamento & Nederlands
☐ Anders (geef a.u.b. aan welke)……………………………
☐ Niet van toepassing

16. Welke taal (of talen) heeft uw vader met u gesproken wanneer u aan het opgroeien was (indien van toepassing)?
☐ Papiamento
☐ Nederlands
☐ Papiamento & Nederlands
☐ Anders (geef a.u.b. aan welke)……………………………
☐ Niet van toepassing

17. Welke taal (of talen) heeft een andere voogd of verzorger met u gesproken wanneer u aan het opgroeien was (indien van toepassing)?
☐ Papiamento
☐ Nederlands
☐ Papiamento & Nederlands

☐ Anders (geef a.u.b. aan welke)……………………………
☐ Niet van toepassing

18. In welke taal (of talen) kreeg u voornamelijk les op de basisschool?
☐ Papiamento
☐ Nederlands
☐ Papiamento & Nederlands
☐ Anders (geef a.u.b. aan welke)……………………………………

19. In welke taal (of talen) kreeg u voornamelijk les op de middelbare school?
☐ Papiamento
☐ Nederlands
☐ Papiamento & Nederlands
☐ Anders (geef a.u.b. aan welke)……………………………………

20. Maak hieronder een lijst van vijf mensen waarmee u het vaakst mee in uw alledaagse leven spreekt, hetzij persoonlijk of aan de telefoon, bijvoorbeeld uw partner, uw kind, een vriend(in), een collega etc. Noteer daarbij welke talen u het vaakst gebruikt tijdens een gesprek met die persoon, zoals te zien in de voorbeeldtabel.

Naam van persoon of relatie	**Taal meest gesproken met die persoon: (plaats een vinkje in één vakje hieronder voor elke regel)**			
	Papiamento	**Nederlands**	**Zowel Papiamento als Nederlands**	**Een andere taal**
1. ***Jan***	✓			
2. ***Moeder***		✓		
3. ***Baas***			✓	
4. ***Janneke***				✓
5. ***Zus***		✓		

<u>Vul alstublieft onderstaand tabel in</u>

Naam van persoon of relatie (gebruik fictieve namen als u wilt)	**Taal meest gesproken met die persoon: (plaats een vinkje in één vakje hieronder voor elke regel)**			
	Papiamento	**Nederlands**	**Zowel Papiamento als Nederlands**	**Een andere taal**
1.				
2.				
3.				
4.				
5.				

Appendix F – The background questionnaire in Papiamento

Kuestionario Participante no............

Nos lo ta hopi buenagradesidu si señor(a) lo por duna nos e siguiente information di señor(a) su pasado pa yuda nos ku nos investigashon.

1. Shon ta: Homber ☐ Muhé ☐? **2. Edat**:……………….………

3. Kiko ta señor(a) su profeshon na e momentu aki (of si señor(a) ta ku penshon of si señor(a) ta desempleá, kiko tabata e delaster profeshon ku señor(a) tabata tin prome ku señor(a) a baha ku penshon of a bira desempleá)?

....

4. Por fabor indiká na unda señor(a) a biba pa tempu significante:
v.b.: Lugá: *Willemstad, Kòrsou* Fecha: *1982-1993*
Lugá: *Kralendijk, Bonèiru* Fecha: *1993-1999*
Lugá: *Tilburg, Hulanda* Fecha: *1999-2002*
Lugá: *Leiden, Hulanda* Fecha: *2002-2005*

Lugá: ………………………………………… Fecha: …………..………………

Lugá: ………………………………………… Fecha: …………..………………

Lugá: ………………………………………… Fecha: …………..………………

Lugá: ………………………………………… Fecha: …………..………………

Lugá: ………………………………………… Fecha: …………..………………

Lugá: ………………………………………… Fecha: …………..………………

5. Kon señor(a) ta sinti su mes prinsipalmente?
☐ Kurasoleño
☐ Bonerianu
☐ Rubiano
☐ Antiano
☐ Hulandes
☐ Otro (por fabor nombra kua)……………………………

6. Kon lo señor(a) pone Papiamento komo lenga riba un eskala di 1 te 5 sigun e siguiente karakterístikanan? Sirkulá un number riba tur liña.

