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Word Recognition in Predictive Contexts

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Abstract

Over the last years several results demonstrated that context-based expectations on both word-class and concepts influence the word processing at very early stages, namely at sensory analysis level. Given that these early effects are modulations of the process of stimulus analysis they depend on physical and orthographical properties of critical words in interaction with linguistic expectations. This evidence on early effects is in contrast with a syntax-first approach for which the cognitive system builds at first the syntactic structure by exploiting word-class information only. This strong syntax-first assumption pushed forward by Friederici (2002) model is based on a very early ERPs effect with latency around 150 ms that is elicited by word-class violations (eLAN: early left-anterior negativity).

I studied three linguistic violations with an ERPs sentence processing paradigm. In two studies in Italian word-class violations on prepositions and verbs were implemented, overcoming the more important methodological limitations of previous studies on word-class violations. In a third study we investigated determiner-noun gender agreement in Italian using nouns for which grammatical gender is expressed unambiguously by a long derivational morpheme, that is very salient at orthographic and visual level.

ERPs results show a LAN (300ms latency) followed by a P600 (500ms latency) for all the conditions. The lack of replicability of eLAN, already discussed in the literature, makes Friederici (2002) model difficult to be maintained. The ERPs elicited by gender disagreeing nouns also show an effect on the amplitude of the N250 (200ms onset), an effect specific to morphological processing since a previous study with no control on how gender was expressed reported a LAN+P600 pattern only (Molinaro et al., 2008). The latter result shows that gender agreement can affect word recognition (at least the morphological parsing) during sentence processing earlier than violation detection indexed by the LAN. This result enrich the evidence about early context top-down effects that are different from syntagmatic structural processing.

Chapter 1

General Introduction

1.1 Sentence Processing: an interactive and a modular perspective

As language unfolds a lot of different cognitive processes are quickly performed in order to interpret the message conveyed by the linguistic input. Analysis and integration processes are probably performed in less than 1s after a word onset, however, it is assumed that after just 250ms all the syntactic and semantic informations of the word are available to the cognitive system (Marslen-Wilson, 1975). The most influent models of sentence processing diverge in the definition of the mechanisms that underlie the incremental (word by word) comprehension and can be reconciled to two principal categories: interactive models and modular models. The main differences concern a) the order in which syntactic and semantic informations are exploited by the cognitive system and b) the characteristics of the interaction between syntactic structure building, word meaning access and message comprehension/interpretation. Interactive models (e.g. Johnson-Laird, 1977;

MacDonald, Pearlmutter, & Seidenberg, 1994) outline sentence comprehension mechanisms where syntactic and semantic analysis interact from the very early processing stages: syntactic and semantic information directly and simultaneously influence the comprehension of the message. These models do not assume the existence of specific and discrete processing stages in that these “stages” directly depend on the information locally available and on the language-specific constraints. On the other side, in modular models (Frazier & Fodor, 1987) sentence comprehension proceeds through independent stages, and, each of them must be accomplished before that the following one can take place. In the models it is proposed that mechanisms dedicated to syntactic and to semantic information analysis can interact only after that part of the syntactic informations are exploited (i.e. in a second processing stage). These models are thus also called syntax-first models of sentence comprehension.

Researchers use theoretic linguistic and general cognition mechanisms knowledge in order to identify the ERP an MEG correlate of specific operations that are assumed to be performed on-line during comprehension and outline neurocognitive models of sentence comprehension.

Findings of electrophysiological experiments conducted in the last 30 years shows that syntactic and semantic anomalies elicit qualitatively distinct ERP effects. These effects differ in multiple dimensions such as timing, polarity and scalp distribution.

Semantic anomalies elicit a negative component with centro-parietal distribution and peaking at about 400ms after critical word onset (Kutas & Hillyard, 1980, 1984; Osterhout & Nicol, 1999). For instance Kutas and Hillyard (1980) found that the amplitude of the N400 was dependent on the semantic appropriateness of that word in

the context. One example of the experimental sentences used by the authors is reported in (1). The manipulation (1b) contains a semantic anomaly and elicited an N400 with respect to condition (1a). Later studies found that, both in sentences and single word processing, the amplitude of the N400 depends on a variety of variables such as the frequency of use of a word, semantic nearness with a primed context and semantic system organization. The precise interpretation of the process underlying the N400 is still debated and two are the main perspective: lexical/semantic access effort and semantic integration difficulties (Federmeier, 2007). Until now the literature provides evidence for both these interpretations suggesting that both the processes affect the amplitude of the N400 (see Lau, Phillips, & Poeppel, 2008 for a recent review that suggests that multiple semantic sub-process that may underlie to the generation of this ERP component).

(1)

- a. It was his first day at work.
- b. * He spread the warm bread with socks.

Differently, syntactic anomalies elicit a positive component with broad and/or posterior distribution on the scalp arising at about 500ms after critical word onset (Hagoort, Brown, & Groothusen, 1993).

This component is referred to as the P600. An example of the experimental sentences used by Hagoort et al. (1993) is reported in 2). In sentences as (2) on the critical word arise a noun-verb number agreement violation.

(2)

a. Het verwende kind gooit het speelgoed op de grond.

The spoilt child throws the toys on the floor.

b. *Het verwende kind gooien het speelgoed op de grond.

*The spoilt child throw the toys on the floor.

The P600 follows every syntactic anomaly also in absence of a proper syntactic violation (De Vincenzi & Di Matteo, 2004) and it is assumed to index re-analysis / repair of the sentence structure. The P600 generally has two stages, a first stage between 500 and 700 ms (linked to the reanalysis of the structure) and a second stage after 700ms after critical word onset (linked to the repair of the structure). For a discussion on the functional interpretation the two stage of the P600 see Kolk and Chwilla (2007). However, several ERP studies recently reported P600 effects, without an accompanying N400, for sentences such as (3), which contained a semantic anomaly.

(3)

At breakfast the eggs would eat ...

For example sentences as (3), studied by Kuperberg, Sitnikova, Caplan, and Holcomb (2003), is semantically deviant because the verb "eat" requires an animate subject to assign the agent thematic role, but "eggs" is inanimate. This effect is called "semantic P600". Kim and Osterhout (2005) propose that this P600 may be elicited by a structural revision that is driven by semantic plausibility (a process they term "semantic attraction"). Namely, (3) could be reinterpreted in a passive form, where

"eggs" becomes the object of the verb "to eat" (i.e. "the eggs would be eaten"). This view is conservative with respect to P600 classic syntactic interpretation. Kuperberg (2007) proposes a slightly different explanation of "semantic P600" in which animacy feature is determinant in a thematic role processing stream that works in parallel with syntax and independently lead to the semantic P600 effect.

Frequently, syntactic mismatches elicit a biphasic pattern where the P600 is preceded by a negativity distributed on the left anterior recording sites arising at about 300ms after critical stimulus onset (Osterhout & Holcomb, 1992; Osterhout & Mobley, 1995; Gunter, Stowe, & Mulder, 1997; Coulson, King, & Kutas, 1998). The elicitation of this negative component, followed by the P600, has been found to be triggered by almost every morphosyntactic disagreement (see Molinaro, Barber, & Carreiras, 2011 for a review). The LAN is assumed by the most of the authors to indicate a difficulty in building the structure due to a syntactic mismatch (Hagoort, 2005; Friederici, 2002). An anterior negativity with earlier onset has been found in some case for word-class violations (e.g. Neville, Nicol, Brass, Forster, & Garret, 1991; Friederici, Pfeifer, & Hahne, 1993; Hahne, & Friederici, 1999; Hahne, & Jescheniak, 2001). Neville et al. (1991) recorded for the first time an early left anterior negativity (called eLAN in subsequent studies by Friederici) following a word-class violation. An example of the experimental sentences is in (4). In violation condition (4b) the preposition "of" is illegal in that structural position and elicit an eLAN with respect to the correct condition (4a).

(4)

- a. The Max's proof of the theorem.
- b. * The Max's of the proof theorem.

While the nature of the manipulations that elicit these components is generally constant across a variety of languages, presentation modalities and laboratories, their functional interpretation is far to be common shared (Osterhout, Mclaughlin, Kim, Greenwald, & Inoue, 2004). Different theoretical backgrounds, ERP components functional interpretations and experimental finding lead to a variety of neurocognitive models that roughly respect the distinction between interactive and modular model of sentence comprehension.

One of the most influent neurocognitive model that do not assume a modular architecture of language processor is described by Hagoort (2005). This model (Memory, Unification and Control: MUC, Hagoort, 2005) is a “lexicalist” model because it assumes that at lexical level is specified the “syntactic environment” of the word that allows to a correct structure construction. Syntactic constraints at lexical level are assumed to be specified with a three way syntactic tree specifying the possible structural attachments of the item. Semantic and pragmatic informations are processed in parallel to the structure building and are used to assign a semantically and pragmatically correct interpretation the structures that have multiple “lexical” syntactically correct configurations. In this model syntactic, semantic and pragmatic informations are assumed to be relevant at the same time and to simultaneously aid the comprehension processes and thus no discrete processing stages are assumed to be specific for different linguistic features.

Differently, a very strong functional interpretation of the reviewed ERP components lead Friederici (2002) to outline one of the most influent sentence processing model, reinterpreting in a neurocognitive perspective the modular model proposed by Frazier and Fodor (1987). This model assumes three processing stages,

and the output of each stage is the pre-condition for the beginning of the followings. In the first stage the syntagmatic structure is built using only word-class information of the word and specific syntactic rules of the language. In the second stage the syntactic analysis proceeds exploiting morphosyntactic informations in order to check the coreference of the lexical items and, in parallel, semantic elaboration processes combine the meaning of the words. In the third stage syntactic and semantic processes interact, and, if it is not possible a coherent interpretation of the sentence (of the part of the sentence until that word) the cognitive system attempts a revision and/or a repair of the sentence. Despite the fact that the Friederici (2002) model is detailed basing mainly on auditory studies, the Author maintains that the three stage architecture of sentence processing, and the relative ERP evidence, holds also for visual modality.

Several evidence attest an interaction between processing streams after 300ms after stimulus onset (e.g. Hagoort, 2003; Wicha, 2002; Gunter, Friederici, & Schriefers, 2000; Bentrovato, Devescovi, D'Amico, & Bates, 1999; Bentrovato, Devescovi, D'Amico, Wicha, & Bates, 2003; Kim & Osterhout, 2005; Kuperberg, 2007). However the most distinctive and discussed assumption of this model is the bottom-up and encapsulated nature of the first stage. The assumption that in the first 300ms after stimulus onset the cognitive system exploit the word-class in order to update the syntagmatic structure is based on the finding of the eLAN selectively for word-class violations. Some scholar (e.g Friederici, 2002) maintain that the eLAN has a special status with respect to the later linguistic components in that it has never been found to modulate in interaction with other linguistic ERP indexes. Moreover, words having both illegal word-class and either a semantic unexpected features or a

morphosyntactic anomalies elicit a “pure” word-class violation pattern, composed by an eLAN followed by a P600 (N400 blocking effect: Friederici, Steinhauer & Frisch, 1999 and LAN blocking effect: Rossi, Gugler, Friederici, & Hahne, 2006; Rossi, Gugler, Hahne, & Friederici, 2005). Based on this results the modular syntax-first models assume that the eLAN has a blocking effect on the other stages. These results are interpreted as an evidence that the building of the syntactic structure is a pre-condition for the effectiveness of other linguistic computations on the input (Friederici, 2002). Syntax-first neurocognitive models (the most influential described by Friederici, 2002) maintain that the timing of eLAN and its here described peculiar properties demonstrate that:

- word-class is always exploited by the cognitive system in a very early stage of word processing in order
- syntactic structure building is performed in the first 300ms with word-class information only
- the output of the syntagmatic structure updating is a pre-condition to proceed through the processing of other linguistic features and relative integration.

However several laboratories failed to consistently replicate the eLAN for word-class violation (e.g. Friederici, Hahne, & Mecklinger, 1996; Hagoort, Wassenaar, & Brown, 2003; Frisch, Hahne, & Friederici, 2004; Roehm & Haider, 2009; see Steinhauer, & Drury, 2012 for an exhaustive review) and the reliability of this interpretation have been strongly criticized. The criticisms addressed both the fact that the eLAN underlies processes purely related to categorical information and that the component is elicited by the manipulation on the critical word. The first two criticisms concern both visual presentation and auditory presentation studies while the

second criticism concern only those studies that found the eLAN with auditory presentation. Two of the most influent criticisms are:

- the eLAN could be due to spillover effects, i.e. large differences in the baseline due to differences in the processing of the previous word(s) (Osterhout et al., 2004). In fact, in classical studies that have reported an eLAN the word before the critical word varied systematically between the conditions. For example, in Neville et al. (1991) the critical word (*of* in 5) was preceded by a noun (*proof* in 5) in the correct condition (5a) and by a proper name with saxon genitive (*Max's* in 5) in the violation condition (5b).
- some acoustic studies on word-class violation (e.g. Rossi et al., 2005; Rossi et al., 2006) reported an eLAN with an onset in the 100-200ms interval but, the word-class marking morpheme (*-t* in example 6) was not yet presented at that latency. In these cases the eLAN effect can only be explained by spillover effects and/or differences in prosody due to the methodology used to create the violation in these connected speech paradigms (see Steinhauer & Drury, 2012 for an exhaustive review of methodological problems for the eLAN interpretation).

(5)

- a. The scientist criticized Max's proof of the theorem.
- b. * The scientist criticized Max's of proof the theorem.

(6)

a. Der Junge im Kindergarten singt ein Lied.

The boy in-the kindergarten sings a song.

b. * Der Junge im singt ein Lied.

* *The boy in-the sings a song.*

1.2 What is early

A peculiarity of the “linguistic” ERPs components related to the sentence level processing (as LAN, N400 and P600) is that their latency is not reported to be affected by lexical variables as word length or frequency of use. Indeed Van Petten (1995) have shown that word frequency affects the amplitude of the N400 while its peak is constantly at 400ms after stimulus onset. Likewise, there are no evidence in the literature that the syntax related ERP components (LAN and P600) variate in latency depending on lexical variables. The LAN in visual modality is always reported to onset at about 350ms (see Molinaro et al., 2011 for a review on disagreements) and the P600 is typically reported to onset at around 550 ms (for an overview see Osterhout et al., 2004).

The latency of the eLAN elicited by word-class violations is actually more variable, ranging between 0 and 200ms (see Friederici, 2002 for an overview). The fact that Friederici dubbed the eLAN with a different nomenclature with respect to LAN is due to the fact that despite eLAN latency variability there is no evidence that the eLAN should be considered “just” a LAN with an earlier onset since it was not possible to find a way (a paradigm) to show a continuity in LAN latency variation from 150ms to 350ms. This coarse and discrete latency variation, together with other properties that distinguish eLAN to LAN (e.g. capability to “block” semantic analysis by the eLAN only, in term of suppression of N400 modulations) justified Friederici to consider the eLAN a component with a different and independent functional interpretation than that of a LAN with just an earlier onset. However, as I reported in the previous section several criticisms have been moved to this component supporting

the hypotheses that it is an artifact due to methodological aspects (see Steinhauer & Drury, 2012 for a review). Basing on the criticisms moved to the eLAN by Osterhout et al., (2004) and Steinhauer and Drury (2012) Despite I agree with these criticisms, I believe that more experimental evidence are needed to exclude the reliability of the eLAN and as an index of structural mismatch (in the next experimental section of this thesis I report two experiments we run on word-class violation). With the exception of the complex topic of the eLAN all other syntactic and semantic anomalies give rise to ERPs effects that emerge in the same time interval, beginning roughly only after 300ms stimulus onset.

By contrast, reaction times (RTs) in behavioral studies have been consistently shown to vary as a function of both linguistic manipulations and lexical variables. Independently of linguistic manipulations RTs are longer for low frequency words and long words (see Just, Carpenter, & Woolley, 1982 for self-paced reading and, Reichle, Raynar & Pollastek, 2003 for eye tracking). In a functional perspective the dissociation between RTs variance and linguistic ERP components constant onset, arguably underlies the distinction between stimulus evaluation/classification processes (that implies activate its phonological, morphological, syntactic and semantic properties) and the integration of that stimulus within the preceding part of the sentence.

This view is also supported by studies on the P300 component. Kutas, McCarthy, and Donchin (1977) demonstrated that the P300 is related to stimulus identification/classification: the deeper is the processing required to evaluate/classify the stimulus the later is the onset of the P300, ranging from 300 to 1000ms. In a later study Polich and Donchin (1988), with an oddball paradigm , have shown that word

frequency affects the P300 latency: a later onset is reported for low-frequency compared to high-frequency words. This is another result suggesting that while the time required to evaluate/classify a stimulus (even a word) depends on stimulus variables, the cognitive system uses the extracted informations to update the syntactic and the semantic context starting at roughly 300ms after stimulus onset.

In the light of these considerations we argue that until about 300ms the cognitive system is engaged with stimulus analysis and only after this time limit, that may be considered a timeout at which the word level analysis should be completed for most words, the processes of proper integration with the context take place, as indexed by the LAN and the N400. In this perspective context effect preceding the 300ms limit are arguably a top-down modulations of the stimulus analysis processes. Several evidence of context effects others than eLAN before 300ms are reported in the recent literature on sentence processing (e.g. Dikker, Rabagliati, & Pylkkänen, 2009; Dikker, Rabagliati, Farmer, & Pylkkänen, 2010; Dambacher, Rolfs, Göllner, Kliegl, & Jacobs, 2009; Kim & Lai, 2012; see next section of this thesis for an overview). Before this “integration stage” (beginning with LAN and N400 onset) the ERP effects can thus depend on linguistic manipulations but, as these effects are modulations of stimulus processing, the linguistic features are mediated by orthography, phonology and morphology. It follows that those effects, that I will call “early effects”, should have peculiar properties different from those of “integrative effects”. The first is that the early effects must have a latency smaller than 300ms. The second is that the effect should be a modulation of brain activity addressable to stimulus processing as visual analysis or lexical access, but not to sentence level syntactic or semantic processes (as, instead, LAN and N400 are). The third is that the elicitation of an early effect of

context based on linguistic constraints/expectations would depend on how a linguistic feature is expressed on the critical word, because early effects are modulations of stimulus analysis processes. In other words given a predictive context, that may imply expectations and/or constraints, early effects should rely on a top-down mechanism that matches expected linguistic features and the properties of the stimuli that are relevant for these features. What is the representational level at which expectations and constraints can interact with stimulus analysis is surely an important aspect of sentence processing that should be inquired in the future. So far, the ERP and MEG experiments reporting early effects of context found a modulation of the stimulus visual analysis (Dikker et al., 2009; Dikker et al., 2010; Dambacher et al., 2009; Kim & Lai, 2012). Whether this mechanism is a anticipatory pre-stimulus activation of expected features or a post stimulus fast feedback mechanism is an open issue.

1.3 Top-down influence of the context

Context based expectations have effects on sentence processing in terms of facilitation for the expected material both in recognition and in integration. Whether these effects are due to top-down mechanisms or to bottom-up integrative facilitation is a question under debate since a long time (see Federmeier, 2007 for an overview on the integrative/anticipatory interpretation of the N400). For instance, it seems particularly difficult to discern between the two different interpretations especially for the effects arising at the LAN/N400 stage, because integration operations are assumed to be overtly at work. Facilitation effects can clearly arise also before 300ms, when stimulus identification processes are going on. These early effects of context on word recognition processes clearly have a top-down component in their underlying mechanisms. In the following part I will report the early effects reported in the recent literature.

1.3.1 Early Effects

Dikker et al. (2009) and Dikker et al. (2010), with a sentence comprehension paradigm in visual presentation, found increased MEG activity in visual areas just 100ms after the onset of words violating the expectation on the word-class. Latency and topography of the effect are consistent with the hypothesis that it is a modulation of amplitude of the M100, an exogenous MEG visual component. Crucially, this effect was present only when the violation took place on words showing typical visual characteristics (morphemes or typical orthographic patterns) of their word-class.

Dikker et al. (2009) found this effect only when the critical word showed the final morpheme “-ed” (example in 7) and when the violation took place on a preposition (example in 8, the experimental material was the same of Neville et al., 1991). The authors argued that both prepositions and “-ed” suffixes are closed class morphemes short, frequent and strongly indicative of the word-class. The effect on the M100 amplitude was absent when the expectation was violated by a word that didn't show any morpheme strongly indicative of the word-class (as in example 9). As authors underlined, it should be noted that sentence (7b) does not consist in an outright word-class violation because a grammatical continuation is possible (as “The discovery was in the reported *interview* ...”). Cloze-probability pre-tests attested however that the grammatical continuation (i.e. a participle in critical position in sentences as 7b) is very unpreferred and thus violation condition consist in a “highly unexpected word-class” condition.

(7)

- a. The discovery was reported ...
- b. *The discovery was in the reported ...

(8)

- a. The boys heard Joe's stories about Africa.
- b. *The boys heard Joe's about stories Africa.

