Electrophysiological Measures of Language Processing in Bilinguals

Alice Mado Proverbio¹, Barbara Čok², and Alberto Zani³

Abstract

The aim of the present study was to investigate how multiple languages are represented in the human brain. Event-related brain potentials (ERPs) were recorded from righthanded polyglots and monolinguals during a task involving silent reading. The participants in the experiment were nine Italian monolinguals and nine Italian/Slovenian bilinguals of a Slovenian minority in Trieste; the bilinguals, highly fluent in both languages, had spoken both languages since birth. The stimuli were terminal words that would correctly complete a short, meaningful, previously shown sentence, or else were semantically or syntactically incorrect. The task consisted in deciding whether the sentences were well formed or not, giving the response by pressing a button. Both groups read the same set of 200 Italian sentences to compare the linguistic processing, while the bilinguals also received a set of 200 Slovenian sentences, comparable in complexity and length, to compare the processing of the two languages within the group. For the bilinguals, the ERP results revealed a strong, left-sided activation, reflected by the N1 component, of the occipito-temporal regions dedicated to orthographic processing, with a latency of about 150 msec for Slovenian words, but bilateral activation of the same areas for Italian words, which was also displayed by topographical mapping. In monolinguals, semantic error produced a long-lasting negative response (N2 and N4) that was greater over the right hemisphere, whereas syntactic error activated mostly the left hemisphere. Conversely, in the bilinguals, semantic incongruence resulted in greater response over the left hemisphere than over the right. In this group, the P615 syntactical error responses were of equal amplitude on both hemispheres for Italian words and greater on the right side for Slovenian words.

The present findings support the view that there are inter-and intrahemispheric brain activation asymmetries when monolingual and bilingual speakers comprehend written language. The fact that the bilingual speakers in the present study were highly fluent and had acquired both languages in early infancy suggests that the brain activation patterns do not depend on the age of acquisition or the fluency level, as in the case of late, not-so-proficient L2 language learners, but on the functional organization of the bilinguals’ brain due to polyglotism and based on brain plasticity.

INTRODUCTION

The study examines the neurofunctional mechanisms of linguistic comprehension in monolingual and bilingual speakers engaged in the processing of well-formed or incongruent sentences in Italian and Slovenian. More specifically, the aim of the study was to investigate whether the two cerebral hemispheres of monolingual and polyglot people process orthographic, semantic, and syntactic aspects of written language differentially. In fact, while it is generally acknowledged that the right hemisphere has limited capabilities in syntactic processing and a higher involvement in semantic processing in monolinguals, there is evidence that hemispheric lateralization of linguistic functions is different in polyglots.

Chernigovskaya, Balonov, and Deglin (1983) showed a different lateralization of semantic and syntactic structures for the first language (L1) and the second (L2) in a bilingual psychiatric patient treated with unilateralized electroconvulsive therapy. The authors described a lateralization of semantic functions to the right hemisphere for L1 and to the left hemisphere for L2, while syntactic functions were lateralized to the left hemisphere for both languages. A differential lateralization of multiple languages has also been reported for professional interpreters (Fabbro, Gran, Basso, & Bava, 1990; Fabbro & Daró, 1995; Fabbro, Gran, & Gran, 1991). However, the pattern of lateralization in these individuals is complicated by an asymmetric use of the ears for listening to the linguistic material to be translated during their professional commitments. In fact, they have the habit of listening to the source language with the left ear (right hemisphere), taking off the right earphone in order to leave the right ear (left hemisphere) free to monitor their own verbal performance (Gran, 1989). Indeed, in a behavioral study (Fabbro et al., 1991) involving a dichotic listening task simulating a simultaneous interpretation performance, professional simultaneous interpreters showed a significant right-ear superiority in recognizing semantic errors in L1, and

¹University of Milano-Bicocca, ²University of Trieste, ³National Research Council (CNR), Italy

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Journal of Cognitive Neuroscience 14:7, pp. 994–1017
syntactic errors in L2, while they showed left-ear superiority in recognizing semantic errors in L2 and syntactic errors in L1. Based on these studies, the conclusion might be drawn that linguistic functions tend to be more differentially lateralized in polyglot brains than in monolingual.