	←			→		
antikuá	1	2	3	4	5	modèrnu
desagradabel	1	2	3	4	5	agradabel
sin influensha	1	2	3	4	5	influyente
sin inspirashon	1	2	3	4	5	inspirá
inútil	1	2	3	4	5	utilisabel
mahos	1	2	3	4	5	bunita

7. Kon lo señor(a) pone hulandes komo lenga riba un eskala di 1 te 5 sigun e siguiente karakterístikanan? Sirkulá un number riba tur liña.

	←			→		
antikuá	1	2	3	4	5	modèrnu
desagradabel	1	2	3	4	5	agradabel
sin influensha	1	2	3	4	5	influyente
sin inspirashon	1	2	3	4	5	inspirá
inútil	1	2	3	4	5	utilisabel
mahos	1	2	3	4	5	bunita

8. Den ki medida señor(a) ta di akuerdo ku e siguiente:
"Den kòmbersashon di tur dia mi ta tene e lenganan Papiamento i hulandes separá."

- ☐ **1** Mi no ta kompletamente di akuerdo
- ☐ **2** Mi no ta di akuerdo
- ☐ **3** Mi ta neutral
- ☐ **4** Mi ta di akuerdo
- ☐ **5** Mi ta kompletamente di akuerdo

9. Den ki medida señor(a) ta di akuerdo ku e siguiente:
"Hende mester evitá di usa Papiamento i hulandes den un kòmbersashon."

- ☐ **1** Mi no ta kompletamente di akuerdo
- ☐ **2** Mi no ta di akuerdo
- ☐ **3** Mi ta neutral
- ☐ **4** Mi ta di akuerdo
- ☐ **5** Mi ta kompletamente di akuerdo

10. Kua nivel di edukashon ta e nivel supremo ku señor(a) a gosa di dje?

- ☐ Enseñansa básiko
- ☐ MAVO/VMBO
- ☐ MBO
- ☐ HAVO
- ☐ VWO
- ☐ HBO
- ☐ Universidat – Bachelor
- ☐ Universidat – Master
- ☐ Niun

11. For di kua tempu señor(a) por papia Papiamento?
- ☐ For di mi tabata tin 2 aña of menos
- ☐ For di mi tabata tin 4 aña of menos
- ☐ For di enseñansa básiko
- ☐ For di skol sekundario
- ☐ Mi a siña papia Papiamento komo adulto

12. For di kua tempu señor(a) por papia hulandes?
- ☐ For di mi tabata tin 2 aña of menos
- ☐ For di mi tabata tin 4 aña of menos
- ☐ For di enseñansa básiko
- ☐ For di skol sekundario
- ☐ Mi a siña papia hulandes komo adulto

13. Kon bon señor(a) ta pensa señor(a) por papia Papiamento riba un eskala di 1 te 4?
- ☐ **1** Mi konose un par di palabra ku ekspreshon so
- ☐ **2** Mi por ekspresá mi mes ku konfiansa den un kòmbersashon básiko
- ☐ **3** Mi por ekspresá mi mes ku un tiki konfiansa den un kòmbersashon amplio
- ☐ **4** Mi por ekspresá mi mes ku hopi konfiansa den un kòmbersashon amplio

14. Kon bon señor(a) ta pensa señor(a) por papia hulandes riba un eskala di 1 te 4?
- ☐ **1** Mi konose un par di palabra ku ekspreshon so
- ☐ **2** Mi por ekspresá mi mes ku konfiansa den un kòmbersashon básiko
- ☐ **3** Mi por ekspresá mi mes ku un tiki konfiansa den un kòmbersashon amplio
- ☐ **4** Mi por ekspresá mi mes ku hopi konfiansa den un kòmbersashon amplio