(9)

- a. The discovery was in the report ...
- b. *The discovery was report ...

In Dikker et al. (2010) the authors exploited the concept of typicality described by

Farmer, Christiansen, and Monaghan (2006). The typicality was defined by Farmer et al. (2006) on the basis of a probabilistic analysis of the distribution of phonological patterns across nouns and verbs. Items that have phonological patterns primarily shared by items of their word class are defined as typical-items whereas items that do not show phonological patterns mostly shared by items of their word class are defined as non-typical items.

Defining typicality in this manner the Authors obtained typical nouns, typical verbs, non-typical nouns and non-typical verbs. The experimental material in Dikker et al. (2010) was built to compare word-class expectations violation on nouns typical of their word-class as *soda* (example in 10) with violations on nouns non-typical of their word-class as *infant* whose phonological pattern is more similar to that of verbs (example in 11). Results of Dikker et al. (2010) showed an M100 amplitude effect for violation occurring on typical nouns (10.b) but not for violations occurring on non-typical nouns (11.b).

(10)

- a. The tasteless soda ...
- b. *The tastelessly soda ...

(11)

- a. The cute infant ...
- b. *The cutely infant ...

In a subsequent study, Dikker, & Pykkänen (2011), showed a similar effect for violations of expectations on specific lexical items. In this experiment, the authors manipulated, in a picture/word matching paradigm, the matching between a DP

(determiner phrase) and a previously presented image. Moreover the images were half predictive for a specific lexical item (e.g. the “tomato” in the example Fig1) and half predictive for a semantic category (e.g. the “shopping bag” in the example Fig1). The effect on visual areas (M100 amplitude modulation) was present only when the word violated expectations on a specific lexical items, but not when all the elements of a specific semantic category was likely to appear (examples and results are summarized in Fig.1).The authors formulated the Sensory Hypotheses, according to their studies reporting a modulation of the amplitude of the M100 and to the knowledge about the functional interpretation of this component. In the Sensory Hypotheses is proposed that the cognitive system, whenever possible, generates sensory anticipations of the typical physical features of the expected material.

Tarkiainen, Helenius, Hansen, Cornelissen, and Salmelin (1999) found that letters and symbol strings evoke an M100 of the same amplitude thus showing that this component is not sensitive to the lexical status of the stimulus. By contrast, the amplitude of this component correlates with features of the stimulus such as complexity, number of items and degradation leading Tarkiainen et al. (1999) to the conclusion that the activity underlying the M100 is linked to low-level visual processing such as extraction of borders and contrast. In the Sensory Hypotheses the typical subletteral features of expected material are assumed to be relatively more activated than those of unexpected material, the unexpectedness M100 effect would thus index the reactivation of typical subletteral features of the unexpected material.





+ / - PRED	PICTURE (900 ms)	NOUN PHRASE (300 ms on/off)	+ / - MATCH	# of items
+ prediction for specific word (form)		+ the apple	+ MATCH	BLOCK 1: 80 BLOCK 2: 80
		+ the apple	- MATCH	BLOCK 1: 80 BLOCK 2: 80
- prediction for specific word (form)	 [any food/drink item]	+ the apple	+ MATCH	BLOCK 2: 80
	 [any animal]	+ the apple	- MATCH	BLOCK 2: 80

Fig 1. Figure adapted from Dikker et al. (2011). The four conditions in Dikker et al. (2011) are shown for the target word "apple". The first two rows depict the specific item predictive pictures, first row in match (apple -> apple) and second row in mismatch (banana -> apple) condition. The last two rows depict the semantic category predictive pictures, first row in match (any food/drink item -> apple) and second row in mismatch (any animal -> apple) condition.

For example, in the experiments on word-class expectation violation (Dikker et al., 2009; Dikker et al., 2010) the effect is present only when the violation occurs on a word that shows typical features of its word-class (e.g. -ed in example 7 or more complex phonological cluster as defined Farmer et al., 2006 in example 10) which must be reactivated during its visual analysis. As regards the violation of specific lexical item expectation (Dikker et al., 2011) all the physical characteristics of the stimulus can be represented at the sensory level (because a specific item is highly expected), the M100 effect thus indexes the reactivation of the physical features of the unexpected word that were less active than those of the expected word. No effects were found when a whole semantic class was expected because in this case, according to

Dikker et al. (2011), no typical phonological clusters and/or physical features are shared by items of the same semantic class and then, any items can be “typical” or “non-typical” in a sensory definition.

Other laboratories reported sensory effects for violations of different linguistic expectations during sentence processing, in different languages and with different presentation modalities supporting the finding that visual analysis can be affected by the sentence context (Hagoort et al., 2003; Dambacher et al., 2009; Herrmann, Maess, Hasting, & Friederici, 2011; Kim & Lai, 2012).

Hermann et al. (2011) reported a very early sensory effect for word-class violation during acoustically presented sentences in German. Hagoort et al. (2003) reported early sensory effects for word-class violation in Dutch with visual presented sentences. Dambacher et al. (2009) in a sentence comprehension paradigm with visual presentation in German found a visual analysis modulation depending on the predictability of an upcoming lexical item (measured with Cloze Probability tests). Finally, Kim and Lai (2012) found early visual activity modulation for pseudo-words compared to expected words depending on the orthographic similarity between pseudo-words and expected word. Example of the experimental material is reported in (12). Compared to expected words (as *cake* in 12a) orthographically similar pseudo-words (as *ceke* in 102) elicited an enhanced P130 while orthographically dissimilar pseudo-words (as *tont* in 12c) elicited an enhanced P170.

(12)

- a. She measured the flour so she could bake a cake...
- b. *She measured the flour so she could bake a ceke...
- c. *She measured the flour so she could bake a tont...

The results here reported on the early effect of context on word recognition are clearly indicative of a top-down influence of the context on word recognition. More precisely these early effects are indicative of a top-down effect of syntactic and semantic context on sensory word analysis. However it is unclear whether a proper sensory anticipation or a feedback between sensory areas and higher levels is responsible for the observed sensory analysis modulations.

One hypothesis that account for early effects of context assumes low level anticipations is the Sensory Hypotheses (Dikker et al., 2009; Dikker et al., 2010; Dikker et al., 2011). However, explanations for early effects can rely on fast-feedback mechanisms and then, possibly, even in absence of effective pre-stimulus anticipations (imagery of visual properties of the expected word forms). Top-down influence of context can be realized pre-stimulus (with anticipations), post-stimulus (with feedbacks) or as a combination of these two mechanisms. The combinations of anticipations and feedbacks implies that expectations are represented at a higher level (with respect to sensory analysis level) and exert a top-down influence on sensory analysis only after that the stimulus is perceived (this is similar to the reverberation account explained by Kim & Lai, 2012).

Whether the cognitive system is really able to represent expectations at sensory level or the early effects of context on word recognition are due to fast feedback mechanisms/reverberations (either purely or accompanied with higher level anticipations), is surely an important question to investigate. For instance, despite theoretical and methodological critical arguments (see Staub & Clifton, 2006 introduction for an overview), a growing number of experimental evidence are demonstrating that during sentence comprehension the cognitive system use the

sentence context, and wider knowledges, to anticipate several feature of the incoming input at different levels of representation (e.g Federmeier & Kutas, 1999 for conceptual anticipation; Otten, Nieuwland, & Van Berkum (2007) for lexical anticipation). In the next section I review the most important recent study on anticipation in the attempt to depict the different level of representation at which an expectation can be represented, and the nature of the informations that the cognitive system exploits to generate the expectations.

1.3.2 Anticipations

To understand the study of mechanisms underlying the anticipations is important to take into account the role of constraints, expectations and priming. In an interactive approach, constraints are restrictions on the well-fitting range of inputs defined as basing on semantic, compositional and syntactic principles, pragmatics and world knowledges applied to the sentence context. The more are the restrictions, the more constraining is the context and the more predictable is the upcoming material (Elman, 1990, 1993; Levy, 2008; Altmann & Mirkovic, 2009). Differently, in a more modular point of view there are restrictions based on syntactic structure constraints whose are proper requirements of the context and, expectations based on non probabilistic computations and semantic or pragmatic combination (e.g. Staub & Clifton, 2006; Vespignani, Canal, Molinaro, Fonda, & Cacciari, 2009). However, in the domain of incremental comprehension of language, not all the constraints are of the same nature and, at least at a theoretical linguistic level, this hold also given different modular and interactive sentence processing models. Despite these distinction between theoretical

approaches, every linguistic environment can be considerate predictive in that it impose syntactic and semantic restrictions on the upcoming material.

Given a predictive context the cognitive system may develop expectations on a wide range of properties of the incoming material whose can be realized in anticipations. Anticipations are activations of (or part of) representations of the upcoming stimuli in terms of syntactic structures or lexical, semantic, pragmatic constructs before the perception of any stimulus that can directly induce this activation in a bottom-up manner. To realize an anticipation then implies that, given a predictive context, the cognitive system is able to create pre-activations, in a top-down manner, as a function of the developed expectations. The researches and the debate on anticipation focalized mostly on two aspects of such phenomenon: the nature of the informations that origin the expectations and the representational level of the anticipations.

As studies were conducted in different languages, with different experimental paradigms and approached from different theoretic perspectives, the conceptualization of mechanisms responsible for anticipations is still a puzzle of apparently different manifestations. Whether there is just one mechanism underlying anticipations (for a more probabilistic interactive view, see Levy, 2008) or different mechanisms are responsible for a variety of anticipatory ability (for a more modular view, see Staub & Clifton, 2006) is an open issue.

Following this definition of anticipation in language processing a distinction is necessary to another context facilitatory phenomenon, called priming. Priming is the facilitatory effect of previous processed material on the processing of a critical item. The priming effect is revealed by either behavioral and psychophysiological results

and it is assumed to be due to residual (eventually spread) activation of the previously processed material (called prime). Such priming effect can occur at different stages during the processing of the stimuli (see McNamara, 2005 for a review on word priming). As regard to word priming during sentence comprehension, a semantically expected input can actually be in part pre-activated by residual/spread activation of the preceding words, activations derived from semantic combination of preceding words, analogies or associations. During sentence processing priming can actually affect the processing and integration of a word but this phenomenon differs from anticipations in that priming does not require a top-down influence from higher representational levels. It is only a byproduct of residual activations induced by the elaboration of the precedent stimuli. Priming, more than a anticipatory mechanism based on the exploitation of ongoing context-based expectations, can be better explained as the result of how informations are stored and structured in the brain. The question of priming have then an important role in the interpretations of effects in predictive contexts not only with respect to semantic processing (see syntactic priming, Pickering & Ferreira, 2008). Given that priming effects have been attested for several stimulus properties but less consistently in comprehension for syntactic structures, in predictive contexts the effects of unexpected inputs do imply an integrative account, but, only for stimulus idiosyncratic expectations (as meaning), but see Otten et al. (2007) for evidence of truly pragmatic anticipation of meaning during sentence comprehension that can not be explained just in terms of priming. Overall, for effects that correlate to structural expectations (as word-class) it is also more likely to assume some sort of anticipation, given the weak evidence of structural priming in comprehension (Pickering & Ferreira, 2008).

In the following sections I will try to clarify the state of the art in the research on anticipation during sentence processing discussing representative experiments divided in: the phrase-marker anticipation, the conceptual anticipation and the lexical anticipation.

Phrase-marker

The question addressed in this section is whether the parser does enter nodes in the phrase-marker (syntactic structure) before any directly input corresponding to that node. Several theories (since Frazier & Fodor, 1978) suggested that the parser is able to build minimal structures in advance. As reported above, an effect for the violation of a grammatical constraints compared to a correct condition is difficult to address to anticipation delusion and not to a bottom up structure updating difficulties. Because of this reason, experiments looking for anticipatory nodes in the phrase-marker evaluated the cognitive system response while reading preferred compared to unpreferred structures. In experiments build with this paradigm both conditions fit the sentence structure without any integration difficulties. Any facilitatory effects can only index that the corresponding structure fragment (or node) was pre-activated.

An exemplar study addressing this question is by Staub and Clifton (2006). The authors followed Frazier and Fodor (1978) in noting that sentences with the word *either* provide a useful context in which to explore both the question of whether syntactic predictability facilitates processing in general and the question of whether it helps readers or listeners to avoid being garden-pathed.

When a reader or listener encounters *either*, it is possible to anticipate a structure in which two constituents are joined by the connective *or*. Crucially, a structure in

which two constituents are joined by the connective *or* is grammatical also when *either* is absent. The word *either* make the conjunction with *or* just more predictable, and thus easy to parse, but not more grammatical.

Eye movements were monitored as participants read sentences where two noun phrases (NP-coordination) or two independent clauses (S-coordination) were connected by the word *or*. The word *either* could be present or absent earlier in the sentence.

Results shown that when *either* was present, the part of the sentence following *or* was read more quickly across both sentence types (NP-coordination and S-coordination). The authors interpret the results as indicating that the word *either* induced the cognitive system to anticipate a coordination structure. This pre-activation facilitated the processing of this structure when it was finally presented.

These results support parsing theories according to which the parser can anticipate expected syntactic fragments before encountering any lexical input that can induce its representation.

Concepts

An experimental difficulty in the researches on the anticipation of conceptual representations is the fact that a modulation itself of an effect (RTs, eye movements, ERP/MEG deflections) do not tell anything about anticipation. When a facilitation effect is found to depend on whether the critical word fits or not the semantic context the affected process can be either anticipatory or integrative. Moreover, effects that can be explained as a result of a spread or residual activation induced by operation on previous words or contextual meaningful material (e.g. any priming effect or some

visual word paradigm) can not be taken as evidence for anticipation mechanism.

As argued by Federmeier and Kutas (1999) an evidence that lead researchers to be sure that an effect underlies the effective conceptual anticipation of predictable material is that such effect correlates with the congruency between the critical word and the properties of the most expected, but not perceived input. Federmeier and Kutas (1999) demonstrated that, at least for the material they used, semantic fit of the critical word in the sentence context is not sufficient to explain the difference in the N400 amplitude elicited by expected and unexpected critical words. Federmeier and Kutas (1999) used predictive pairs of sentences (examples in 13) and manipulated the critical word in two different deviant conditions. In the within category condition (13b) the unexpected word shared the semantic category with the expected word (palms and pines are both trees). In the between category condition (13c) the unexpected word belonged to a different semantic category (as in example 13c, tulips are not trees).

(13)

They wanted to make the hotel look more like a tropical resort.

So, along the driveway, they planted rows of . . .

a. palms ..

b. *pines ..

c. *tulips ..

Even if the fit in the context (tropically plantable things) do not change between critical words (pines and tulips), results shown a larger N400 for the between category condition (tulips) than that for the within category condition (pines).

The results clearly indicate that the processing induced by the presentation of the critical word do not depend only on the congruency between critical word and context. Processing following the critical word depends also on the semantic similarity of the critical word to the most expected one (in the between category condition they are both trees). An effect due to the context only would have primed every tropical living (or even just plantable) things and then any difference between equally context-incongruent words should have been observed depending on whether they were trees or not. The amplitude of the N400 elicited by the critical word varied as a function of the overlapping semantic features between the strongest expectation and the critical word. The most expected concept “palms” must then be “anticipated” at least at a conceptual level.

Lexical Items

We have seen that cognitive system can realize pre-activations (anticipations) for expectations on nodes of the syntactic structure and on predictable concepts. These two kind of anticipations however do not imply that a specific lexical entry is pre-activated. For example Federmeier and Kutas (1999) demonstrated that semantic features of the concept *palms* were pre-activated, but there was no evidence whether this anticipation regarded lexical and syntactic properties of *palms* or not.

Various Authors (e.g. Wicha, Moreno, & Kutas, 2004; Van Berkum, Brown, Zwitterlood, Kooijman, & Hagoort, 2005; Otten et al., 2007; DeLong, Urbach, & Kutas, 2005) used a paradigm similar to that used by Federmeier and Kutas (1999) to explore the extent to which a conceptual anticipation is also realized in a lexical pre-activation.

Wicha et al. (2004) exploited a property of Spanish language to inquire whether grammatical gender informations of a predictable word was pre-activated. As grammatical gender is assumed to be expressed at lexical representation level its pre-activation would index that anticipations is specified at lexical entries level. The Authors built sentences that induced strong context-based expectations on a specific lexical item, the expected word was preceded by a gender congruent (14a) or incongruent article (14b). At that point in the sentence both masculine and feminine articles were equally syntactically integrable in the preceding part of the structure. The article were congruent or incongruent only with the most expected word that was still to be presented.

(14)

a. El príncipe soñaba con tener el trono de su padre. El sabía que cuando su padre muriera podría al fin ponerse la corona por el resto de su vida.

The prince dreamt about having the throne of his father. He knew that when his father died he would finally be able to wear the [fem] crown [fem] for the rest of his life.

b. *El príncipe soñaba con tener el trono de su padre. El sabía que cuando su padre muriera podría al fin ponerse el corona por el resto de su vida.

The prince dreamt about having the throne of his father. He knew that when his father died he would finally be able to wear the [masc] crown [fem] for the rest of his life.

Waveforms elicited by the article showed a P600 for the expectation-incongruent condition compared to the expectation-congruent condition. This is a clear

demonstration that grammatical gender information relative to the most expected word was pre-activated before the word onset. This study has shown that, basing on the combination of words in the sentence, the cognitive system develops expectations for a lexical entry specified at lemmas level (in the Levelt et al., 1999 model of lexicon organization). Van Berkum et al. (2005) obtained similar results using adjectives as target words. The results showed a very early (150ms onset) broad distributed positivity for the adjectives mismatching with the gender of the most expected, but not yet presented, word.

Also Otten et al. (2007), with a similar paradigm, inquired expectations on grammatical gender. Otten et al. (2007), in addition, used a negation to modulate the effective “message” predictiveness of sentences maintaining the same “content-word priming” power. Results shown a frontal negativity in the 300-600 ms interval for the (expectation) mismatching adjective. The effect, however, was present only when the negation was absent, suggesting that anticipations are guided by the computation of the actual “message” and not just by semantic combination of single words. The Authors argued that “content-word priming” itself is not enough to develop such kind of lexical anticipations.

DeLong et al. (2005) exploited an English language property to probe whether lexical anticipations are specified even at lexeme level, including phonological informations of the expected word. In English, words beginning with a vowel require *an* as indefinite article while words beginning with a consonant require *a* as indefinite article. The Authors, as in the previous studies on grammatical gender, used sentences that induced strong expectations on a specific lexical item, the strongly expected word was preceded by a phonological congruent (15a) or incongruent article (15b).

(15)

a. The day was breezy so the boy went outside to fly a ...

[kite was highly expected]

b.*The day was breezy so the boy went outside to fly an ...

[kite was highly expected]

Crucially the two articles (*a* and *an*) are syntactically and semantically equivalent and, at their onset, they fit equally in the preceding part of the sentence. Their congruency is relative to the most expected, but not yet presented word phonology. Waveforms on the articles shown an N400 for the (expectations) incongruent condition compared to the (expectation) congruent condition. Results clearly demonstrated that expectations for a specific lexical entry can be specified at a phonological level.

The literature here reported on the lexical anticipation (Wicha et al., 2004; Van Berkum et al., 2005; Otten et al., 2007; DeLong et al., 2005) suggests that sentence context allows the developments of online expectations on specific lexical entries and, that the cognitive system is able to anticipate these expectations in enough detail to include grammatical gender and phonological properties. This is revealed by the congruity effect of the critical word (determiner or adjective) with an highly expected, but not yet presented, content word. While these results clearly shown that lexical properties of the most expected word were already pre-activated at the onset of the preceding word, the reported effects varied in topography, latency and polarity across experiments and thus different underlying mechanisms have been proposed.

Wicha et al. (2004), whose found a P600 on the determiner for gender expectations mismatch, suggested that different anticipation processes can underlie the effect whether the expected gender is a morphosyntactic property of the expected item or not. In fact, in a previous study, Wicha, Moreno, and Kutas (2003) found an N400 using the same experimental material of Wicha et al. (2004) but with the target being pictures instead of words. Wicha et al. (2004) argued that this difference can depend on the experimental requirements: when the target are words the gender properties are directly involved in the anticipated representation, while, when the target are pictures, more semantic and conceptual emphases is required. Another account is proposed by DeLong et al. (2005), whose found an N400 for the phonological expectations mismatching article. DeLong et al. (2005) argue that the, together with the most expected word, is anticipated also its matching article. In this perspective the mismatch at the article is lexical, and the anticipatory representation affect the lexical identification of the critical article. Finally, Van Berkum et al. (2005) suggests that “people can, at least under some circumstances, detect agreement violations involving an anticipated head noun”. Van Berkum et al. (2005) reported a broad distributed positivity at about 150 after that a gender expectations mismatching adjective was presented. This such early effect is similar in polarity and topography to the P600 generally reported for disagreements (see Molinaro et al. for a review on agreement violations). In this perspective the effect on the critical adjective is due to an attempt of an integration with the anticipated head noun. It remains however partially unclear why a disagreement with an anticipated (and not still presented) constituent should induce such an early disagreement effect compared to effects elicited by already presented words. Moreover the same early effect is not found by Wicha et al. (2004)

and Otten et al. (2007) in studies where the gender expectation mismatch arise in a determiner instead than on an adjective.