15. Kua lenga(nan) señor(a) su mama tabata papia ku señor(a) ora señor(a) tabata kresiendo (si ta aplikabel)?
- ☐ Papiamento
- ☐ Hulandes
- ☐ Papiamento & hulandes
- ☐ Otro (por fabor nombra kua)……………………………
- ☐ No ta aplikabel

16. Kua lenga(nan) señor(a) su tata tabata papia ku señor(a) ora señor(a) tabata kresiendo (si ta aplikabel)?
- ☐ Papiamento
- ☐ Hulandes
- ☐ Papiamento & hulandes
- ☐ Otro (por fabor nombra kua)……………………………
- ☐ No ta aplikabel

17. Kua lenga(nan) señor(a) su vogt of kuidadó tabata papia ku señor(a) ora señor(a) tabata kresiendo (si ta aplikabel)?
- ☐ Papiamento
- ☐ Hulandes
- ☐ Papiamento & hulandes
- ☐ Otro (por fabor nombra kua)……………………………
- ☐ No ta aplikabel

18. Na kua lenga(nan) señor(a) a haña les durante di señor(a) su enseñansa básiko?
☐ Papiamento
☐ Hulandes
☐ Papiamento & hulandes
☐ Otro (por fabor nombra kua)……………………………

19. Na kua lenga(nan) señor(a) a haña les durante di señor(a) su skol sekundario?
☐ Papiamento
☐ Hulandes
☐ Papiamento & hulandes
☐ Otro (por fabor nombra kua)……………………………

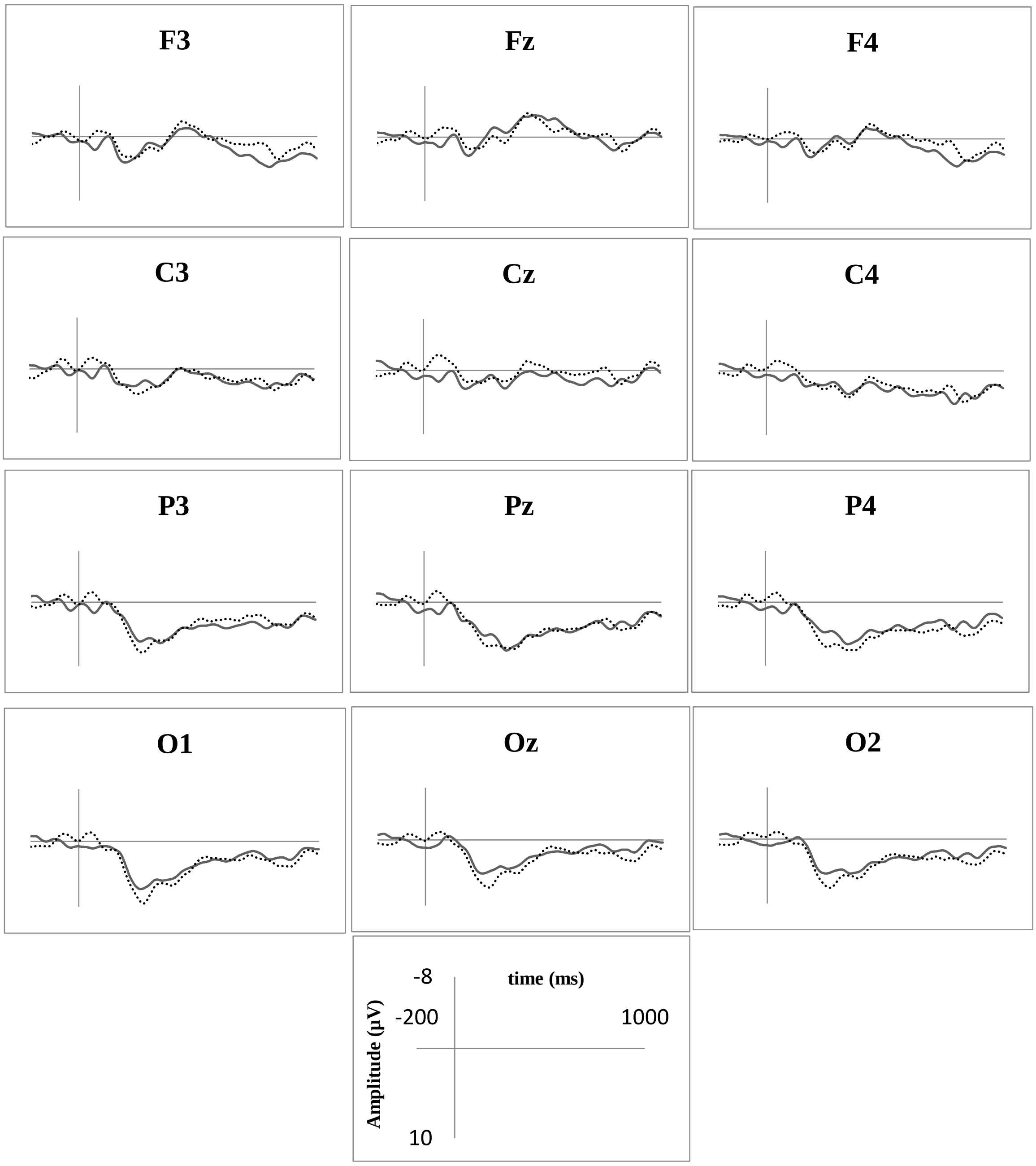
20. Traha un lista akibou di sinku hende ku señor(a) ta papia ku ne mas tantu den señor(a) su bida di tur dia, sea personalmente of na telefòn, por ehèmpel señor(a) su partner, su yu, un amigu/amiga, un kolega etc. Nota ku esei kua lenga(nan) señor(a) ta usa durante di un kòmbersashon ku e persona ei, manera den e tabèl di ehèmpel.

Nomber di persona of relashon	**Lengá mas papiá ku e persona ei: (marka e den e vak pa tur persona of relashon)**			
	Papiamento	**Hulandes**	**Tantu Papiamento komo hulandes**	**Un otro lenga**
1. ***Jan***	✓			
2. ***Moeder***		✓		
3. ***Baas***			✓	
4. ***Janneke***				✓
5. ***Zus***		✓		

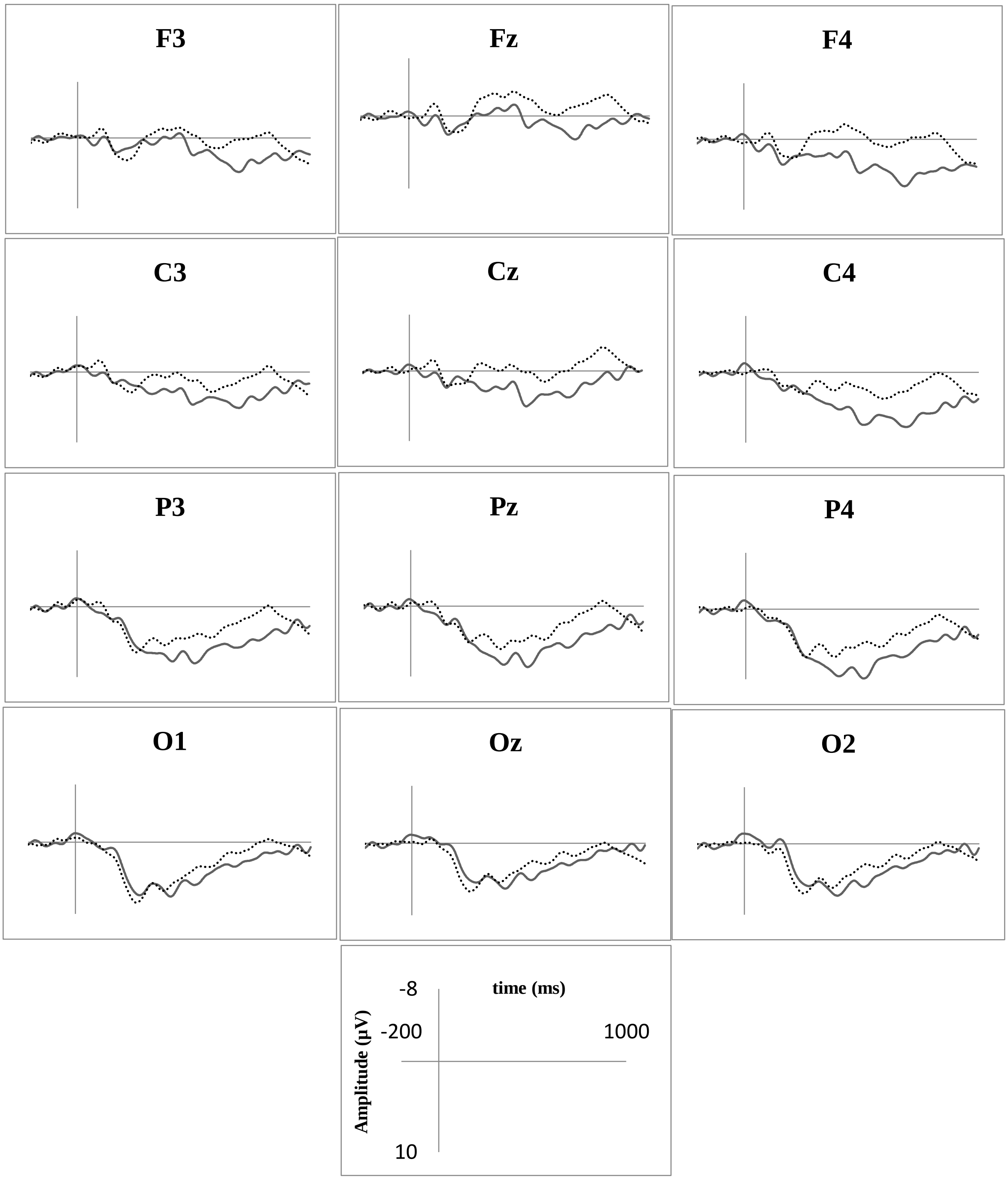
<u>Por fabor yena e tabèl akibou</u>

Nomber di persona of relashon (usa nomber fiktisio si ta nesesario)	**Lenga mas papiá ku e persona ei: (marka e den e vak pa tur persona of relashon)**			
	Papiamento	**Hulandes**	**Tantu Papiamento komo hulandes**	**Un otro lenga**
1.				
2.				
3.				
4.				
5.				