In sum, while it seems clear that the cognitive system do anticipate lexical items (and relative gender and phonological features) in highly predictive contexts, it is under debate the possibility that, different mechanisms can be involved in different contexts. With different contexts I mean different source of expectations (words semantic combination/message level), task demand (words/pictures target) and different critical items (determiners/adjectives).

A study on Italian idioms showed that distinct predictive mechanisms are implied whether the nature of the expectation is probabilistic or categorical (Vespignani et al., 2009). Idioms are stable multi-words expressions whose meaning is generally not derived with a combination of its single parts. An influent perspective on idiom comprehension is the Configuration Hypothesis (Cacciari & Tabossi, 1988). According to the Configuration Hypothesis idioms are processed word by word, as any other linguistic input, until enough syntactic and semantic information has accumulated to recognize the string as a specific idiom and than retrieve the multi-word expression from long term memory. The position in the expression where the idiom is recognized is named recognition point. Only retrieving the whole multi-word expression people understand the idiomatic meaning. Vespignani et al. (2009) argued that when an idiom is recognized the incoming input can be matched with the retrieved multi-word expression. In this case the expectation is not only probabilistically inferred by the preceding context, but predictability of incoming words is determined by the knowledge of the specific multi-word expression stored in long term memory. After the idiom recognition, the expectation on upcoming words

has also a categoric component (i.e. correct idiom recognition / incorrect idiom recognition).

Vespignani et al. (2009) compared ERP waveforms elicited by idioms (16a) with two correct but unexpected literal control conditions. The literal conditions diverged to the idiomatic condition in one case at the recognition point (16b) and, in the second case, at the word immediately after the recognition point (16c).

(16)

a. Giorgio aveva un buco_[RP] nello_[RP+1] stomaco quella mattina.

George had a hole in the stomach that morning.

[namely George was hungry that morning]

b. Giorgio aveva un dolore_[RP] nello_[RP+1] stomaco quella mattina.

George had a pain in the stomach that morning.

c. Giorgio aveva un buco_[RP] sulla_[RP+1] camicia quella mattina.

George had a hole on the shirt that morning.

Results showed that until the idiomatic expression is not recognized the predictability of words affects only the N400 amplitude (16b compared to 16a), revealing probabilistic expectation effect. After the idiom have been recognized, the difference between idiomatic condition and non idiomatic (less predictable) condition is also due to a P300 for the idiomatic condition (16c compared to 16a). The Authors argued that this result clearly demonstrate that different predictive mechanism operate during sentence comprehension depending on the probabilistic vs. categorical nature of the information source that lead to expectations.

1.4 Introduction to the Studies

As evident from the reviewed literature, context constraints and expectations of multiple nature play a role in the incremental sentence comprehension as soon as a word recognition begins and until its integration (Wicha et al., 2004; Van Berkum et al., 2005; Otten et al., 2007; DeLong et al., 2005; Federmeier & Kutas, 1999; Hagoort et al., 2003; Dambacher et al., 2009; Hermann et al., 2011; Kim & Lai, 2012; Dikker et al., 2009; Dikker et al., 2010; Dikker et al., 2011). On an other hand the classical earliest ERP effect of context, that is the eLAN for word-class violations, has undergone several criticisms and it is no longer a widely shared reliable index of syntactic structure building mismatches. In the studies that I report in the following chapters I studied the time course of both structural mismatches and gender agreement effects, three experiments directly addressed whether:

- the syntactic structure building in Italian elicit an eLAN
- outright word-class violations in Italian elicit an eLAN
- gender-marking derivational morphemes can allow the gender informations to be relevant at earlier processing stages than the LAN, namely during word recognition.

Chapter 2

Study 1

2.1 Introduction

Friederici (2002) argues that in the first 200ms after word onset the cognitive system exploits word-class information in order to update the syntactic structure of the sentence. Friederici (2002) underlies that word-class violations, whose induce a syntactic structure mismatch, elicit an eLAN. The eLAN is then interpreted as the ERP correlate of the first stage of syntax-first models. However, Friederici (2002) doesn't specify exactly what a word-class is. The Author refers in fact to word-classes in a vague way. Crucially, it should be noted that not only a rough difference between verbs, nouns and prepositions can induce mismatches in the syntactic structure, also a distinction within major lexical category can be crucial to successfully achieve a correct syntagmatic structure building. Verbs are the more clear example of this: not all verb forms are inflected for tense and since tense expression is assumed to be the head of a clause the fact if a verb is inflected or not clearly has a strong impact for the structure building of a clause. On the other side in particular contexts verbal forms

can occur as head of the NPs (phenomenon known as grammatical transcategorization, Gaeta, 2002) while other verbal forms can not. The informations that the cognitive system needs for updating the syntagmatic structure should then be detailed at a finer grained level. If within 200 ms from word onset the cognitive system exploits the informations relevant to syntagmatic structure updating it should be sensitive to the difference between fitting and unfitting verbal forms. Despite Friederici (2002) does not directly face the question I think that, after reading a determiner it is not so useful for the parser the information that the word is a “verb” in general but it would be extremely useful to gain as soon as possible if it is a verb in a finite or non-finite form.

With respect to the distinctions relevant to the syntagmatic structure of Italian NPs with nominalized verbal head we should detail the word-class information within verbs in a rather detailed way. For example computational taggers are able to distinguish verbs in a rather detailed way: the Italian version of the Tree Tagger probabilistic tagging method (Schmid, Baroni, Zanchetta, & Stein, 2007) encodes verb forms into different parts of speech tags (POS): all finite verbal forms are tagged as the same POS while infinitive, participle and gerundive forms are tagged as distinct POSs. The four different verbal POS indeed have different features that can be relevant and needed in a specific linguistic context: gender, number, mood, person, tense and aspect (Givòn, 1986).

This study on syntagmatic structure violation in Italian capitalizes on a principle that rules the behavior of NPs with nominalized verbal heads. In Italian, infinitive, gerundive and participle verbal moods (which are non-finite verbal moods) can all be nominalized and occur as noun heads.

With respect to agreement properties the NP heads need to agree in gender and number with the determiner. Participles and gerundive express themselves gender and number and they thus require a determiner to agree with these feature values. Differently, verbs in infinitive form do not explicitly express gender and number features and can not be inflected for gender and number in relation of the contextual constrains.

With respect to agreement, infinite forms of verbs always require a masculine determiner however it is not clear if this requirement has to be considered as a true agreement process since it is possible that verbs in infinite forms are defective with respect to the expression of number and gender and thus the masculine and singular determiner is chosen as a default, that has to agree with with an underspecified NP in terms of features.

Independently from the theoretical description of the phenomena and with respect to possible predictive function of parser it must be noted that in an unfolding noun phrase after a masculine determiner the (to appear) head can be a noun, a gerundive verb, a participle verb or an infinitive verb (as in 17a). Differently, when the determiner is feminine, only nouns, gerundives and participles are legal continuations (as in 17b). After a feminine determiner no verb in infinitive form can be integrated in the existent structure and no inflectional repair on the critical word is possible.

(17)

- a. il tavolo / dottorando / richiedente / cadere
- b. la tavola / dottoranda / richiedente / * cadere

Within the on-line study of sentence comprehension an outright syntactic violation

is distinguished from ambiguities and unpreferred continuation in that for a given word after a given prefix string of words no grammatical continuation is possible. A difference can be further drawn between structural violations and other, less severe, violations such as violations of lexical restrictions or of semantic and morphosyntactic (agreement) feature (De Vincenzi & Di Matteo, 2004). A structural violation can be operationally defined a violation for which not only the specific target word does not allow a grammatical continuation but for which also any other words of the same class in that position would rise a violation. Clearly this type of violations only can be detected on the basis of a partial lexical access that transmits the word-class information to the parser before full lexical access. According to Friederici (2002) the eLAN is elicited by this kind of violations when the system is able to early (within less than 200ms from the onset of the word) retrieve the relevant word-class information.

Only after a first structural check the morphosyntactic information of the target word is exploited (after about 300ms) and the agreement is checked. Friederici (2002) thus assumes that the structure updating is realized with word-class information only however, as outlined above, what a word-class really is underspecified in the model. Within this frame it is very likely that the infinite-verb word-class information is early available when parsing the word *scoccare* (stroke) in sentences as (18), given the fact that: a) infinite verb forms in Italian are explicitly morphologically marked with one of three 3-letters suffixes (-are, -ere, -ire) and b) this level of definition of word-class is more likely to be useful in structure building than the rough category of “verbs”.

(18)

a. *Allo* scoccare della mezzanotte la scarpetta scivolò giù dalle scale.

At the (m) stroke of midnight, the shoe slid down the stairs.

b. * *Alla* scoccare della mezzanotte la scarpetta scivolò giù dalle scale.

* *At the (f) stroke of midnight, the shoe slid down the stairs.*

In order to expect a LAN in (18b) with respect to (18.a) another hypothesis is necessary, namely that the parser during the first stage of Friederici (2002) model takes into account the gender feature of the determiner to constrain the possible legal structural continuations. In natural reading or during speech perception since determiners are typically short and frequent it is possible that the cognitive system has not enough time to fully exploit determiner properties before the NP head perception but in the typical serial visual presentation in ERP sentence reading experiments this is more likely to be possible. In sentence reading ERPs experiments words typically presented one at time with an SOA between 400ms and 600ms and thus, despite this presentation is rather unnatural and non fluent especially for determiners, the system has the necessary time to fully exploit gender information of determiner and to compute the syntactic restrictions on the following NP head.

To summarize, independently from the linguistic nature of the phenomena, but using a processing operational definition, the violation in (18b) at the verb *scoccare* is a structural violation. Structural violations should be processed in the first parsing stage of Friederici model (i.e. well before 300ms), thus expecting an eLAN if:

- word-class category in the model is detailed at the level that infinitive forms of verb are in a different class with respect to finite forms and other non-finite

forms (gerundive, participles) and the system is able to early detect this information as an outcome of a partial lexical access (before full access to the lexical property of the root of the verb)

- the system has the time to fully process the feature of a determiner (i.e. gender) and to compute the syntactic restrictions associated with them.

Given that these two hypothesis are very likely to be verified in a visual sentence reading ERP paradigm, we hypothesize that the pattern elicited by (18b) with respect to (18a), would be, in the frame of Friederici model, that of structural violations (an eLAN followed to a P600) rather than that of an agreement violation (a LAN followed to a P600).

2.2 Method

2.2.1 Stimuli and Lists

As first step to create the experimental sentences we chose 104 verbs in infinitive form. We avoided those infinitive verbal forms that have also a noun entry in Italian¹ to exclude that the manipulation induces a pure morphosyntactic disagreement (e.g. “mangiare” that means both “to eat” and “food” in Italian). 104 NPs containing a verb in infinitive form were created in correct condition as described above (i.e. NPs as “Allo scoccare” in 18a). Adjectives with neutral inflection (-e) were present in 15 of the critical NPs between the determiner and the verb in order to vary the material and make less predictable a violation immediately after a feminine determiner (e.g. “Il costante interrompere ...”, “The constant stop ...”). The 104 correct NPs have then been inserted in 104 semantically correct grammatical Italian sentences. With these 104 correct sentences we created 104 versions with a word-class violation condition changing the gender of the determiner (or of the complex preposition including the determiner). All the experimental sentences in both correct and violation condition are in the Appendix1.

1: This constraint in the material building is important for having an homogeneous set in the repair stage (P600) but, with respect to the eLAN hypothesis developed in the introduction it must be noted that all infinite verbs that can be fully used as a noun are masculine. Moreover, as all the verbs that can be used as nouns actually have a verbal morphology/orthography and declination, arguably only after a full lexical access (i.e. at the second stage) they can be recognized as verbs with a noun usage.

The position of the critical word and the structure of the host sentence were varied to prevent participants to develop specific expectations about the likelihood of encountering a violation in specific linear or structural positions. The linear position of the critical word in the sentence (i.e. the position of the nominalized verb measured in a linear word by word order) varied ranging from position 2 to position 10 and were never the last word of the sentence. The NP containing the manipulation is 76 times in the object and 28 times in the subject phrasal position.

Each participant has been presented with one of two lists containing the 104 sentences, half in the correct and half in the violation condition, intermixed with other 208 filler sentences. Of these 208 sentences a quarter contain the word-class violation on the preposition described in the experiment 2, a quarter contain a grammatical gender agreement violation described in the experiment 3, and half are correct. Overall half of the sentences were correct and half were ungrammatical. The conditions were counterbalanced across two lists following a latin square design. Two pseudorandom orders of presentation was created for each list giving rise to four experimental lists.

2.2.2 Participants

35 right-handed Italian native speakers with no history of neurological disease participated as volunteers in the experiment. Nine participants were excluded from the analysis because more than 50% of the epochs were rejected from the analysis because of EEG artifacts (see below). Mean age of the remaining 26 participants was 24 years (ranging from 19 to 38) and 17 were female.

2.2.3 Procedure

The experiment took place in a silent and electrically shielded room. Participants were seated in front of a PC monitor and they were instructed to silently read for comprehension and minimize eye blinks, facial and body movements. They were asked to perform an acceptability judgment task: after the end of each sentence they were asked to judge if the presented sentence was grammatical in Italian or not. The lists were split into 4 blocks preceded by a short practice sentences. After the practice they could ask clarifications about the task and procedure and between blocks participants could take a break. Participants were presented with a fixation cross in the center of the monitor and asked to press the bar space to start each trial. Sentences were shown word by word in the center of a monitor with 600 ms SOA: every word was displayed for 300 ms in white font on a gray background and followed by a 300ms blank display. The total time of a session was approximately two hours, including montage of the EEG cap and debriefing.

2.2.4 Data Recording

Electroencephalogram (EEG) was continuously recorded from 29 active sites placed according to the 10-10 positioning standard (10-10 system; A1, A2, Ve1, Ve2, T7, T8, FP1, FP2, F3, F4, F7, F8, F9, F10, Fz, FC5, FC6, C3, C4, Cz, CP5, CP6, P3, P4, P7, P8, Pz, O1, O2), 25 of them were mounted with the aid of an elastic cap and 2 placed below the eyes (Ve1, Ve2) to monitor eye movements and blink (distribution of the electrodes on the scalp is reported in Tab1). The impedance was lowered under 10KOhm. Each electrode was referenced to the left mastoid and ground placed

anterior to Fz. The EEG signal was recorded with a BrainAmp system (BrainProducts, München). A low-pass filter with a cutoff frequency of 80 Hz and an high pass filter with a 10s time constant was applied before digitalizing at a sampling rate of 250Hz. Data were off-line rereferenced to average of the two mastoids and filtered with a low pass filter with cutoff frequency of 0.0318 Hz (time Constant 5 s, 24 dB/oct) and an high pass filter with 40.0000 Hz (24 dB/oct sec) of time constant. Epochs in the interval between 300 ms before to 900 ms after each critical word have been extracted and a baseline correction was performed by subtracting the mean voltage amplitude of the [-200ms interval to each waveform (e.g. channel and epoch). Two differential channel were offline computed: Veog as the difference between the average of Fp1 and Fp2 and the average of Ve1 and Ve2, and Heog as the difference between F9 and F10. Epochs whose signal amplitude exceeded the -100,100 μ V amplitude interval within the whole epoch for at least one channel were rejected (-30,30 μ V for electrooculogram).

Artifact free epochs in Verb correct and violation condition.

After the two stages automatic artifact rejection procedure 9 participants for which remained less than 50% of epochs in one of the two conditions were not considered in further analysis. With respect to the remaining 26 participants the mean number of artifact free epochs used in the further analyses were 87% for the correct condition and 83% for the violation condition.

2.2.5 Statistical Analyses

Single trial epochs were averaged for each subject and condition obtaining single

subject waveforms that were separately averaged for each condition in order to obtain the grandaverage plots used for qualitative analysis. On the basis of qualitative inspection of grandaverage we selected the time intervals for which an ANOVA on the mean amplitude was computed. The ANOVAs have been performed on the mean amplitude of the 18 electrodes and considering four factors: grammaticality, lateralization, longitude and dorsality (topographical factors are reported in Tab.1).

Chanel	Longitude	Lateralization	Dorsality
F7	A	S	V
FC5	A	S	VD
F3	A	S	D
F8	A	D	V
FC6	A	D	VD
F4	A	D	D
T7	C	S	V
CP5	C	S	VD
C3	C	S	D
T8	C	D	V
CP6	C	D	VD
C4	C	D	D
P7	P	S	V
P3	P	S	VD
O1	P	S	D
P8	P	D	V
P4	P	D	VD
O2	P	D	D

Tab 1. The three topographical factors considered for statistical analysis are reported: lateralization (2 levels, left-right), longitude (3 levels, frontal-central-posterior) and dorsality (2 levels, dorsal-medial-dorsal).

2.3 Results

2.3.1 Behavioral Results

Nine of the 35 subjects were not considered in the ERPs analysis, given the high number of epochs rejected for artifacts (see below). For the remaining 26 subjects the mean overall (including experimental sentences and fillers) accuracy to the acceptability judgment was 0.9 (range 0.75-0.99).

With respect to the experimental items, participants responded to the correct condition (0.93) and for the violation (0.91) with a similar accuracy ($t_{(25)} < 1$). The reaction times (RTs) were faster for the violation (648ms) than for the correct condition (720ms) as shown by a paired t-test $t_{(25)} = 2.57$, $p < 0.05$.

2.3.2 ERP Results

ERP waveforms elicited to the critical word, at the 18 recording sites used for statistical analysis, are shown in Fig.2 Visual inspection of the waveforms revealed a biphasic ERP pattern.

A negative deflation, identifiable as a LAN for the violation condition compared to the correct condition, is evident on the anterior sites of left hemisphere. It arises around 300ms and lasts at around 450ms after critical word onset. The negativity is however visible also on dorsal and central sites.

500ms after stimulus onset until the end of the epoch the violation is more positive

than the control condition. This positivity, identifiable as a P600, is broadly distributed on the scalp at the onset and more posterior in a later phase. This positive effect doesn't show any lateralization.

After visual inspection I performed ANOVAs in two time windows: between 320 and 440 ms after the critical word onset for for the LAN and between 500 and 700 ms after the critical word onset for the P600. The ANOVAs have been performed on the mean amplitude of the 18 electrodes shown in Fig.2 and considered four factors: grammaticality (2 levels: grammatical-ungrammatical), lateralization (2 levels: left-right), longitude (3 levels: frontal-central-posterior) and dorsality (2 levels: ventral-dorsal-ventral). Topographical factors are reported in Tab.1.

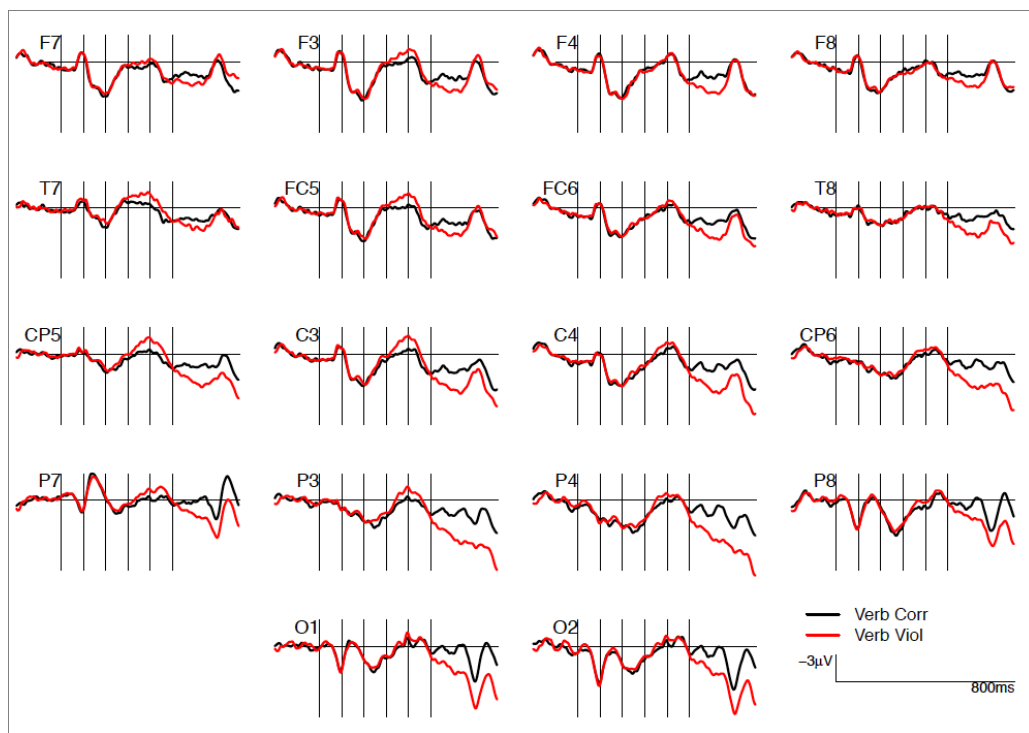


Fig.2 Grand average of event-related brain potential waveforms time-locked to the verb onset in correct (black line) and violation (red line) condition. Negative polarity is plotted upward and vertical lines are plotted at 0, 100, 200, 300, 400, 500 milliseconds latency. In figure are depicted the 18 electrodes used for the analysis.

Mean amplitude analysis in the 320-440 ms time window (LAN)

The ANOVA in the 320-440 ms interval showed an interaction between grammaticality, longitude and laterality $F(2,50)=7.26$ $p<0.05$ due to the negativity for the violation condition with respect to control at left centro-frontal sites.

Mean amplitude analysis in the 500-700 ms time window (P600)

The ANOVA in the 500-700 ms interval shows an interaction between grammaticality, longitude and dorsality $F(4,100)=2.84$ $p<0.01$. The positivity is visible on both anterior and posterior sites, but with a greater amplitude on centro-parietal sites.

Summary of the results

Statistical analyses showed that this violation on nominalized infinitive verbs elicited an ERP pattern comparable to what previously reported in literature for morphosyntactic mismatches (a LAN followed by the P600). The Part of Speech violation we studied elicited a biphasic ERP pattern compared to the correct condition: a LAN in the 320-440ms post critical word onset time windows and a P600 with onset at 500ms after critical word onset.

2.4 Discussion

Friederici (2002) argued that in the first 200ms after word onset the cognitive system update the syntactic structure of the sentence exploiting word-class information only and that, a mismatch at this stage elicit an eLAN. However, Friederici (2002) refers to a rough definition word-class without defying exactly what a word-class is. The studies that Friederici reported as evidence for the first parsing stage of her model (Friederici 2002) used more roughly defined word-classes, as nouns, verbs and prepositions (e.g. Neville et al., 1991; Friederici et al., 1993; Hahne & Friederici, 1999; Hahne & Jescheniak, 2001). In the present study we induced a syntactic structure mismatch with a within-verbs manipulation. Participants were presented to sentences where a verb in infinitive form was (18a) or was not (18b) a legal prosecution of the syntagmatic structure.

Results shown that the critical verb in violation condition elicited a LAN followed by a P600 compared to the critical verb in correct condition. This biphasic ERP pattern, with a left anterior negativity arisings with 300ms of latency, is typically reported for agreement violations and reflects the second parsing stage in Friederici (2002) syntax-first modular model.

According to Friederici (2002) the building of the syntactic structure pertain to specific bottom-up processes carried out in the first 300ms after stimulus onset. Our manipulation induced a syntactic structure mismatch but no effect are recorded earlier than 300ms after critical word onset as would be predicted by Friederici (2002). We argue that two explanations can account for the lack of effects before 300ms assuming Friederici (2002) model as interpretation framework. One explanation is that the

cognitive system does not fully exploit the features of the perceived (and already integrated) items to generate syntactic restrictions relevant for the structure building. In our experimental sentences the ungrammaticality of infinitive verbal forms at critical point was determined by the feminine gender of the preceding article. If the cognitive system does not exploit the gender information of the article to compute syntactic restrictions relevant for the syntactic structure building, then, any effect are expected to arise in the first stage of Friederici (2002) model.

A second explanation is that the cognitive system does not detect the distinction between infinitive and other non-finite (gerundive, participles) or finite verb forms in the eLAN time interval. Friederici (2002) maintains that in the first 300ms the cognitive system exploits the word-class, whose is obtained as an outcome of a partial lexical access. On the one hand it could be that Friederici's model, whose is underspecified with respect to word-class definition, does not contemplates the within-verb categorical distinction that we exploited. On the other hand it is possible that the cognitive system, in the partial lexical access performed in the 300ms, does not obtain adequate information to detect within-verb categorical distinctions.

In the present experiment we studied how the brain reacts to a particular syntactic structure mismatch, trying to better specify what are the informations exploited by the cognitive system in building the syntactic structure of the sentence. Friederici (2002) model is underspecified with regard to the particular structural mismatch we exploited. Because of that reason in the present study we do not directly addressed the reliability of the eLANs reported for other kind of (more roughly defined) word-class violations, instead, we addressed the cognitive function (bottom-up structure building) of the fist parsing stage of Friederici (2002) model. With respect to the cognitive

function of the first parsing stage in Friederici (2002), our results showed that the checking of the syntagmatic structure consistency do not mandatory pertains to the first 300ms of post critical word onset processing. If it was the case, an eLAN would have been elicited at the violation in (18b). This is clearly in contrast with the assumption of Friederici (2002) model that the syntactic structure building is always performed in the first 300ms and that an eLAN is elicited in case of structural mismatches.

The present result thus have shown that, at least under certain conditions (i.e. non categorical source of information for the syntactic structural relevant restrictions; within-verb categorical distinctions), the cognitive system is not sensitive to syntactic structure mismatches in the first 300ms after word onset.

Chapter 3

Study 2

3.1 Introduction

In experiment 1 I studied a linguistic manipulation with the aim of giving a better definition of what the first stage of Friederici model is, by checking if a special type of structural violation with a well balanced control condition elicits an eLAN. A typical LAN with onset at 300ms was found instead. Despite the fact that other explanations of the late effect for this specific structural violation are possible an easy explanation is the weak empirical evidence about the eLAN and thus about separate stages in the processing of structural versus morphosyntactic violation.

In experiment 1 I showed that, under certain conditions non-specified in the Friederici (2002) model, a structural mismatch does not elicits an eLAN. In the present experiment I wanted to test whether a structural mismatch can elicit an eLAN, when the manipulation is realized across roughly-defined word-classes in Italian.

The reliability of the eLAN and, consequently of the basic assumptions of Friederici model, has in fact undergone to several criticism in the past. Steinhauer and

Drury (2012) report that both the relations of the eLAN to the the processing of the critical word and the word-class status of a violation, are susceptible to criticisms. As reviewed in the introduction, two of the most influential methodological criticisms to the eLAN are a) spillover effects due to difference in the processing of previous word(s) and, b) temporal availability of word-class informations due to acoustic presentation (Steinhauer & Drury, 2012). In particular if the eLAN effects reported in the literature are mainly due to spillover effects a strong falsification of Friederici hypothesis regarding the first stage of the model would be the simpler explanation of the results of the first experiment of this thesis. However given that a number of possible alternative explanation of the result are possible it is important to to develop a paradigm for which an unambiguous word-class violation is created by also controlling the properties of the word preceding the target.

In this experiment we thus want to test the reliability of an eLAN elicitation for clear word-class violations in absence of possible confounds that caused several criticisms to its previous finding in languages other than Italian, by using the experimental sentences as exemplified in (19). Violation condition is exemplified in (19.b) and control condition in (19a).

(19)

a. Le urla vivaci dei bambini giungono forti ...

The screams lively of the children come strongly ...

The lively screams of children come strongly ...

b. * Le vivaci dei bambini giungono forti ...

** The lively of the children come strongly ...*

* The lively of children come strongly ...

The spillover issue is efficiently addressed with this violation on prepositions in Italian because a) the manipulation induce a pure word-class violation linguistically similar to Neville et al. (1991) and b) we exploited the Italian property that allows both a prenominal position for adjectives (*le vivaci urla*, lit. *the lively screams*) and a post nominal one (*le urla vivaci*, lit. *the screams lively*) in noun phrases (NP). The two possible positions of an adjective allows to keep constant the word immediately preceding the violation and thus avoid baseline problems.

In the correct condition (19a) the minimal sequence containing both the manipulation and the critical word is composed by the head of a prepositional phrase (PP) preceded by a noun phrase (NP) whose are embedded in a determiner phrase (DP) headed by a determiner.

The word-class violation is created removing the head of the NP. With this manipulation, the parser can easily integrate the adjective since Italian allows prenominal adjectives and thus sequences as *Determiner – Adjective – Noun* are perfectly legal. Clearly after perceiving a determiner-adjective sequence a NP head is still needed to grammatically complete the whole DP. After the adjective, only logical operators (and, or) and/or other adjectives (with specific semantic and syntactic restrictions) are grammatical before a noun head and any preposition is ungrammatical, consisting thus in a structural word-class violation. The correct control condition was created with a postnominal adjective order to have the exact same word (i.e. the adjective) immediately preceding the target word (i.e. the preposition) in both conditions.

The sequences containing the manipulation are then *Specifier – Noun – Adjective – Prep* in the correct condition and *Specifier – Adjective – Prep* in the violation

condition. It must be noted that in some cases a sequence *Specifier – Adjective – Prep* constitute a full grammatical DP in Italian, without the need of a subsequent noun. This may be because of two possible reasons. The first reason is that the noun can be omitted when it is very salient and inferable by the communicative context as in sentence (20), where the (N) position (the striker) is empty.

(20)

Il presidente vuole acquistare un attaccante,

The President wants to buy a striker,

sta pensando al grande (N) del Madrid

he is thinking to the great (N) of the Madrid

The second reason is that some Italian adjectives are homophones to nouns, and than a structure as in (21) is grammatical even if after reading the first two words there is still an ambiguity between the reading of *importante* as a prenominal adjective or as a noun. The ambiguity is then resolved at the preposition where, given a *Determiner – Adjective – Noun* structure is impossible the only possible reading remains that with *importante* as a noun.

(21)

L'importante_{Noun} nella carriera di uno studente è avere ...

The important_{Noun} in the career of a student is to have ...

For these reason, despite the clear nature of structural violation of the condition (19b), the building of the experimental material needs to carefully avoid situations for which the sequence may be in a way grammatical. I thus adopted two constraints to

avoid that a preposition can legally follow the adjective in the context of our experimental violation condition.

On the one hand we used simple single sentences so that the noun can not be pragmatically inferred and, on the other hand, we did not use adjectives that also have a noun lexical entry in the Italian lexicon (this was done according to the on-line Garzanti Dictionary and the knowledge of myself and other two colleagues Italian native speakers). With these constraints, we built structures where no preposition is a legal continuation following the prenominal adjective (as in 19b).

Additionally, we checked that both the noun and the adjective of the critical sequence within each correct sentence have the phonotactic properties to legally follow the determiner. For example in (22a) the phonotactic agreement between the adjective and the specifier is not required but, when the noun is removed to create the violation, the adjective also requires phonotactic agreement with the specifier. If a phonotactic disagreement occurs between specifier and adjective (as in 22b) an anomaly precedes the critical word, probably affecting its processing, or, in any case, affecting the baseline (see Molinaro, Vespignani, & Job, 2008).

(22)

a. Claudia ha comprato uno scialle meraviglioso per la cena.

Claudia bought a shawl amazing for the dinner.

Claudia bought an amazing shawl for the dinner.

b. * Claudia ha comprato uno * meraviglioso per la cena.

**Claudia bought a * amazing for the dinner.*

* Claudia bought an amazing for the dinner.

Moreover, while in the violation condition the adjective is always interpreted as in prenominal position, in correct condition it is always in post-nominal position. However some Italian adjectives can not appear in both prenominal and postnominal position. To avoid anomalies preceding the preposition we used only adjectives that can occur in both prenominal and postnominal position. For example an adjective as the Italian *bel* can be correctly used in prenominal position (Il *bel* divano che ... → The *nice* sofa that ...), allowing that creation of a good violation condition (Il *bel* che ... → The *nice* that ...). However, the adjective *bel* can not be correctly used in post-nominal position (Il divano **bel* che ...; The sofa **nice* that ...), thus it would create an anomaly when used preceding the preposition in the correct condition.

Adopting these constraints I created a syntactic structure violation induced by a word-class violation in absence of the main potential confounds that are present in most eLAN studies (spillover effects and temporal availability of word-class information). Two possible results are expected for the violation condition (19b) compared to the correct condition (19a). If the predictions of syntax-first models as explained by Friederici (2002) hold for our manipulation, an eLAN will be elicited at the preposition. Alternatively, if at this very early stage wrong categorical informations only is not enough to all the detection of the violation, we expect a later effect, arguably a LAN. Both the possible effects should be followed by a P600. Crucially, if we record an eLAN for the violation condition it can not be interpreted as an artifact due to spillover effects.

3.2 Method

3.2.1 Stimuli and Lists

104 minimal structures containing the manipulation were created in correct condition as described above (i.e. NPs as “Le urla vivaci” in 1.a) and then inserted in 104 semantically and formally correct sentences immediately preceding a PP whose head is thus the critical word (as “dei bambini” in 1.a). With these 104 correct sentences we created the 104 versions with a violation at the preposition by removing the noun as in (19b). All the experimental sentences in both correct and violation condition are reported in the Appendix.

The position of the critical word and the structure of the host sentence were varied to prevent participants to develop specific expectations about the likelihood of encountering a violation in specific linear or structural positions. The linear position of the critical word in the sentence (i.e. the position of the head of the PP measured in a linear word by word order) varied ranging from position 3 to position 10. The sequence containing the manipulation and the critical word is 77 times as the object and 27 times as the subject of the a clause.

Each participant has been presented with one of two lists containing the 104 sentences, half in the correct and half in the violation condition, intermixed with other 208 sentences. Of these 208 sentences a quarter contain the word-class violation on the verb described in experiment 1, a quarter contain a grammatical gender agreement violation described in experiment 3, and half are correct. The conditions were

counterbalanced into two lists, following a latin square design. Two pseudorandom orders of presentation was created for each list giving rise to four experimental lists.

3.2.2 Participants and Procedure

The participants and the procedure are the same of Experiment 1 (see pag. 47-48).

3.2.3 Data Recording

The data recording and averaging procedure and parameters are the same of Experiment 1 (see pag. 48).

Artifact free epochs in Preposition correct and violation condition.

After the two stages automatic artifact rejection procedure 9 participants for which remained less than 50% of epochs in one of the two conditions were not considered in further analysis. With respect to the remaining 26 participants the mean/range number of artifact free epochs used in the further analyses were 86% for the correct condition and 87% for the violation condition.

3.2.4 Statistical Analyses

The procedure for statistical analyses is the same of Experiment 1 (topographical factors are reported in Tab.1).

3.3 Results

3.3.1 Behavioral Results

Nine of the 35 subjects were not considered in the ERPs analysis, given the high number of epochs rejected for artifacts (see below). For the remaining 26 subjects the mean overall (including experimental sentences and fillers) accuracy to the acceptability judgment was 0.9 (range 0.75-0.99).

With respect to the experimental items, participants responded with higher accuracy to the correct condition (0.96) than for the violation (0.87) as shown by a paired t-test ($t_{(25)}=2.11$, $p<0.05$). The reaction times (RTs) for the violation (696ms) and for the correct condition (658ms) were similar (t-test $t_{(25)}=1.68$, n.s.).

3.3.2 ERP Results

Visual inspection

ERP waveforms elicited to the critical word, at the 18 recording sites used for statistical analysis, are shown in Fig.3. The visual inspection of the waveforms revealed a biphasic ERP pattern.

A negative deflation for the violation condition compared to the correct condition is evident on the left anterior sites. It arises at around 280ms and lasts until about 400ms after critical word onset. The negativity is visible bilaterally on frontal dorsal

sites but the amplitude of the difference is larger on sites over the left hemisphere. Despite its early onset, in comparison to typical morphosyntactic negativities (300-500ms), the effect is identifiable as a LAN.

At about 450ms after stimulus onset until the end of the epoch the violation condition elicits an ERP that is more positive than the control condition. This positivity is distributed on central-posterior sites and it doesn't show any lateralization and can be thus classified as a P600.

After visual inspection I performed two separate ANOVAs in two time windows: between 280 and 380 ms after the critical word to assess the reliability of the LAN and between 500 and 700 ms after the critical word onset to assess the reliability of the P600. The ANOVAs have been performed on the mean amplitude of the 18 electrodes shown in Fig.3 and considered four factors: grammaticality (2 levels: grammatical-ungrammatical), lateralization (2 levels: left-right), longitude (3 levels: frontal-central-posterior) and dorsality (2 levels: ventral-dorsal-ventral). Topographical factors are reported in Tab.1.

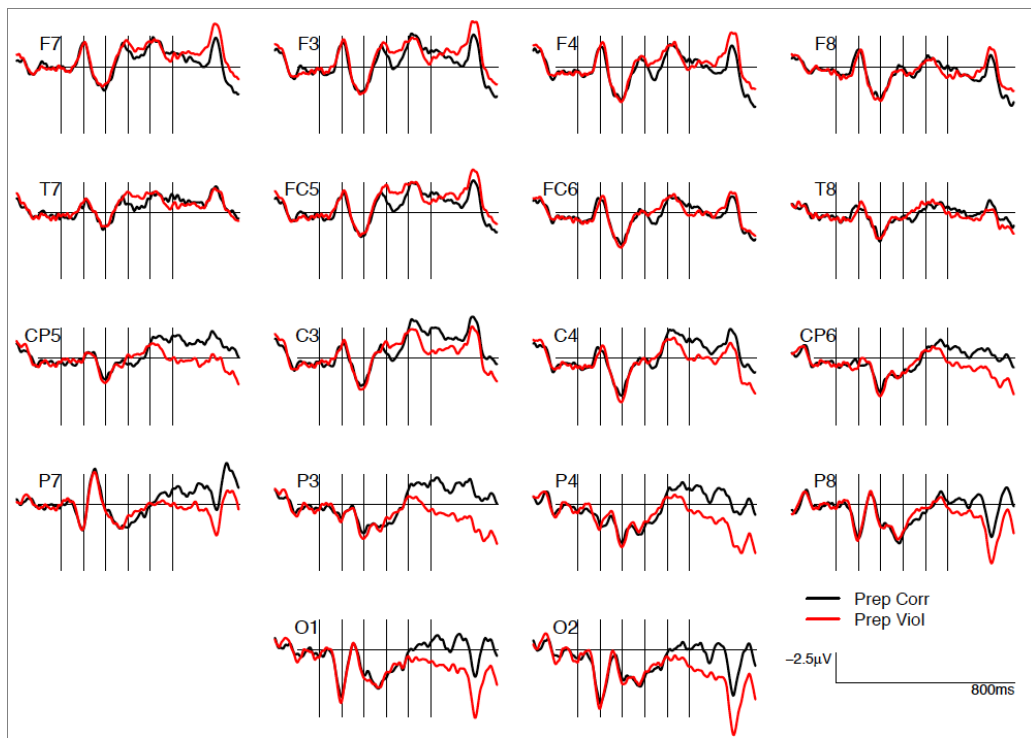


Fig.3 Grand average of event-related brain potential waveforms time-locked to preposition onset in correct (black line) and violation (red line) condition. Negative polarity is plotted upward and vertical lines are plotted at 0, 100, 200, 300, 400, 500 milliseconds latency. In figure are depicted the 18 electrodes used for the analysis.

Mean amplitude analysis in the 280-380 ms time window (LAN)

The ANOVA in the 280-380 ms interval showed two three-way effects interactions containing the factor grammaticality.

An interaction between grammaticality, longitude and laterality $F(2,50)=4.95$ $p<0.05$ due to the negativity for the violation condition with respect to control condition at left frontal sites. And an interaction between grammaticality, longitude and dorsality $F(4,100)=4.53$ $p<0.05$ due to the fact that the negativity for the violation condition with respect to control condition is larger left dorsal with respect to left ventral sites.

Mean amplitude analysis in the 500-700 ms time window (P600)

The ANOVA in the 500-700 ms interval shows an interaction between grammaticality, longitude and dorsality $F(4,100)=4.21$ $p<0.01$. The positivity is visible on both central and posterior sites, but with a larger amplitude on parietal and occipital dorsal sites.

Summary of the results

Statistical analyses showed that this word-class violation elicited an ERP pattern already reported for similar violations (a LAN followed by the P600). Crucially, no effect are found in the eLAN interval (100-200ms post stimulus onset).

The word-class violation we studied elicited a biphasic ERP pattern compared to the correct condition: a LAN with early onset statistically significant between 280ms and 380ms post critical word onset and a P600.

3.4 Discussion

I studied the brain response to a word-class violation on a preposition that induce a syntactic structure mismatch. The preposition occurs after an adjective, before any noun head was presented. The presentation of the preposition consist then in a word-class violation and the parser should not be able to legally update the syntactic structure with the inclusion of the critical word. The experiment was built to study a word-class violation without two of the most important methodological criticisms moved to the finding of the eLAN: a) the temporal asynchrony between stimulus and categorical information onset, and b) spillover effects due to differences in the processing of previous word(s) (see Steinhauer & Drury, 2012 for a review).