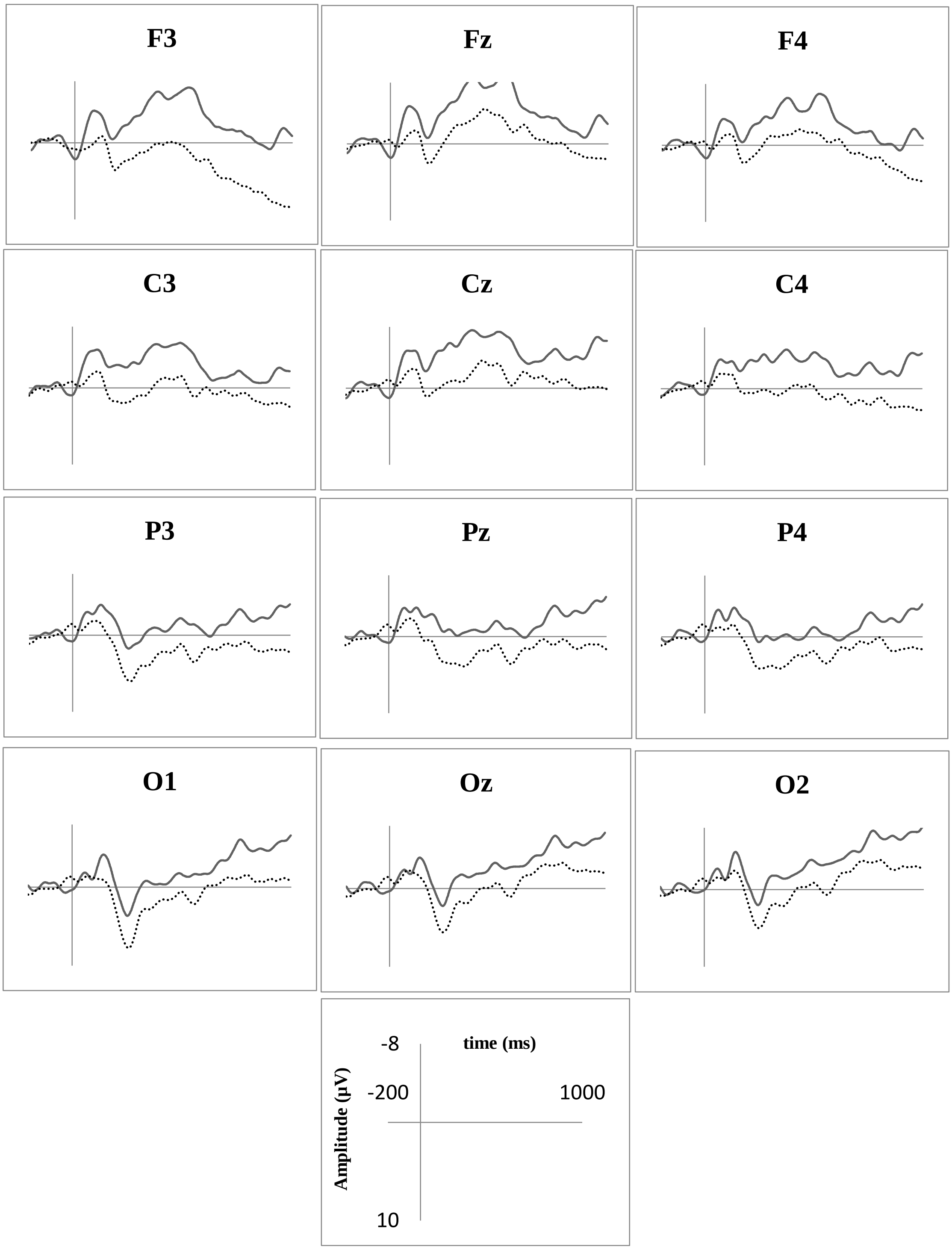
Appendix G – The Grand Average waveforms of the age-related analysis