The study failed to replicate the eLAN for word-class violation whose have been found in other languages (e.g. Neville et al., 1991, Friederici et al., 1999; Gunter, Friederici, & Hahne, 1999; Yamada & Neville, 2007 in visual presentation and, Friderici et al., 1993; Hanhe & Friederici, 1999; Rossi et al., 2005, 2006; Pakulak & Neville, 2010 in auditory presentation). The critical preposition in violation condition (19b) elicited a LAN followed by a P600 compared to the critical word in correct condition (19a). To be noted, however, that the LAN onsets at 280ms after critical stimulus onset, that is 40-50 ms earlier than the typical onset of LANs elicited in visual presentation by morphosyntactic agreement violations (see Molinaro et al., 2011 for a review). The time interval of this anterior negativity however is clearly more compatible with a LAN interpretation than with al eLAN interpretation. Two different explanation are possible to account for the latency of the LAN in this study. On the one hand it can be argued that, despite the lack of an eLAN, the word-class is

exploited at a stage that precedes the agreement checking. This would be an evidence to syntax-first models and, at the same time, a confirm of the criticisms to the eLAN. On the other hand the early onset could be due to properties of the critical words we used in this experiment. Prepositions are function words, short and very frequent. These properties of the critical words that we used can account for the earliness of the LAN with respect to the LANs generally reported for morphosyntactic disagreements occurring on content words, whose, on average, are longer and less frequent than prepositions. However even if this latter explanation is appealing there is no evidence in the literature that LAN latency depends of lexical variables such as number of letters or word frequency.

Results thus confirm that, in absence of any methodological confound, the wrong word-class information do not necessary elicit effects in the 100-200ms time interval as, instead, is argued by Friederici (2002) in her neurocognitive version of syntax-first sentence processing models. I thus conclude that the assumption that the cognitive system exploits the word-class in the first 200ms after stimulus onset in order to update the syntactic structure (Friederici, 2002) should be, at least, restricted to some context (auditory presentation) or specific languages or structures. In this study we report that syntactic mismatch induced by an outright word-class violation in Italian NPs processing does not elicit any ERP effect prior to the LAN stage.

The lack of effects in the eLAN time window, for a syntactic structure mismatch induced by an outright word-class violation, in presence of a later left anterior negativity (LAN) and a P600 shed important doubts on the syntax-first assumption that word-class exploitation and syntagmatic structure building are a modular process encapsulated and performed in the first 200ms after word onset.

This result taken together with the criticisms to the eLAN findings present in the literature (reported by Steinhauer & Drury, 2011) and a different literature reporting several early effects found for different violations (Dikker et al., 2009; Dambacher et al., 2009; Dikker et al., 2012; Dikker et al., 2011; Hermann et al., 2011; Kim & Lai, 2012) impose to reconsider the reliability of the relation between word-class exploitation, syntactic structure building and effects preceding the LAN stage.

Chapter 4

Study 3

4.1 Introduction

In this study we investigate the processing of determiner-noun grammatical gender agreement during sentence reading in Italian on words in which grammatical gender is systematically and unambiguously expressed by a derivational morpheme.

In romance languages the gender agreement is required between many phrasal constituents (nouns, verbs, adjectives, pronouns, determiners) and it has been reported that gender agreement violations elicit a biphasic pattern composed by a left anterior negativity (LAN) followed by a P600 (see Molinaro et al., 2011 for a review). The LAN is assumed to indicate a difficulty in building the structure due to a morphosyntactic mismatch while the P600 is assumed to reflect later stages of repair, reanalysis or conflict monitoring (Hagoort, 2005; Friederici, 2002).

The LAN latency is generally stable across studies with an onset at around 300ms after the critical word (but see Deutsch, & Bentin, 2001). On the other side the topography of the effect is much more variable than for number agreement violations:

Molinaro et al. (2011) observed that clearly left-lateralized anterior negativities are reported only in those studies in which the gender of the critical word was morphologically expressed, while when gender is opaque a more centrally distributed negativity is recorded. Capitalizing on this observation Molinaro et al. (2011) argue that *“a feature expressed by the functional morphology would initiate a search for a target constituent with a matching feature. If the features are expressed formally, as functional morphemes attached to lexical stems, (...)”* and *“does not match the syntactic context, a LAN is triggered”*.

Recent studies (Dikker et al., 2009; Dikker et al., 2010) reported that earlier than the onset of ERPs component that have been attributed to sentence building processes (eLAN, LAN, P600) the cognitive system is sensitive to orthographic/morphologic properties relevant for sentence-level processes. Dikker et al. (2009) and Dikker et al. (2010), in two MEG sentence comprehension studies, found a larger visual component M100 for a violation of the expectations of a given word class only when the word class information was conveyed by typical visual/orthographic properties. These effects have been associated with stimulus analysis processes that can be modulated by context rather than proper sentence-level processes such as unification. The results of Dikker et al. (2009) and Dikker et al. (2010) suggest thus that a manipulation of expectations can modulate the processes at different stages, depending on how the feature is expressed (the presence of critical orthographic or morphologic markers).

A crucial point for the development of sentence comprehension models thus becomes the time required to the cognitive system to take into account specific word form properties within specific predictive processes such as syntactic parsing and

semantic composition (e.g. Altmann & Mirkovic, (2009); Levy, 2008).

The possibility that information about the suffix could be available at a very early processing stage is also supported by models of lexical access. Rastle, Davis, and New (2004) in a masked priming paradigm found the same amount of facilitation for a lexical decision for semantically (morphologically transparent) pairs (*hunter-hunt*) and for pseudo-morphological (*opaque*) pairs (*corner-corn*) with respect to controls, non-morphologic (orthographic), pairs (*scandal-scan*). On these bases the morpho-orthographic parsing model (Rastle et al., 2004; Rastle & Davis, 2008) assumes that “*the recognition system rapidly decomposes any printed stimulus that has the appearance of morphological complexity*” and that such a process takes place independently of any lexical or supra lexical factors. Morris, Frank, Grainger, & Holcomb (2007) found a graded effect of morphological masked priming on a specific ERP component, dubbed N250. The N250 was significantly larger for morphologically transparent than for pseudo-morphological pairs and was also larger for pseudo-morphological with respect to orographic pairs. The results suggest, contra Rastle et al. (2004), that the morphological parsing is a process based on a “resonance” between bottom-up prelexical representations (Taft & Foster, 1975) and supralexical lexical semantic ones (Giraudo & Grainger, 2001). Further researches (Morris, Grainger, & Holcomb, 2008) distinguished two different stages in the N250: in a first stage the complex word is segmented, separating stem and suffix, while in the second stage the parts of the word are combined together to in order to obtain the full meaning.

The research on morphological decomposition during word recognition has been mainly studied with lexical decision and masked priming. As noted by Duñabeitia,

Kinoshita, Carreiras, & Norris (2011), that found a difference between morphologically transparent and pseudo-morphological pairs in a same-different task, it is possible that fast pre-lexical morpho-orthographic segmentation mechanisms may depend on task requests.

The current debate on morpho-orthographic segmentation mechanisms and the early orthographic MEG effects found by Dikker et al. (2009) and Dikker et al. (2010) strongly suggests that it is possible that when an agreement feature is expressed by an easily recognizable morpheme the effect of a mismatch may emerge at an earlier stage than that of the LAN in terms of N250 or of the electrical counterpart of the M100. Moreover since it has been shown that morpho-orthographic segmentation mechanisms may depend on task request is it extremely important to test whether sentence context properties such as syntactic constrains can also modulate the effectiveness of prelexical morphological parsing (indexed by the N250) with respect to alternative or concurrent (Schroeder & Baayen, 1997) whole-word recognition processes in a natural reading task.

In order to maximize the likelihood of a morphological decomposition in agreement we needed words where the gender feature is expressed morphologically and not inflectionally. In some Italian nouns gender is expressed by long derivational morphemes, more than 4 letters. For such derivational morphemes, easy to recognize visually, a morphological segmentation during lexical access is strongly expected. Moreover, to enhance the possibility of an interaction between orthographical/morphological operations and syntactic context we needed morphemes very associated, in terms of orthographic properties, to the expressed gender. Some Italian derivational morphemes have just one output for gender, they are

orthographically transparent and do not allow inflections. For those reasons we studied gender violations between determiner and noun (Molinaro et al., 2008 reported the classic LAN+P600 pattern for determiner-noun gender violation in Italian, with no control on inflectional/derivational gender expression). In line with the required semantic and orthographic constraints we choose four derivational morphemes to express the gender on critical words: -ezza, -anza, -ismo, -mento, two feminine and two masculine respectively. Assuming that as the determiner is encountered the cognitive system initiates to search for a coherent functional morphology in order to establish a syntactic relationship we hypothesize that, if lexical access occurs through morphological parsing, long and salient suffixes may lead to earlier effects than inflections and, possibly, even at visual sensory level.

4.2 Method

4.2.1 Stimuli and Lists

The critical stimuli were 104 Italian sentences composed as in (23) in two versions: violation (23b) and control (23a). The critical word (underlined in 23) was always a noun for which gender is expressed by one of the four derivational morphemes we choose.

(23)

a. Il direttore ha garantito la riservatezza ei dati raccolti.

The Director assured the_[+F] confidentiality_[+F] of data collected.

The Director assured the confidentiality of collected data.

b. *Il direttore ha garantito il riservatezza dei dati raccolti.

**The Director assured the_[+M] confidentiality_[+F] of data collected.*

*The Director assured the confidentiality of collected data.

For each of the four morphemes we selected 26 derived words. Words as “razzismo” (racism), that is a masculine noun derived from a feminine word “razza” (race) that is feminine were not considered to avoid root-derived gender conflicts. Words with an high frequency member of the derivational family were also excluded. . All the selected words had a medium-high frequency and were not longer than 12 letters (average length: 10.21 letters) to avoid the tendency of ocular movements. The selected words are available as supplementary material.

With the selected nouns 52 semantically sensible sentences in the two versions as in (1) were composed. For 14 sentences the critical determiner phrase (DP) had a *Det – Adj – Noun* structure with the adjectives between determiner and noun always a bigender inflected in “-e” (same form for masculine and feminine). The position of the critical word and the structures of the host sentences were varied to prevent participants to develop specific expectations about the likelihood of encountering a violation in specific linear or structural positions: 29 DP were at sentence beginning, 44 in the middle and 31 in the last part of the clause (but the critical was never the final word, to avoid wrap-up effects); the critical DPs was the subject (37 times) and the object (67 times) of the main clause. Each participant has been presented with one of two lists containing the 140 sentences, half in the correct and half in the violation condition, intermixed with other 208 fillers (half containing a word class violation and half correct). The conditions were counterbalanced across two lists in a latin square design. Two pseudorandom orders of presentation were created for each list giving rise to four experimental lists.

4.2.2 Participants and Procedure

The participants the procedure are the same of Experiment 1 (see pag. 47-48).

4.2.3 Data Recording

The data recording and averaging procedure and parameters are the same of Experiment 1 (see pag. 48).

Artifact free epochs in Noun correct and violation condition.

After the two stages automatic artifact rejection procedure 9 participants for which remained less than 50% of epochs in one of the two conditions were not considered in further analysis. With respect to the remaining 26 participants the mean/range number of artifact free epochs used in the further analyses were 85% for the correct condition and 84% for the violation condition.

4.2.4 Procedure for Statistical Analyses

The procedure for statistical analyses is the same of Experiment 1 (topographical factors are reported in Tab.1).

4.3 Results

4.3.1 Behavioral Results

Nine of the 35 subjects were not considered in the ERPs analysis, given the high number of epochs rejected for artifacts (see below). For the remaining 26 subjects the mean overall (including experimental sentences and fillers) accuracy to the acceptability judgment was 0.9 (range 0.75-0.99).

With respect to the experimental items, participants responded with higher accuracy to the correct condition (0.96) than for the violation (0.92) as shown by a paired t-test ($t_{(25)}=2.10$, $p<0.05$). The reaction times (RTs) for the violation (647ms) and for the correct condition (662ms) were similar (t-test $t_{(25)}<1$).

4.3.2 ERP Results

Visual Inspection

ERP waveforms elicited to the critical word, at the 18 recording sites used for statistical analysis, are shown in Fig.4. Visual inspection of the waveforms revealed a threephasic ERP pattern.

A positivity for the violation condition compared to the correct condition is evident dorsally, principally on parietal sites between 200 and 320 ms after critical word onset. This deflation is interpretable as an N250 for the correct condition that lack in

the violation condition. This effect, in fact, is very similar for timing and topography, to the N250 reported by Morris et al. (2007). Also the nature of the stimulation (morphologically complex words) suggest an interpretation in terms of N250. A negative deflation, identifiable as a LAN for the violation condition compared to the correct condition, is evident on the left anterior and central sites. It arises at around 320ms and lasts at 450ms after critical word onset. At about 500ms after stimulus onset until the end of the epoch the violation is more positive than the control condition. This positivity, that we identify as a P600, shows a broad scalp distribution at its onset but a more central-posterior distribution after 700ms post stimulus onset.

After visual inspection we performed ANOVAs in three time windows: between 220 and 320 ms after critical word onset for the N250, between 320 and 440 ms after the critical word onset for for the LAN and between 500 and 700 ms after the critical word onset for the P600. The ANOVAs have been performed on the mean amplitude of the 18 electrodes shown in Fig.4 and considered four factors: grammaticality (2 levels: grammatical-ungrammatical), lateralization (2 levels: left-right), longitude (3 levels: frontal-central-posterior) and dorsality (2 levels: ventral-dorsal-ventral). Topographical factors are reported in Tab.1.

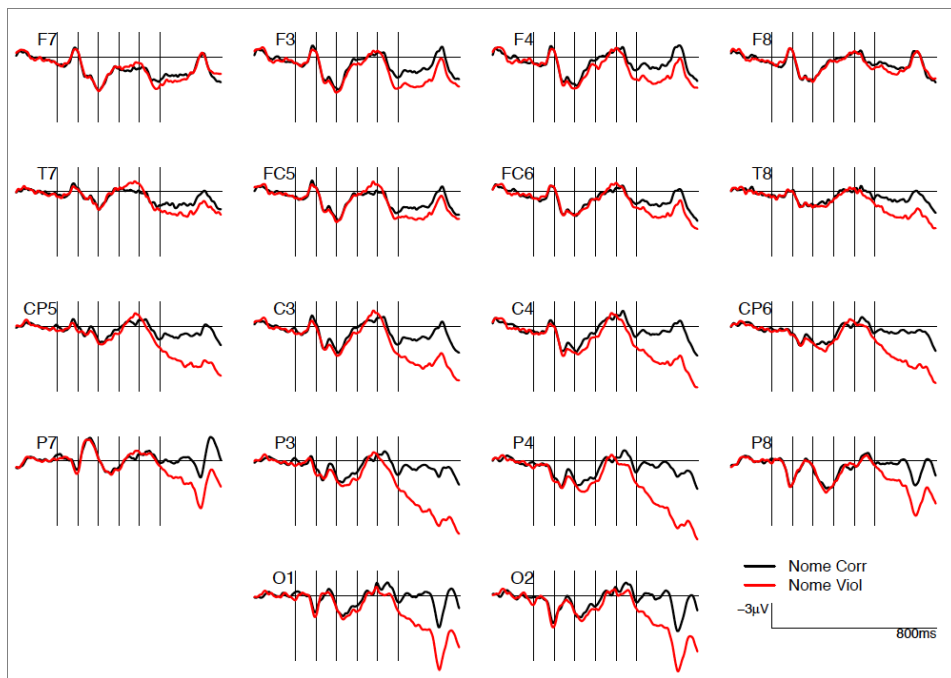


Fig.2 Grand average of event-related brain potential waveforms time-locked to noun onset in correct (black line) and violation (red line) condition. Negative polarity is plotted upward and vertical lines are plotted at 0, 100, 200, 300, 400, 500 milliseconds latency. In figure are depicted the 18 electrodes used for the analysis.

Mean amplitude analysis in the 200-320 ms time window (N250)

The ANOVA in the 200-320 ms interval shows an interaction of grammaticality with longitude and dorsality $F(4,100)=3.98$ $p<0.05$. Visual inspection suggests that the effect is due to the fact that the control condition is bilaterally more negative at dorsal posterior sites. The topographic distribution of the effect is compatible with that of N250 reported in previous studies (e.g. Morris et al., 2007; Morris et al., 2008)

Mean amplitude analysis in the 320-440 ms time window (LAN)

The ANOVA in the 320-440 ms interval showed an interaction between grammaticality, longitude and dorsality $F(4,100)=4.30$ $p<0.05$. Visual inspection suggests that the effect is due to the fact that the negativity for the violation condition

with respect to control at ventral centro-frontal sites. Despite the statistical analysis does not show an interaction including laterality the effect is numerically larger at left sites and can thus be classified as a LAN.

Mean amplitude analysis in the 500-700 ms time window (P600)

The ANOVA in the 500-700 ms interval shows an interaction between grammaticality, longitude and dorsality $F(4,100)=7.10$ $p<0.01$. The positivity is visible on both anterior and posterior sites, but with a greater amplitude on centro-parietal sites.

Statistical analyses showed that gender agreement violation on nouns with a derivational gender marking morpheme elicited a different ERP pattern compared to what previously reported in literature for morphosyntactic mismatches (a LAN followed by the P600). The gender mismatch we studied elicited a threephasic ERP pattern compared to the correct condition: a positivity in the 200-320 ms time window (interpreted as a reduction of the N250 for the violation), a LAN and a P600.

4.4 Discussion

In the present sentence comprehension ERP study we inquired the effect of grammatical gender agreement violation on nouns where the gender was expressed by derivational morphemes. Basing on recent results reporting a relation with morpho/orthographic properties and early effects (e.g. Dikker et al. 2009; Dikker et al. 2010; Kim & Lai 2012) we argued that gender agreement violations on words where the gender is unambiguously expressed by frequent derivational morphemes can lead to effects earlier than the LAN (generally reported for morphosyntactic agreement violations preceding a P600).

ERP results on critical word shown a threephasic pattern for the violation condition compared to the correct condition: a reduction of the N250 amplitude followed by a LAN and a P600.

The pattern following the N250 window is the classic biphasic pattern elicited by morphosyntactic agreement violations (see Molinaro et al. 2011 for a review). This “late” pattern indexes that our gender agreement manipulation affected sentence processing level as attested in morphosyntactic disagreements literature.

The difference between this result and those previously reported in literature for gender violations (Molinaro et al. 2011) reveals that the manipulation of gender agreement can modulate the processing at different stages depending on how the feature is expressed on the critical word. For instance, Molinaro et al. (2008) studied determiner-noun gender agreement violations in Italian, without controlling the way the gender was expressed on noun, did not reported any effect at morphological parsing stage. This result is a new evidence that deepen the mechanisms of sentence

processing shedding more light on the conditions under which context-based constraints and linguistic feature of a word can interact at different processing stages.

However, as expected, using nouns where gender is expressed by a derivational morpheme we found earlier effects. This allows to infer that the cognitive system detected a difference between correct and incorrect gender prior to the stage when agreement is typically checked. Basing on the literature on the functional interpretation of the N250 (Morris et al., 2007; Morris et al., 2008) we argue that the decrease of amplitude for violations (e.g. *il riservatezza* – *the*_[mas] *confidentiality*_[fem]) reveals that the effectiveness of the morphological parsing is reduced in a situation of lack of congruency between the gender of the word and the context constraints.

Morris et al. (2008) proposed a two stage model of the N250 component where the first stage is the ERP correlate of morphological segmentation and the second one is the ERP correlate of morphemes recombination. The results of Morris et al. (2008) showed in fact that, at least when lexical access is required, the first stage of the N250 is not affected by top-down semantic influences. In that, Morris et al. (2008) support the morpho-orthographic parsing hypotheses proposed by Rastle et al. (2004). In the morpho-orthographic parsing hypotheses the orthographic appearance of a word is crucial in triggering a first, bottom-up, stage of morphological parsing.

Our data do not allow us to discern between these two hypothetical stages of the N250 so that the top-down influence of syntactic context could be either on the segmentation stage or on the recombination one. Further studies are needed to explicitly address whether the effect we found has to attributed either to the segmentation stage or to the recombination one. However, in the present study we found that the morphological parsing of a word is affected during sentence processing

as a consequence of syntactic constraints.

The N250 has been reported so far only in single word masked priming studies and thus attributed to lexical access processes. Moreover its onset precede the 300-500ms interval when, during sentence parsing, compositional processes are performed, as reflected by the LAN and the N400. Thus, we argue that the modulation of the N250 amplitude by the syntactic context is an evidence of early top-down effects on word recognition processes.

Notably, the present finding suggest that, beside the classical masked priming studies, morphological parsing can be profitably be studied in a more ecological paradigm such as sentence comprehension. Indeed the advantages of decomposed versus whole-word recognition may be not only be a function of lexical variables but also of the interplay with a given syntactic and semantic constraining contexts.

Chapter 5

General Discussion

The aim of the present research was to test the role of syntactic constraints in early stages of words processing. As described in the introduction the assumption of the neurocognitive syntax-first model by Friederici (2002) is that within the first 300ms after a word onset only the word-class information is exploited and a phrase structure is built according to this information only. This specific feature is an assumption not common shared by other models, for example an other leading model of sentence comprehension (Hagoort, 2005) does not assume a serial sequence of stages during which different types of information are exploited but that different constrains act as soon as they are available.

In this thesis early stages of processing were studied with ERP and MEG methodologies reporting evidence that, at least under certain conditions, morphosyntactic disagreements elicit earlier effects than word-class violations.

In the two experiments on word category violation (Experiments 1& 2) we reported a biphasic pattern composed by a LAN followed by a P600, without any earlier effect. In Experiment 1 we tested the violation of a fine graded word category distinctions. The experiment was designed to test the strictness of word category

expectations whose violation can elicits a syntactic mismatch effect at eLAN stage. The critical word was a verb in infinitive form and the violation was induced varying the gender of the preceding determiner. In italian NPs only nouns, adjectives, participles and gerundives can follow feminine determiners. A verb in infinitive form can be nominalized, but it takes masculine grammatical gender by default, and than, it is illegal when presented after a feminine determiner. Assuming that the model described by Friederici (2002) accurately describes the cognitive mechanisms underlying sentence processing, we argue that also a this fine graded word category violation could elicit an eLAN. The results shown that no effects prior to the LAN stage are elicited for this word category violation on verbs in infinitive form. In Experiment 2 we tested a word-class violation on a preposition. In this experiment an eLAN would be predicted assuming the model of Friederici (2002). Results shown that neither the word-class violation on verbs nor the word-class violation prepositions in our paradigm elicited an eLAN.

However, as shown by a qualitative inspection the LAN elicited by the preposition has a shorter latency than the LAN elicited by the verb. We performed an additional analysis to estimate the onset of the effects in the two violations (methodological details and results are reported in the appendix). We performed a t-test comparison on the mean amplitude of EEG signal between correct and violation condition in contiguous 10ms time windows to estimate the onset of the components. The LAN in Experiment 1 (violation on the verb) resulted to be reliable from 330ms after stimulus onset while the LAN in Experiment 2 (violation on the preposition) resulted to be reliable 290ms after stimulus onset. We argue that there are two possible explanations for this latency difference. While the violation on the preposition is a clear word-class

violation, the one on the verb could be interpreted as a grammatical gender disagreement, despite the fact that for infinitive forms of verbs the masculine gender has to be assumed as a default rather than explicitly expressed at morphological or lexical level. In this perspective it is possible to interpret the difference in the LAN latency as an evidence for the syntax-first model described by Friederici (2002): a word-class violation is detected 40ms before the “agreement” violation.

However, the effect is clearly later than the eLAN that Neville et al. (1991) reported for a word-class violation on prepositions in English with visual presentation (manipulation very similar to the one we studied in Experiment 2). Neville et al. (1991) reported a left anterior negativity for word-class violation at about 125ms after stimulus onset. The difference between the latency of the effects that we found in Experiments 1 & 2 and the latency of the eLAN reported by Neville et al. (1991) support the hypotheses that the effects we reported in Experiments 1 & 2 are actually in the LAN time interval. With respect to the methodological criticisms moved against the eLAN (Osterhout et al., 2004 and Steinhauer & Drury, 2012), the latency of the negativities that we found for and outright word-class violations with identical pre-critical word across conditions is an evidence in favor of the hypotheses that the eLAN found by Neville et al. is actually a baseline artifact (see Steinhauer & Drury, 2012). This observation leads to a second account for the LAN onset difference between the violation on the verb and the violation on the preposition. The early latency of the LAN for the violation on the preposition can also be due to the fact that prepositions are short and very frequent words with respect to verbs and thus may be accessed earlier. We hypothesize that lexical variables of words (as length and frequency) can affect the latency of integration effects within the same processing

stage (the LAN stage). This hypothesis is clearly plausible, however, no study in the literature directly addressed this point (Osterhout, Allen, & McLaughlin, 2002 shown that the variance of N280 amplitude and latency is explained more and better by the word length than by the grammatical category, however the Authors did not crossed the frequency with a structural fit manipulation).

In sum, Experiments 1 & 2 addressed the question of the two stage syntactic parsing proposed by Friederici (2002) in which in the first 300ms the syntactic structure is built exploiting the word-class information only. The lack of effects in the eLAN time interval in our experiments is a further evidence against this model. Our results in Experiments 1 & 2 should be summed to other evidence that the eLAN is probably an artifact (Steinhauer & Drury, 2012) and thus, no evidence support the hypotheses of two separated and sequential parsing stages where in the first (0-300ms) word-class informations are exploited and only in the second (300-500ms) morphosyntactic informations are accessed. We argue that syntactic (syntagmatic and morphosyntactic) mismatches leads to anterior negative deflections (LANs) in the 300-500ms time interval and that, the latency of the effect can be slightly earlier or later depending either on words properties (such as length or frequency of use) or on the strength of the violation (word-class vs agreement). Further studies should directly address with more explicit manipulation to see if lexical variables only are able to effectively impact on the latency of the LAN (Van Petten, 1995 showed that word frequency and number of letters impacts amplitude but not latency of the N400 effect).

Nevertheless, several effects preceding the LAN are reported in the literature in both sentence processing studies and single word recognition (see introduction). There

are two main differences that worth to be noted between the eLAN and the other early effects reported in the literature. The first is that the eLAN is assumed to reflect the selective sensitivity of cognitive system to word-class informations while other early effects are found for the violation of lexical-semantic expectations (e.g. Dikker et al., 2011 with an MEG picture/word matching paradigm and Kim et al., 2011 with an EEG sentence processing paradigm). The lack of replicability of the eLAN together with the finding of several effects in the same early time interval for non-syntactic violations suggests that the cognitive system is sensitive to multiple linguistic features during early processing stages. The second difference pertain the functional interpretation of the effects. As argued by Hagoort (2005) “*the prefrontal cortex part of LIFG is crucial for unification operations required for binding single word information into larger structures*”. According to leading neurolinguistic model of Friederici (2002) part of the LIFG (the BA 44) is the source of the eLAN and LAN activities. Friederici (2002) report a review of brain imaging studies arguing that the left frontal cortex and the inferior part of BA 44 are involved in the local structure building and thus the eLAN is assumed to underlie sentence level binding difficulties. Differently, the early effects in the literature are interpreted as modulation of word recognition processes. Dikker et al. (2009) and Dikker et al. (2010) reported an amplitude modulation of the exogenous visual MEG component M100 for violations of expectations on word-class. According to Tarkiainen et al. (1999) this component underlies low level stimulus analysis and, thus, it is not interpretable as a correlate of sentence level combining processes (as, instead, are the left frontal negativities). The effect on the M100 amplitude found by Dikker et al. (2009) and Dikker et al. (2010) clearly highlights a top-down influence of syntactic constraints on word recognition

processes. Interestingly, as reported in the introduction, the M100 effect was present only when morpho/orthographic cues for word-class were present on the critical word. Dambacher et al. (2009), in an EEG study with sentence comprehension paradigm in visual presentation, found a modulation of ERPs activity on occipital recording sites before 100ms for violation of high expectations on a specific word. Top-down influences of the sentence context on visual analysis of the word is reported also by Kim & Lay (2012). In this latter study the authors reported an early visual activity modulation for pseudo-words compared to highly expected words. Crucially, when the pseudo-word was orthographically similar to the highly expected word (ceke – cake) the early effect was a modulation of the P130 amplitude while, when the pseudo-word was orthographically very different to the highly expected word (tont – cake) the early effect was a modulation of the N170 amplitude. The findings of Kim & Lay (2012) are, as the authors argue, consistent with a rapid interactions between lexical and sub-lexical representations during word recognition.

The identification of early effects of context thus depend on a number of properties of the effect. The first is the timing: as the LAN is the first stable effect related to sentence level processing, the effect should precede the typical LAN latency. The second is that the effect should consist in the modulation of an activity linked to the word processing, possibly reported in studies manipulating word properties out of sentence context. The third is that the effect can consists in an interaction between a linguistic manipulation (the congruency between contextual constraints and linguistic informations of the word) and a physical, orthographical/phonological or morphological properties of the critical stimulus.

With respect to the gender manipulation that we studied in Experiment 3 we

reported a threephasic pattern composed by a reduction of the N250, a LAN and a P600 for the violation condition compared to the correct condition. This result highlighted the fact that, when the gender is expressed by a derivational suffix, a gender mismatch can induce effects earlier than the LAN. This is inconsistent with predictions based on the model described in Friederici (2002) that assumes that effects for gender agreement violations should emerge only after 300ms. The reduction of the N250 for the gender mismatching condition is a very important result against Friederici (2002) model because in this model is assumed that in the first 300ms after word onset only the word-class is exploited. The early timing of the effect that we found for grammatical gender mismatch indexes that the gender information can be relevant already in the 200-300ms time interval. The fact that a grammatical gender mismatch induced an effect so early is even more important in the light of the lack of early effects that we report in Experiments 1 & 2, where two types of word-class violations were studied. Moreover, this early effect for gender disagreement is not important only in terms of timing: the effect is not a LAN (that is actually present in the LAN time interval) and it is not interpretable as a sentence level integration difficulty. The reduction of the N250, in the light of results reported by Morris et al. (2007) and Morris et al. (2008) with morphological masked priming, is arguably a reduction in the effort of morphological parsing. This functional interpretation of the N250 activity classifies our result as an early effect of context since it shows that word recognition processes are affected by sentence level syntactic constraints, and in particular by agreement constraints. The expectation on the grammatical gender, based on the previous part of the sentence (i.e. by the preceding determiner or complex preposition) interacts with word recognition at the level of morphological

parsing. Even if we do not have a direct comparison between violations on derived and inflected words, a previous study on grammatical gender disagreement in Italian where the expression of the gender was not controlled did not report any effect prior to the LAN (Molinaro et al., 2008). This effect is not even reported in other studies on gender disagreement (see Molinaro et al., 2011 for a review on disagreements). This difference in the effect reported for gender agreement violations could be due to two reasons. As argued in some lexical access models (e.g. *AAM* model by Burani & Caramazza, 1987 and *Race Model* by Schreuder & Baayen, 1995) both the whole word form and the decomposed lexical access are possible, with the morphological parsing effectiveness that depends on lexical variables, such as frequency and length of the word or of the composing morphemes. Assuming these two ways of processing for lexical access a modulation of morphological parsing could be possible only for derived words, as they are more long and less frequent than inflected words. However, these lexical access models (Burani & Caramazza, 1987; Schreuder & Baayen, 1995) are not a common shared assumption in psycholinguistics. Other models assume a decomposed lexical representation - and then, we argue, a segmentation stage during lexical access - for all words (e.g. Cubelli, Lotto, Paolieri, Girelli, & Job, 2005). If one assumes the same lexical access mechanism for all words, the lack of effects on the N250 in the ERPs literature on gender violation could be due to the fact that a modulation of effort in the morphological parsing is large enough to be reliably measured only for long morphemes. We then found an effect on the amplitude of the N250 because in our experiment the gender was systematically expressed on long derivational morphemes. However, despite the fact that this could be an issue to inquire with further studies, the important result is that our effect on N250 amplitude

was never reported when the morpho-orthographic properties of the critical words were not systematically controlled. The effect on the N250 thus depends on how the gender is expressed on the word, this is an evidence of the fact that gender agreement is relevant for word processing at different stages, depending on specific properties of the processed word. Moreover, while the early effects found in literature (Dikker et al., 2011; Dikker et al., 2009; Dikker et al., 2010; Dambacher et al., 2009; Kim & Lai, 2012) are effects on the sensory processes of word recognition, our result shows an early effect of context on morphological parsing stage.

Top-down effects of context on word recognition processes are then found at several processing stage with our study on gender disagreement adding new evidence on both the nature of expectations that can lead to early effects and the level of processing at which bottom-up and top-down mechanisms interact. While word-class and strong lexical-semantic expectations lead to modulations of the sensory analysis, the grammatical gender expectations can also lead to a the modulation of morphological parsing.

In sum evidence from ERPs and MEG are growing against the fact that very early processing stages are specific for word-class information and phrase structure building only. As reviewed, a large number of ERP and MEG works have recently reported very early effect for violations of syntactic, morphosyntactic and lexical-semantic constraints. The N250 effect that we reported in Experiment 3 for grammatical gender violation was never reported in the literature of agreement violation. The evidence about early effects of context on word processing inside sentences suggests that, at very early processing stages, a linguistic feature (syntactic, morphosyntactic or lexical-semantic) can be relevant or not, depending on how it is

expressed on the critical word. A further development of the study of the interfaces between word-level processing and sentence-based expectations is needed to shed more light on language processing mechanisms.

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Appendixes

Appendix 1 - Sentences

Experiment 1 Correct Versions

- 1 La barca procede grazie al veloce remare di Ferruccio.
- 2 Sergio è abituato al costante cambiare le carte in tavola del suo superiore.
- 3 Il marinaio è caduto nel legare la barca al molo.
- 4 Un compito dei figli è il badare ai genitori quando diventano anziani.
- 5 Il citare articoli casualmente è un comportamento non professionale.
- 6 Nel solerte svolgere le proprie mansioni risiede la virtù di Edoardo.
- 7 I bambini si sono divertiti molto nello scalare la piccola parete rocciosa.
- 8 I leghisti non sono d'accordo sul continuare la politica di integrazione.
- 9 Mattia ha cambiato idea riguardo al comprare una macchina nuova.
- 10 Le persone anziane perdono ore nel raccontare le esperienze vissute.
- 11 Il piano del poliziotto corrotto è tutto incentrato sullo sviare le indagini.
- 12 Lo studente molto esperto parte dallo studiare il sommario del libro.
- 13 Una abilità fondamentale nella caccia consiste nello snidare la preda.
- 14 Ognuno di noi è rimasto affascinato dal raggianti sorridere di Anita.
- 15 La testimone si è contraddetta nel descrivere la sua relazione con la vittima.
- 16 Gloria è stata scoperta nel leggere il diario della figlia.
- 17 La nonna di Luigi è inciampata nello scendere il gradino della cucina.
- 18 Gli uomini non possono fare nulla contro il perenne scorrere del tempo.
- 19 Alfredo ammira il rapidissimo cucire della sarta.
- 20 Nel venire al ristorante Loretta ha bucato una gomma.
- 21 Gino ha incontrato il rappresentante nel salire le scale.
- 22 Il capo della spedizione è determinato nel proseguire la perlustrazione.
- 23 Una qualità del bravo comico è di certo lo stupire sempre il pubblico.
- 24 La civiltà umana corre gravi rischi nel continuare a sviluppare la tecnologia nucleare.
- 25 Il perenne mutare delle stagioni è dovuto al moto di rivoluzione terrestre.
- 26 Il dissipare calore può essere ridotto utilizzando pareti adiabatiche.

- 27 Con il passare del tempo anche le ferite peggiori si rimarginano.
28 Antonio spese la sua liquidazione nel bere solo whisky scozzese di marca.
29 Nel tingere il tessuto Paolo rovinò la sua nuova maglietta.
30 Maria si addormentò nel guardare la televisione.
31 Il re si quietò al sopraggiungere dei rinforzi.
32 Egidio si sporse dal finestrino nel chiedere informazioni al capotreno.
33 Il rivelare segreti aziendali è una possibile causa di licenziamento.
34 Al sorgere del sole il campo di battaglia mostrò tutta la crudeltà della guerra.
35 Fra il mentire ed il perire un eroe sceglie il secondo.
36 Al diminuire delle entrate pubbliche Tremonti aumentò le tasse sulla benzina.
37 Il perseguire scopi abietti è tipico di un uomo malvagio.
38 Il russare può essere grave causa di tensioni coniugali.
39 In alcuni paesi il ruttare è segno di aver gradito il pasto.
40 Il risolvere le conflittualità interne è compito dello psicologo del lavoro.
41 Il puntuale sparire nelle occasioni importanti è da codardi.
42 Il nascondere le contestazioni del pubblico è un male necessario.
43 Il temere sempre il peggio porta ad un altissimo stress.
44 La cuoca si è scottata nel friggere le cotolette.
45 Il paziente archeologo ha speso una vita nel decifrare questi antichi reperti.
46 Il costante interrompere i film con le pubblicità è molto fastidioso.
47 Il nuovo lavoro consiste nel compilare moduli tutto il giorno.
48 La commissione si è divisa nel decidere il vincitore.
49 La mamma di Alessio si diletta nel vestire suo figlio alla moda.
50 Il confondere le convinzioni più profonde è una nota strategia di manipolazione.
51 Il romanziere ha avuto una intuizione nello scrivere il capitolo conclusivo.
52 I due bambini si sono divertiti nel chiamare numeri telefonici a caso.
53 La maestra insiste nello sgridare gli alunni in difficoltà.
54 Il mirare con precisione è la qualità distintiva di un cecchino.
55 Il domare un cavallo selvaggio è molto difficile.
56 La sapienza nel giocare a briscola si tramanda dai nonni ai nipoti.
57 Dopo la rapina stiamo discutendo sul blindare la porta di ingresso.
58 Il padre lo aveva avvertito sui rischi dello sposare quella donna.
59 Aldo ha trascorso la giornata nel cercare una soluzione al problema.
60 Guido si è bagnato nel bere dalla fontana.
61 Il corridore si è rotto una caviglia nel cadere in prossimità del traguardo.
62 I colleghi si sono dilungati nel discutere particolari inutili.
63 Ormai ci siamo abituati al frequente nascere di banche in ogni città.
64 La professoressa ha dissuaso il preside dal sospendere alcuni studenti.
65 La nuova mansione comprende il vendere assicurazioni porta a porta.
66 La parrucchiera si è distratta nel tingere i capelli alla signora.
67 Nelle presentazioni mi agito nel dire il mio nome.
68 Gli alunni si distinguono sempre per il loro fornire risposte puntuali a domande vaghe.
69 I due colleghi concordano sullo spedire la lettera per raccomandata.
70 Lo scoprire nuove meraviglie è il sogno degli esploratori.
71 Nello sfuggire agli aggressori Giorgio ha perso il cellulare.
72 Lo smaltire i rifiuti radioattivi è un punto critico nello sviluppo nucleare.

- 73 Il testimone è piuttosto incerto nel riferire gli eventi cruciali.
 74 Il punto di forza di quel politico risiede nello sminuire i suoi reati.
 75 Diego ha capito che il mentire non è una buona azione.
 76 Il fluente narrare degli antichi è andato estinguendosi.
 77 Il sagace indagare è necessario per risolvere casi complessi.
 78 Elisa si attaccò le dita nel sigillare la busta con la ceralacca.
 79 Al tramontare del sole il gufo si risveglia.
 80 Al sentire pronunciato il suo nome Anna si voltò di scatto.
 81 Con il suonare delle campane fu reso noto che il matrimonio si era compiuto.
 82 Il costante immaginare una vita parallela conduce alla follia.
 83 Nel dichiarare il suo orientamento sessuale Gianni arrossì.
 84 Se sei un buon venditore finisci spesso con il fregare la gente.
 85 Il naufragare nella passione amplia la percezione del piacere.
 86 Il marcire provoca sempre un odore sgradevole.
 87 Allo scoccare della mezzanotte la scarpetta scivolò giù dalle scale.
 88 Il bravo arbitro finì però con il favorire la sua squadra del cuore.
 89 Nantas morì nel risucchiare acqua dalla stiva danneggiata.
 90 Il capo sostenne che il boicottare alcuni prodotti era una mossa politica.
 91 Il comporre frasi per esperimenti lo ridusse ad uno straccio.
 92 Il falsario è specializzato nel riprodurre pitture antiche.
 93 Nel soffrire in silenzio Tommaso ha trovato la via per la saggezza.
 94 Gianni è un esperto nel mantenere sempre la calma.
 95 I due genitori concordavano solo nel punire il figlio.
 96 Carletto si è stancato del perenne girare a vuoto per il centro.
 97 Il curiosare nel cassetto dei ricordi lo tenne occupato per tutto il pomeriggio.
 98 La solidarietà si manifesta anche nel dividere più equamente le risorse.
 99 Luisa è una specialista nel cedere ad ogni tentazione.
 100 Il confidare troppo nelle sue capacità ha portato Claudio a lavorare in solitudine.
 101 Salvatore è logorato dal condividere ogni minuto della giornata con il collega.
 102 In questo gioco la vera difficoltà del finire il secondo livello è trovare la porta giusta.
 103 Il barista ha dissuaso il ragazzo ubriaco dal guidare la macchina fino a casa.
 104 Settimio si è accorto del grafico mancante nel rilegare la tesi.

Experiment 1 Violated Versions

- 105 La barca procede grazie alla veloce remare di Ferruccio.
 106 Sergio è abituato alla costante cambiare le carte in tavola del suo superiore.
 107 Il marinaio è caduto nella legare la barca al molo.
 108 Un compito dei figli è la badare ai genitori quando diventano anziani.
 109 La citare articoli casualmente è un comportamento non professionale.
 110 Nella solerte svolgere le proprie mansioni risiede la virtù di Edoardo.
 111 I bambini si sono divertiti molto nella scalare la piccola parete rocciosa.
 112 I leghisti non sono d'accordo sulla continuare la politica di integrazione.
 113 Mattia ha cambiato idea riguardo alla comprare una macchina nuova.
 114 Le persone anziane perdono ore nella raccontare le esperienze vissute.