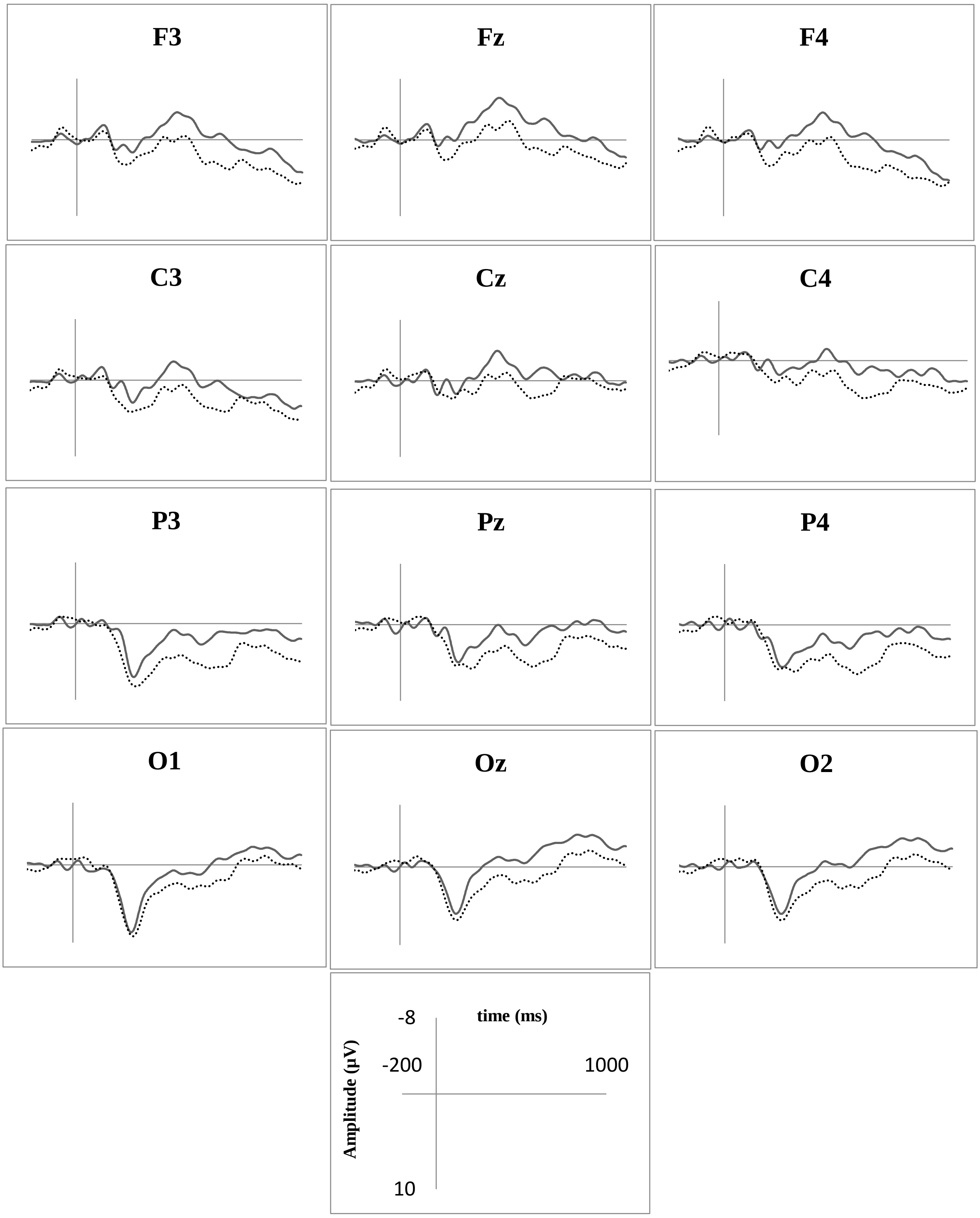
The grand average waveforms of twelve representative electrode sites for the MLF violation (dotted line) and its correct counterpart (solid line) of condition 1 (MLF+ / ML= Dutch/ Adj Dutch – Noun Pap) versus condition 7 (MLF- / ML=Pap / Adj Dutch – Noun Pap. Zero on the time axis marks the onset of the picture and color presentation. Electrodes are arrayed from most anterior (top) to most posterior (bottom) and from left to right as they were positioned on the scalp. Negativity is plotted up.



The grand average waveforms of twelve representative electrode sites for the MLF violation (dotted line) and its correct counterpart (solid line) of condition 2 (MLF+ / ML= Dutch/ Adj Pap- Noun Dutch) versus condition 8 (MLF- / ML=Pap / Adj Pap – Noun Dutch. Zero on the time axis marks the onset of the picture and color presentation. Electrodes are arrayed from most anterior (top) to most posterior (bottom) and from left to right as they were positioned on the scalp. Negativity is plotted up.



The grand average waveforms of twelve representative electrode sites for the MLF violation (dotted line) and its correct counterpart (solid line) of condition 5 (MLF+ / ML= Pap / Noun Pap – Adj Dutch) versus condition 3 (MLF- / ML=Pap / Noun Pap – Adj Dutch). Zero on the time axis marks the onset of the picture and color presentation. Electrodes are arrayed from most anterior (top) to most posterior (bottom) and from left to right as they were positioned on the scalp. Negativity is plotted up.



*The grand average waveforms of twelve representative electrode sites for the MLF violation (dotted line) and its correct counterpart (solid line) of condition 6 (MLF+ / ML= Pap / Noun Dutch – Adj Pap) versus condition 4 (MLF- / ML=Pap / Noun Dutch - Adj Pap. Zero on the time axis marks the onset of the picture and color presentation. Electrodes are arrayed from most anterior (top) to most posterior (bottom) and from left to right as they were positioned on the scalp. Negativity is plotted up.***t**