- 115 Il piano del poliziotto corrotto è tutto incentrato sulla sviare le indagini.
116 Lo studente molto esperto parte dalla studiare il sommario del libro.
117 Una abilità fondamentale nella caccia consiste nella snidare la preda.
118 Ognuno di noi è rimasto affascinato dalla raggianti sorridere di Anita.
119 La testimone si è contraddetta nella descrivere la sua relazione con la vittima.
120 Gloria è stata scoperta nella leggere il diario della figlia.
121 La nonna di Luigi è inciampata nella scendere il gradino della cucina.
122 Gli uomini non possono fare nulla contro la perenne scorrere del tempo.
123 Alfredo ammira la rapidissimo cucire della sarta.
124 Nella venire al ristorante Loretta ha bucato una gomma.
125 Gino ha incontrato il rappresentante nella salire le scale.
126 Il capo della spedizione è determinato nella proseguire la perlustrazione.
127 Una qualità del bravo comico è di certo la stupire sempre il pubblico.
128 La civiltà umana corre gravi rischi nella continuare a sviluppare la tecnologia nucleare.
129 La perenne mutare delle stagioni è dovuto al moto di rivoluzione terrestre.
130 La dissipare calore può essere ridotto utilizzando pareti adiabatiche.
131 Con la passare del tempo anche le ferite peggiori si rimarginano.
132 Antonio spese la sua liquidazione nella bere solo whisky scozzese di marca.
133 Nella tingere il tessuto Paolo rovinò la sua nuova maglietta.
134 Maria si addormentò nella guardare la televisione.
135 Il re si quietò alla sopraggiungere dei rinforzi.
136 Egidio si sorse dal finestrino nella chiedere informazioni al capotreno.
137 La rivelare segreti aziendali è una possibile causa di licenziamento.
138 Alla sorgere del sole il campo di battaglia mostrò tutta la crudezza della guerra.
139 Fra la mentire ed il perire un eroe sceglie il secondo.
140 Alla diminuire delle entrate pubbliche Tremonti aumentò le tasse sulla benzina.
141 La perseguire scopi abietti è tipico di un uomo malvagio.
142 La russare può essere grave causa di tensioni coniugali.
143 In alcuni paesi la ruttare è segno di aver gradito il pasto.
144 La risolvere le conflittualità interne è compito dello psicologo del lavoro.
145 La puntuale sparire nelle occasioni importanti è da codardi.
146 La nascondere le contestazioni del pubblico è un male necessario.
147 La temere sempre il peggio porta ad un altissimo stress.
148 La cuoca si è scottata nella friggere le cotolette.
149 Il paziente archeologo ha speso una vita nella decifrare questi antichi reperti.
150 La costante interrompere i film con le pubblicità è molto fastidioso.
151 Il nuovo lavoro consiste nella compilare moduli tutto il giorno.
152 La commissione si è divisa nella decidere il vincitore.
153 La mamma di Alessio si diletta nella vestire suo figlio alla moda.
154 La confondere le convinzioni più profonde è una nota strategia di manipolazione.
155 Il romanziere ha avuto una intuizione nella scrivere il capitolo conclusivo.
156 I due bambini si sono divertiti nella chiamare numeri telefonici a caso.
157 La maestra insiste nella sgridare gli alunni in difficoltà.
158 La mirare con precisione è la qualità distintiva di un ceccino.

- 159 La domare un cavallo selvaggio è molto difficile.
160 La sapienza nella giocare a briscola si tramanda dai nonni ai nipoti.
161 Dopo la rapina stiamo discutendo sulla blindare la porta di ingresso.
162 Il padre lo aveva avvertito sui rischi della sposare quella donna.
163 Aldo ha trascorso la giornata nella cercare una soluzione al problema.
164 Guido si è bagnato nella bere dalla fontana.
165 Il corridore si è rotto una caviglia nella cadere in prossimità del traguardo.
166 I colleghi si sono dilungati nella discutere particolari inutili.
167 Ormai ci siamo abituati alla frequente nascere di banche in ogni città.
168 La professoressa ha dissuaso il preside dalla sospendere alcuni studenti.
169 La nuova mansione comprende la vendere assicurazioni porta a porta.
170 La parrucchiera si è distratta nella tingere i capelli alla signora.
171 Nelle presentazioni mi agito nella dire il mio nome.
172 Gli alunni si distinguono sempre per la loro fornire risposte puntuali a domande vaghe.
173 I due colleghi concordano sulla spedire la lettera per raccomandata.
174 La scoprire nuove meraviglie è il sogno degli esploratori.
175 Nella sfuggire agli aggressori Giorgio ha perso il cellulare.
176 La smaltire i rifiuti radioattivi è un punto critico nello sviluppo nucleare.
177 Il testimone è piuttosto incerto nella riferire gli eventi cruciali.
178 Il punto di forza di quel politico risiede nella sminuire i suoi reati.
179 Diego ha capito che la mentire non è una buona azione.
180 La fluente narrare degli antichi è andato estinguendosi.
181 La sagace indagare è necessario per risolvere casi complessi.
182 Elisa si attaccò le dita nella sigillare la busta con la ceralacca.
183 Alla tramontare del sole il gufo si risveglia.
184 Alla sentire pronunciato il suo nome Anna si voltò di scatto.
185 Con la suonare delle campane fu reso noto che il matrimonio si era compiuto.
186 La costante immaginare una vita parallela conduce alla follia.
187 Nella dichiarare il suo orientamento sessuale Gianni arrossì.
188 Se sei un buon venditore finisci spesso con la fregare la gente.
189 La naufragare nella passione amplia la percezione del piacere.
190 La marcire provoca sempre un odore sgradevole.
191 Alla scoccare della mezzanotte la scarpetta scivolò giù dalle scale.
192 Il bravo arbitro finì però con la favorire la sua squadra del cuore.
193 Nantas morì nella risucchiare acqua dalla stiva danneggiata.
194 Il capo sostenne che la boicottare alcuni prodotti era una mossa politica.
195 La comporre frasi per esperimenti lo ridusse ad uno straccio.
196 Il falsario è specializzato nella riprodurre pitture antiche.
197 Nella soffrire in silenzio Tommaso ha trovato la via per la saggezza.
198 Gianni è un esperto nella mantenere sempre la calma.
199 I due genitori concordavano solo nella punire il figlio.
200 Carletto si è stancato della perenne girare a vuoto per il centro.
201 La curiosare nel cassetto dei ricordi lo tenne occupato per tutto il pomeriggio.
202 La solidarietà si manifesta anche nella dividere più equamente le risorse.
203 Luisa è una specialista nella cedere ad ogni tentazione.
204 La confidare troppo nelle sue capacità ha portato Claudio a lavorare in solitudine.

- 205 Salvatore è logorato dalla condividere ogni minuto della giornata con il collega.
- 206 In questo gioco la vera difficoltà della finire il secondo livello è trovare la porta giusta.
- 207 Il barista ha dissuaso il ragazzo ubriaco dalla guidare la macchina fino a casa.
- 208 Settimio si è accorto del grafico mancante nella rilegare la tesi.

Experiment 2 Correct Versions

- 209 I medici hanno delle calligrafie illeggibili per i farmacisti.
- 210 Il notaio ha voluto un compenso modestissimo per la mediazione.
- 211 Il comune ha organizzato un concerto imperdibile ai giardini pubblici.
- 212 Le condizioni fatiscenti degli edifici popolari sono state denunciate dalla popolazione.
- 213 Le conseguenze catastrofiche della tua azione saranno pagate da tutti.
- 214 Un corso avanzato di lingua tedesca sarebbe molto utile.
- 215 Le decorazioni bronzee sul portone erano opera di una giovane artista.
- 216 Un esemplare rarissimo del famoso macaco africano fu oggetto di studi etologici.
- 217 Il primo medico ha curato la ferita dolorosa del paziente.
- 218 Il giardino rigoglioso sul retro è motivo di orgoglio per i proprietari.
- 219 Lucia ha scoperto un gioco divertente al computer.
- 220 I costi di un mutuo rappresentano un impegno oneroso per un operaio.
- 221 Angelo ama raccontare le gesta favolose dei suoi avi.
- 222 Il pentito ha dato delle indicazioni confuse in merito al luogo del delitto.
- 223 E' indispensabile un interlocutore ragionevole nella mediazione.
- 224 In una intervista recente a Panorama la velina ha annunciato le sue nozze.
- 225 Ho notato un miglioramento significativo negli studenti.
- 226 Tante offerte convenienti del volantino sono esaurite.
- 227 I palazzi fatiscenti della estrema periferia stanno per essere ristrutturati.
- 228 Linda ha scelto un percorso faticoso per allenarsi.
- 229 Una pianta imponente nel giardino dei vicini è caduta per il forte vento.
- 230 Il sindacato ha proclamato la protesta imminente dei dipendenti comunali.
- 231 Il giocatore ha segnato un punto decisivo allo scadere del tempo.
- 232 Grazie alle radici robuste degli alberi il pendio non è franato.
- 233 Il maresciallo esaminò il rapporto lacunoso del carabiniere.
- 234 La ragazza ha avuto una reazione coraggiosa alla notizia.
- 235 Teresa ha organizzato un ricevimento sontuoso per inaugurare la stagione.
- 236 Il giovane non otterrà mai i risultati prestigiosi del suo grande predecessore.
- 237 La noce moscata esalta il sapore delicato dei funghi.
- 238 La sconfitta clamorosa della attuale campionessa è la fine di una gloriosa carriera.
- 239 Guido ama le serate piacevoli in casa.
- 240 Non tutti gli spagnoli fanno la siesta pomeridiana per riposarsi.
- 241 Lo scrittore aveva scelto una stanza luminosa per lavorare.
- 242 La superficie ruvida del pavimento non permette ai mobili di scivolare.
- 243 Giorgia ha subito un torto inaccettabile da un nuovo collega.

- 244 Ieri ho denunciato una aggressione violenta in pieno centro.
245 Lo scambio repentino dei ruoli dei protagonisti non era nel copione.
246 I sacrifici di un cittadino medio per vivere sono immensi.
247 Il diplomatico ha esibito una conoscenza accurata della cultura orientale.
248 Gabriele ricorda sempre alcuni consigli utilissimi del maestro.
249 Il critico ha dato un giudizio pesante su tutte le opere.
250 Il portiere ha effettuato un intervento strabiliante sulla linea di porta.
251 Il professore era stupito dalle soluzioni ingegnose dello studente.
252 Gaspare ha riferito un messaggio segretissimo del nuovo presidente.
253 La terapia ha prodotto un miglioramento netto delle condizioni del paziente.
254 Il signore ha spalato la neve fresca dalla lunga rampa.
255 Greta ha dichiarato un obiettivo difficilissimo da raggiungere.
256 Il musicista ha scoperto le potenzialità sconfinata delle scale armoniche.
257 La promessa di un premio cospicuo a tutta la squadra ha stimolato il lavoro di gruppo.
258 Gli ispettori hanno trovato delle prove schiaccianti della colpevolezza del sospettato.
259 Michela ha comprato una racchetta leggerissima per allenarsi meglio.
260 La voce ruvida del cantante è rimasta nella storia della musica.
261 Il vecchio magistrato indaga sulle attività lucrose della associazione benefica.
262 Il presidente ha proposto un cambiamento impensabile per il consiglio.
263 Mario non immagina la solitudine profondissima degli immigrati clandestini.
264 La protezione civile prevede una catastrofe imminente di natura geologica.
265 Debora ha tratto delle conclusioni precipitose dalle analisi.
266 La brava cuoca ha preparato una crema squisita per dessert.
267 I funzionari devono rispettare la decisione irrevocabile della cancelleria.
268 Daria ha fatto una escursione faticosissima sul Monte Bianco.
269 Le dichiarazioni esplosive del ministro hanno fatto grande clamore.
270 Il regista ha girato un film commovente sulla prima guerra mondiale.
271 Il bambino ha colto delle fragole saporitissime nel bosco.
272 Le imprese gloriose dei condottieri romani sono passate alla storia.
273 Tullio ha rifiutato un incarico interessante per dedicarsi alla famiglia.
274 La spia ha intercettato molte informazioni confidenziali dei nemici.
275 Il gruppo ha effettuato una inversione repentina di marcia.
276 Il malcontento diffuso degli elettori è un punto di forza del giovane candidato.
277 Il finto turista ha rubato un manufatto pregiato dagli scavi.
278 Queste orribili menzogne offendono il mestiere dignitoso del magistrato.
279 Il commerciante aveva un guadagno notevole su tutti i prodotti.
280 Esce sempre un odore nauseante da quel lacero rimorchio.
281 La condizione vacillante del sistema economico preoccupa gli analisti.
282 Il giornalista ha delineato una prospettiva verosimile per la scena politica italiana.
283 La protesta legittima dei ricercatori è appoggiata dal rettore.
284 I regolamenti vigenti in materia stradale prevedono limiti di velocità bassissimi.
285 Il cameriere ha un ricordo vivido dello strano avventore.
286 Nessun indagato ha fornito una ricostruzione verosimile del delitto.
287 Lo studioso ha stupito con la rinuncia plateale al premio Nobel.

- 288 Lo studente ha avuto una ripresa netta nel rendimento.
 289 Il ricco direttore ha scelto un ristorante prestigioso per il suo pranzo.
 290 Il bilancio ha evidenziato i risultati tangibili della nuova gestione.
 291 Le scuse garbate della bella signora hanno calmato Diego.
 292 Il grande studioso era preoccupato per la situazione caotica del mercato.
 293 Il licenziamento del capo ha prodotto una situazione paradossale in ufficio.
 294 Queste reazioni rilasciano una sostanza dannosa per la salute.
 295 Giorgio ha una tendenza irrefrenabile a mentire.
 296 Il restauratore ha scritto un trattato interessante sullo stile del famoso pittore.
 297 Le urla vivaci dei bambini giungono forti dalla sala.
 298 Una versione obsoleta del programma non ci sarebbe di nessun aiuto.
 299 I militari hanno iniziato un attacco organizzato alle truppe nemiche.
 300 Il notaio ha comunicato la data concordata per la riunione.
 301 Gioia ha sposato un cantante famoso in tutto il mondo.
 302 In città si respira un clima rilassato da molto tempo.
 303 Nessuno immaginava un epilogo funesto della spedizione.
 304 Le insegnanti hanno denunciato un episodio gravissimo di bullismo.
 305 Il maestro mi ha consigliato un esercizio basilare per iniziare.
 306 La interpretazione eccellente del giovane soprano ha stupefatto la platea.
 307 I paesaggi suggestivi delle colline toscane incantavano il turista.
 308 Il paziente presenta una ripresa rapidissima della motilità.
 309 Gli inglesi si sono impadroniti delle risorse principali del Sud Africa.
 310 Un temporale fortissimo ad alta quota ha impedito la ultima missione.
 311 Il contratto a tempo indeterminato è un traguardo illusorio nella vita.
 312 La banca centrale ha imposto una analisi occasionale dei consumi.

Experiment 2 Violated Versions

- 313 I medici hanno delle illeggibili per i farmacisti.
 314 Il notaio ha voluto un modestissimo per la mediazione.
 315 Il comune ha organizzato un imperdibile ai giardini pubblici.
 316 Le fatiscenti degli edifici popolari sono state denunciate dalla popolazione.
 317 Le catastrofiche della tua azione saranno pagate da tutti.
 318 Un avanzato di lingua tedesca sarebbe molto utile.
 319 Le bronzee sul portone erano opera di una giovane artista.
 320 Un rarissimo del famoso macaco africano fu oggetto di studi etologici.
 321 Il primo medico ha curato la dolorosa del paziente.
 322 Il rigoglioso sul retro è motivo di orgoglio per i proprietari.
 323 Lucia ha scoperto un divertente al computer.
 324 I costi di un mutuo rappresentano un oneroso per un operaio.
 325 Angelo ama raccontare le favolose dei suoi avi.
 326 Il pentito ha dato delle confuse in merito al luogo del delitto.
 327 E' indispensabile un ragionevole nella mediazione.
 328 In una recente a Panorama la velina ha annunciato le sue nozze.
 329 Ho notato un significativo negli studenti.
 330 Tante convenienti del volantino sono esaurite.
 331 I fatiscenti della estrema periferia stanno per essere ristrutturati.

- 332 Linda ha scelto un faticoso per allenarsi.
333 Una imponente nel giardino dei vicini è caduta per il forte vento.
334 Il sindacato ha proclamato la imminente dei dipendenti comunali.
335 Il giocatore ha segnato un decisivo allo scadere del tempo.
336 Grazie alle robuste degli alberi il pendio non è franato.
337 Il maresciallo esaminò il lacunoso del carabiniere.
338 La ragazza ha avuto una coraggiosa alla notizia.
339 Teresa ha organizzato un sontuoso per inaugurare la stagione.
340 Il giovane non otterrà mai i prestigiosi del suo grande predecessore.
341 La noce moscata esalta il delicato dei funghi.
342 La clamorosa della attuale campionessa è la fine di una gloriosa carriera.
343 Guido ama le piacevoli in casa.
344 Non tutti gli spagnoli fanno la pomeridiana per riposarsi.
345 Lo scrittore aveva scelto una luminosa per lavorare.
346 La ruvida del pavimento non permette ai mobili di scivolare.
347 Giorgia ha subito un inaccettabile da un nuovo collega.
348 Ieri ho denunciato una violenta in pieno centro.
349 Il repentino dei ruoli dei protagonisti non era nel copione.
350 I sacrifici di un medio per vivere sono immensi.
351 Il diplomatico ha esibito una accurata della cultura orientale.
352 Gabriele ricorda sempre alcuni utilissimi del maestro.
353 Il critico ha dato un pesante su tutte le opere.
354 Il portiere ha effettuato uno strabiliante sulla linea di porta.
355 Il professore era stupito dalle ingegnose dello studente.
356 Gaspare ha riferito un segretissimo del nuovo presidente.
357 La terapia ha prodotto un netto delle condizioni del paziente.
358 Il signore ha spalato la fresca dalla lunga rampa.
359 Greta ha dichiarato un difficilissimo da raggiungere.
360 Il musicista ha scoperto le sconfinato delle scale armoniche.
361 La promessa di un cospicuo a tutta la squadra ha stimolato il lavoro di gruppo.
362 Gli ispettori hanno trovato delle schiacciati della colpevolezza del sospettato.
363 Michela ha comprato una leggerissima per allenarsi meglio.
364 La ruvida del cantante è rimasta nella storia della musica.
365 Il vecchio magistrato indaga sulle lucrose della associazione benefica.
366 Il presidente ha proposto un impensabile per il consiglio.
367 Mario non immagina la profondissima degli immigrati clandestini.
368 La protezione civile prevede una imminente di natura geologica.
369 Debora ha tratto delle precipitose dalle analisi.
370 La brava cuoca ha preparato una squisita per dessert.
371 I funzionari devono rispettare la irrevocabile della cancelleria.
372 Daria ha fatto una faticosissima sul Monte Bianco.
373 Le esplosive del ministro hanno fatto grande clamore.
374 Il regista ha girato un commovente sulla prima guerra mondiale.
375 Il bambino ha colto delle saporitissime nel bosco.
376 Le gloriose dei condottieri romani sono passate alla storia.
377 Tullio ha rifiutato un interessante per dedicarsi alla famiglia.
378 La spia ha intercettato molte confidenziali dei nemici.
379 Il gruppo ha effettuato una repentina di marcia.

- 380 Il diffuso degli elettori è un punto di forza del giovane candidato.
381 Il finto turista ha rubato un pregiato dagli scavi.
382 Queste orribili menzogne offendono il dignitoso del magistrato.
383 Il commerciante aveva un notevole su tutti i prodotti.
384 Esce sempre un nauseante da quel lacero rimorchio.
385 La vacillante del sistema economico preoccupa gli analisti.
386 Il giornalista ha delineato una verosimile per la scena politica italiana.
387 La legittima dei ricercatori è appoggiata dal rettore.
388 I vigenti in materia stradale prevedono limiti di velocità bassissimi.
389 Il cameriere ha un vivido dello strano avventore.
390 Nessun indagato ha fornito una verosimile del delitto.
391 Lo studioso ha stupito con la plateale al premio Nobel.
392 Lo studente ha avuto una netta nel rendimento.
393 Il ricco direttore ha scelto un prestigioso per il suo pranzo.
394 Il bilancio ha evidenziato i tangibili della nuova gestione.
395 Le garbate della bella signora hanno calmato Diego.
396 Il grande studioso era preoccupato per la caotica del mercato.
397 Il licenziamento del capo ha prodotto una paradossale in ufficio.
398 Queste reazioni rilasciano una dannosa per la salute.
399 Giorgio ha una irrefrenabile a mentire.
400 Il restauratore ha scritto un interessante sullo stile del famoso pittore.
401 Le vivaci dei bambini giungono forti dalla sala.
402 Una obsoleta del programma non ci sarebbe di nessun aiuto.
403 I militari hanno iniziato un organizzato alle truppe nemiche.
404 Il notaio ha comunicato la concordata per la riunione.
405 Gioia ha sposato un famoso in tutto il mondo.
406 In città si respira un rilassato da molto tempo.
407 Nessuno immaginava un funesto della spedizione.
408 Le insegnanti hanno denunciato un gravissimo di bullismo.
409 Il maestro mi ha consigliato un basilare per iniziare.
410 La eccellente del giovane soprano ha stupefatto la platea.
411 I suggestivi delle colline toscane incantavano il turista.
412 Il paziente presenta una rapidissima della motilità.
413 Gli inglesi si sono impadroniti delle principali del Sud Africa.
414 Un fortissimo ad alta quota ha impedito la ultima missione.
415 Il contratto a tempo indeterminato è un illusorio nella vita.
416 La banca centrale ha imposto una occasionale dei consumi.

Experiment 3 Correct Versions

- 417 Il cambiamento climatico degli ultimi anni sta allarmando molti ambientalisti.
418 I sottaceti sono spesso utilizzati nel condimento per il riso freddo.
419 Il nuovo ministro degli esteri ha appena fatto il giuramento sulla costituzione.
420 Un forte calo del gradimento da parte del pubblico ha causato la sospensione del programma.
421 La associazione culturale ha un orientamento ideologico che non condivido.

- 422 Il pubblico ministero ha avviato un procedimento a carico di un importante politico locale.
- 423 Leonardo si è offeso per il riferimento del direttore al suo recente fallimento.
- 424 Tutta la tifoseria spera in un ripensamento del presidente sulla vendita della società.
- 425 Per un reale rilancio della ditta serve un risanamento dei conti.
- 426 Il traffico intenso è dovuto ad un tamponamento fra una macchina e un motorino.
- 427 Giorgio avrebbe vinto la gara se non avesse avuto un tentennamento al giro finale.
- 428 Il testamento del famoso milionario ha scatenato la lite fra i figli e la moglie.
- 429 La banca ha confermato che il versamento sul conto del fornitore è avvenuto correttamente.
- 430 A molte persone non è chiaro se il buddismo sia una filosofia o una religione.
- 431 La lega nord è il partito che propone il federalismo nel nostro paese.
- 432 Un famoso esponente del futurismo in Italia è Marinetti.
- 433 Il problema risiede nel meccanismo di selezione dei candidati.
- 434 Uno dei simboli classici del nazismo è la svastica.
- 435 A volte il patriottismo sfocia nel razzismo.
- 436 Nelle grandi metropoli il pendolarismo comporta un problema per la viabilità.
- 437 Nella gestione delle risorse mediatiche il pluralismo è fondamentale.
- 438 Il positivismo è una corrente filosofica ottocentesca.
- 439 Debora adora il pragmatismo del suo istruttore di escursionismo.
- 440 Il proselitismo non è contemplato nella religione ebraica.
- 441 I rappresentanti sindacali devono affrontare la situazione con il realismo necessario.
- 442 Le opere di Segantini esprimono il simbolismo dominante in quel periodo.
- 443 Nessuno metteva in dubbio la colpevolezza del fidanzato della vittima.
- 444 La cupezza del tono di colori caratterizza le ultime opere di Goya.
- 445 Il giovane ha manipolato con molta destrezza le carte.
- 446 La gentilezza della fanciulla ha commosso tutti gli amici.
- 447 Monica ha misurato la grandezza della stanza prima di comprare un divano.
- 448 I politici discutono con molta lentezza sulle misure finanziarie importanti.
- 449 Gli scienziati hanno mostrato molta pacatezza durante la discussione sulla controversia.
- 450 La purezza stilistica è uno dei valori principali di questo scrittore.
- 451 Il suo modo di scrivere con troppa ricercatezza non è piaciuto al direttore.
- 452 Il direttore ha garantito la riservatezza dei dati personali raccolti.
- 453 Il meteorologo ha confermato con molta sicurezza la pioggia per domani.
- 454 La sregolatezza di quel fanciullo ricorda quella di suo padre.
- 455 La morte del pappagallo ha procurato una grande tristezza ai familiari.
- 456 La concordanza fra le parti non fu mai raggiunta.
- 457 La campionessa ha dimostrato una grande costanza nella gara di maratona.
- 458 La dimenticanza del nonno ha provocato un grosso guaio.
- 459 I giornalisti hanno notato una sconvolgente ignoranza del ministro su questo tema.
- 460 I dipendenti hanno ammirato la considerevole lungimiranza del loro capo.
- 461 La grande maggioranza dei consumatori ha boicottato quella marca.

- 462 Molti popoli soffrono ancora una crudele mancanza di libertà di espressione.
463 Il fenomeno della delinquenza coinvolge una piccola minoranza degli
adolescenti.
- 464 I turisti americani sono stati spaventati dalla petulanza dei venditori ambulanti.
465 La rilevanza di questo studio è stata riconosciuta dal comitato.
466 La riluttanza di Elisa ad accettare il compito traspare dalla sua risposta.
467 La pericolosità del detenuto richiede una sorveglianza speciale.
468 Nel Trentino si apprezza la vicinanza alle belle Dolomiti.
469 La struttura è crollata per colpa di un cedimento improvviso di alcune colonne.
470 Non uccidere è un importante comandamento della religione cristiana.
471 Una prolungata esposizione al freddo può provocare il congelamento dei
tessuti organici.
- 472 Alle feste della associazione universitaria il divertimento è sempre assicurato.
473 Lo storico negozio di alimentari rischia il fallimento da quando ha aperto il
centro commerciale.
- 474 Alcuni studiosi hanno scoperto riserve di minerali preziosi nel giacimento
abbandonato.
- 475 Il movimento delle placche tettoniche può provocare terremoti ed eruzioni.
476 Il parlamento non ha approvato la legge di bilancio per un solo voto.
477 Il pentimento è sempre il primo passo verso la redenzione.
478 Il film che esce oggi nelle sale è il rifacimento di un vecchio poliziesco.
479 Il cliente ha chiesto un risarcimento per il ritardo nella consegna della merce.
480 Lo sfruttamento del lavoro minorile è un problema molto diffuso nelle
economie emergenti.
- 481 Il concorrente ha risposto correttamente alla domanda solo grazie al
suggerimento del pubblico.
- 482 La caduta di questo governo segnerà probabilmente la fine del bipolarismo in
Italia.
- 483 Aldo Grasso sostiene che il cinismo è la crudeltà dei delusi.
484 Il dogmatismo è una caratteristica costante delle religioni.
485 Cartesio introdusse il dualismo nella filosofia moderna.
486 Il presidente della camera ha abbandonato il fascismo negli anni novanta.
487 Con lo sviluppo di internet il giornalismo ha dovuto affrontare difficili sfide.
488 I giovani hanno generalmente un metabolismo più rapido degli anziani.
489 Nelle democrazie in crisi il nepotismo è una patologia frequente.
490 Un batterio è un organismo vivente monocellulare.
491 La caduta delle borse giustifica il pessimismo dei piccoli investitori.
492 I componenti del gruppo non sopportano più il protagonismo del cantante.
493 La commissione ha abbandonato lo scetticismo dimostrato inizialmente.
494 Il tempismo non è il punto di forza del nuovo terzino.
495 Paolo ha ammirato la notevole bellezza del lago al tramonto.
496 La brillantezza del ragazzo ha impressionato tutti i professori.
497 Una certezza è che raggiungeremo il nostro obiettivo di vendita.
498 La completezza delle prove non fu sufficiente per dimostrare la sua innocenza.
499 La causa della sconfitta elettorale fu la discutibile correttezza morale del
candidato.
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501 La finezza della sua poesia ha incantato il pubblico.

- 502 Vogliamo andare a visitare la fortezza sulla collina.
503 La forza e la giovinezza degli atleti ispirarono gli scultori greci.
504 La tavola è stata apparecchiata con molta raffinatezza da Giovanna.
505 La socievolezza dei compagni di scuola ha aiutato molto il nuovo allievo.
506 Le sue battute satiriche pur nella loro sottigliezza hanno colpito nel segno.
507 La belligeranza tra i partiti politici ha infiammato la rabbia dei cittadini.
508 La cittadinanza italiana può essere richiesta dagli immigrati dopo molti anni.
509 Un ispettore ha attribuito il motivo del reato alla concomitanza di interessi personali.
510 Il ricercatore ha scoperto una forte discrepanza tra i risultati dei due laboratori.
511 La distanza fra la terra e il sole è detta unità astronomica.
512 Quel pittore è noto per una forte esuberanza di carattere.
513 Il barbone ha espresso una vibrante esultanza dopo aver vinto la lotteria.
514 Giovanni ha appena ricevuto la notizia della gravidanza di sua cugina.
515 La latitanza degli imputati ha aumentato il sospetto del giudice.
516 Il sito della rappresentanza permanente delle nazioni unite si trova a Ginevra.
517 Lo studente ha ripetuto un esame per la terza volta con la speranza di alzare i voti.
518 Anna viene riconosciuta subito per la eccezionale stravaganza nel vestire.
519 Mostrò una sottile titubanza prima di accettare la proposta.
520 I negozianti hanno mostrato scarsa tolleranza durante la discussione.

Experiment 3 Violated Versions

- 521 La cambiamento climatico degli ultimi anni sta allarmando molti ambientalisti.
522 I sottaceti sono spesso utilizzati nella condimento per il riso freddo.
523 Il nuovo ministro degli esteri ha appena fatto la giuramento sulla costituzione.
524 Un forte calo della gradimento da parte del pubblico ha causato la sospensione del programma.
525 La associazione culturale ha una orientamento ideologico che non condivido.
526 Il pubblico ministero ha avviato una procedimento a carico di un importante politico locale.
527 Leonardo si è offeso per la riferimento del direttore al suo recente fallimento.
528 Tutta la tifoseria spera in una ripensamento del presidente sulla vendita della società.
529 Per un reale rilancio della ditta serve una risanamento dei conti.
530 Il traffico intenso è dovuto ad una tamponamento fra una macchina e un motorino.
531 Giorgio avrebbe vinto la gara se non avesse avuto una tentennamento al giro finale.
532 La testamento del famoso milionario ha scatenato la lite fra i figli e la moglie.
533 La banca ha confermato che la versamento sul conto del fornitore è avvenuto correttamente.
534 A molte persone non è chiaro se la buddismo sia una filosofia o una religione.
535 La lega nord è il partito che propone la federalismo nel nostro paese.
536 Un famoso esponente della futurismo in Italia è Marinetti.

- 537 Il problema risiede nella meccanismo di selezione dei candidati.
- 538 Uno dei simboli classici della nazismo è la svastica.
- 539 A volte la patriottismo sfocia nel razzismo.
- 540 Nelle grandi metropoli la pendolarismo comporta un problema per la viabilità.
- 541 Nella gestione delle risorse mediatiche la pluralismo è fondamentale.
- 542 La positivismo è una corrente filosofica ottocentesca.
- 543 Debora adora la pragmatismo del suo istruttore di escursionismo.
- 544 La proselitismo non è contemplato nella religione ebraica.
- 545 I rappresentati sindacali devono affrontare la situazione con la realismo necessario.
- 546 Le opere di Segantini esprimono la simbolismo dominante in quel periodo.
- 547 Nessuno metteva in dubbio il colpevolezza del fidanzato della vittima.
- 548 Il cupezza del tono di colori caratterizza le ultime opere di Goya.
- 549 Il giovane ha manipolato con molto destrezza le carte.
- 550 Il gentilezza della fanciulla ha commosso tutti gli amici.
- 551 Monica ha misurato il grandezza della stanza prima di comprare un divano.
- 552 I politici discutono con molto lentezza sulle misure finanziarie importanti.
- 553 Gli scienziati hanno mostrato molto pacatezza durante la discussione sulla controversia.
- 554 Il purezza stilistica è uno dei valori principali di questo scrittore.
- 555 Il suo modo di scrivere con troppo ricercatezza non è piaciuto al direttore.
- 556 Il direttore ha garantito il riservatezza dei dati personali raccolti.
- 557 Il meteorologo ha confermato con molto sicurezza la pioggia per domani.
- 558 Il sregolatezza di quel fanciullo ricorda quella di suo padre.
- 559 La morte del pappagallo ha procurato un grande tristezza ai familiari.
- 560 Il concordanza fra le parti non fu mai raggiunta.
- 561 La campionessa ha dimostrato un grande costanza nella gara di maratona.
- 562 Il dimenticanza del nonno ha provocato un grosso guaio.
- 563 I giornalisti hanno notato un sconvolgente ignoranza del ministro su questo tema.
- 564 I dipendenti hanno ammirato il considerevole lungimiranza del loro capo.
- 565 Il grande maggioranza dei consumatori ha boicottato quella marca.
- 566 Molti popoli soffrono ancora un crudele mancanza di libertà di espressione.
- 567 Il fenomeno della delinquenza coinvolge un piccola minoranza degli adolescenti.
- 568 I turisti americani sono stati spaventati dal petulanza dei venditori ambulanti.
- 569 Il rilevanza di questo studio è stata riconosciuta dal comitato.
- 570 Il riluttanza di Elisa ad accettare il compito traspare dalla sua risposta.
- 571 La pericolosità del detenuto richiede un sorveglianza speciale.
- 572 Nel Trentino si apprezza il vicinanza alle belle Dolomiti.
- 573 La struttura è crollata per colpa di una cedimento improvviso di alcune colonne.
- 574 Non uccidere è una importante comandamento della religione cristiana.
- 575 Una prolungata esposizione al freddo può provocare la congelamento dei tessuti organici.
- 576 Alle feste della associazione universitaria la divertimento è sempre assicurato.
- 577 Lo storico negozio di alimentari rischia la fallimento da quando ha aperto il centro commerciale.

- 578 Alcuni studiosi hanno scoperto riserve di minerali preziosi nella giacimento abbandonato.
- 579 La movimento delle placche tettoniche può provocare terremoti ed eruzioni.
- 580 La parlamento non ha approvato la legge di bilancio per un solo voto.
- 581 La pentimento è sempre il primo passo verso la redenzione.
- 582 Il film che esce oggi nelle sale è la rifacimento di un vecchio poliziesco.
- 583 Il cliente ha chiesto una risarcimento per il ritardo nella consegna della merce.
- 584 La sfruttamento del lavoro minorile è un problema molto diffuso nelle economie emergenti.
- 585 Il concorrente ha risposto correttamente alla domanda solo grazie alla suggerimento del pubblico.
- 586 La caduta di questo governo segnerà probabilmente la fine della bipolarismo in Italia.
- 587 Aldo Grasso sostiene che la cinismo è la crudeltà dei delusi.
- 588 La dogmatismo è una caratteristica costante delle religioni.
- 589 Cartesio introdusse la dualismo nella filosofia moderna.
- 590 Il presidente della camera ha abbandonato la fascismo negli anni novanta.
- 591 Con lo sviluppo di internet la giornalismo ha dovuto affrontare difficili sfide.
- 592 I giovani hanno generalmente una metabolismo più rapido degli anziani.
- 593 Nelle democrazie in crisi la nepotismo è una patologia frequente.
- 594 Un batterio è una organismo vivente monocellulare.
- 595 La caduta delle borse giustifica la pessimismo dei piccoli investitori.
- 596 I componenti del gruppo non sopportano più la protagonismo del cantante.
- 597 La commissione ha abbandonato la scetticismo dimostrato inizialmente.
- 598 La tempismo non è il punto di forza del nuovo terzino.
- 599 Paolo ha ammirato il notevole bellezza del lago al tramonto.
- 600 Il brillantezza del ragazzo ha impressionato tutti i professori.
- 601 Un certezza è che raggiungeremo il nostro obiettivo di vendita.
- 602 Il completezza delle prove non fu sufficiente per dimostrare la sua innocenza.
- 603 La causa della sconfitta elettorale fu il discutibile correttezza morale del candidato.
- 604 La giovane attrice ha recitato Giulietta con un delicatezza squisita.
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Appendix 2 - LAN Timing Analysis

In Figure 6 are depicted the values of the t-Tests conducted on the average voltage on a left-anterior cluster of sites (F3, FC5, C3, T7, CP5) as a function of time in the correct versus violation conditions at the critical word for both verbs (Experiment 1) and prepositions (Experiment 2). The straight horizontal line corresponds to the significance level ($\alpha = .05$). The onset time of the effect, defined as the time where at least five subsequent tests were significant, is 330ms for the violation in the verb and 290ms for the violation on the preposition. The waveforms of average voltage on a left-anterior cluster of sites (AL) are depicted in Figure 5.

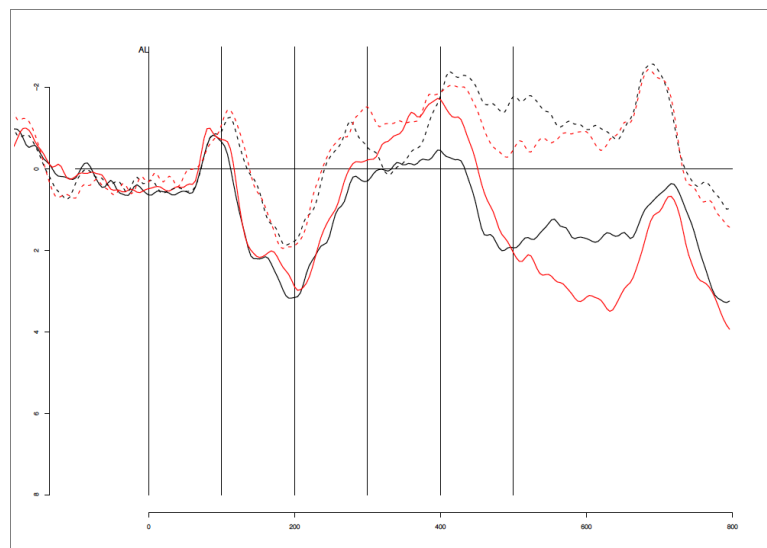
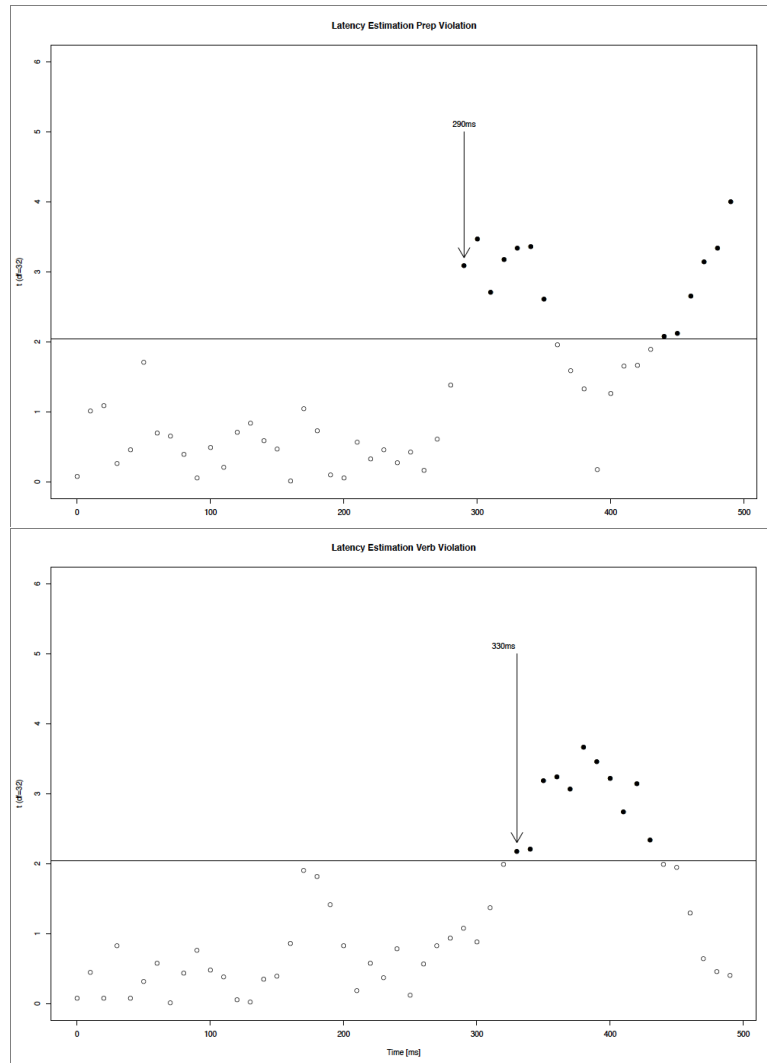


Fig 5. Waveforms of average voltage on a left-anterior cluster of sites (F3, FC5, C3, T7, CP5) were the LAN amplitude is maximal in both Experiment 1 and Experiment 2.

Figure 6. t-test on the average voltage within contiguous 10ms time



windows for the comparisons between the correct and the violation conditions at the critical word for verbs (top) and prepositions (bottom). Horizontal lines correspond to significance level ($p < .05$). Onset latency estimations are plotted on the graphics.