Clinical cases of polyglot aphasia have also suggested that the linguistic representation of L1 and L2 in polyglots might involve separate neurofunctional circuits, and/or be caused by a dysfunction of a putative switching mechanism between the languages. This assumption is based on evidence that after the insult polyglot patients may selectively recover one language while showing severe aphasic symptoms for the other language. However, lesion data have provided a rather complex pattern of results, including a selective recovery of the language learned earlier in life or the one spoken most frequently (Paradis, 1989), as well as a pathological mixing of the languages (Abutalebi, Miozzo, & Cappa, 2000; Aglioti, Beltrame, Girardi, & Fabbro, 1996; Aglioti & Fabbro, 1993).

In general, although the role of the right hemisphere in bilinguals’ language processing remains controversial, there is a great deal of evidence supporting a differential intrahemispheric representation for monolingual and bilingual speakers. For example, Dehaene et al. (1997) used fMRI to assess intersubject variability in the cortical representation of language comprehension in moderately fluent French/English bilinguals while they listened to stories in the two languages. They found that while the first language (L1) activated a similar set of areas in the left temporal lobe in all subjects, the second language (L2) activated a highly variable network of the left and right temporal and frontal areas, with individual subjects varying from a standard left lateralization to a complete right hemispheric lateralization. However, another fMRI study (Illes et al., 1999) described a different pattern of results with fluent English/Spanish bilinguals who acquired their second language years after acquiring their first language. In this study, no differences in brain activation were found across groups for semantic analysis of the two languages.

A further important dimension related to bilingualism and polyglotism is the age of acquisition of a given language, this leading to considerable variation in the pattern of brain activation for native and second languages. The fMRI findings of Kim, Relkin, Lee, and Hirsch (1997) indicate that while the language-sensitive regions of the temporal lobe (Wernicke’s area) show little or no difference in activity based on the age of language acquisition, those of the frontal lobe (Broca’s area) show a differential activation as a function of the age of acquisition of the second language. When the second language is acquired during early language development, the native and second languages tend to be represented in common frontal cortical areas, whereas when they are acquired at a later stage of linguistic development (in adulthood), the areas of activation of the two languages appear to be distributed slightly differently. Perani et al. (1996) used positron emission tomography (PET) to study brain activity in adults listening to stories in their native language (L1), in a second language acquired after the age of 7 (L2), and in an unknown third language (L3). They found that several areas, similar to those already observed in monolinguals, were activated by L1 but not by L2. These results demonstrated the great importance of early exposure to the maternal language in shaping linguistic areas of the brain. However, in a later study (Perani et al., 1998), the same authors demonstrated another important dimension in determining cortical representation of languages in polyglots to be the proficiency level of a given language, regardless of acquisition age. They evaluated the effect of early and late acquisition of L2 in highly proficient bilinguals testing a group of Italian/English bilinguals who had acquired L2 after the age of 10 years (high proficiency, late acquisition bilinguals) and a group of Spanish/Catalan bilinguals who had acquired L2 before the age of 4 years (high proficiency, early acquisition bilinguals). Failing to find any difference in the cortical response of volunteers listening to stories in L1 and L2, Perani et al. (1998) ascribed the difference between the data of that study and those of their earlier study (Perani et al., 1996) to the low proficiency level attained by the late acquisition bilinguals in the previous PET study. On the basis of these data, they also concluded that attained proficiency is more important than age of acquisition as a determinant of the cortical representation of L2.

Linguistic processing in bilinguals has also been investigated by event-related potentials (ERPs) of the brain. Indeed, ERPs are very useful tools to study the neural basis of language comprehension, as they provide information on the temporal course of information processing neural flow in different semantic and morphosyntactic tasks. In fact, ERP studies on language (see Federmeier, Kluender, & Kutas, 2002, for a recent review; Kutas & Van Petten, 1994; Kutas & Hillyard, 1980) have shown that semantic integration is reflected by the N400 component, a centro-parietal negativity with a latency of around 400 msec very sensitive to word cloze probability. On the other hand, phrase structure assignment and syntactic integration are assumed to be reflected by an early left anterior negativity (ELAN) with a latency of about 100–300 msec; a left anterior negativity (LAN) with a latency of about 300–500 msec, and a left centro-parietal positivity (P600), also called syntactic positive shift (Friederici, Steinhauer, & Frisch, 1999; Hahne & Friederici, 1999; Münte, Heinze, Matzke, Wieringa, & Johannes, 1998; Osterhout & Holcomb, 1992, 1993). The ELAN is reported to reflect a first-pass parsing process and to be very sensitive to word category, being guided by phrase structure rules. The later negativity (LAN), overlapping in time with semantic N400, reflects
morphosyntactic analysis while the late positivity reflects relatively controlled language-related processes (Hahne & Friederici, 1999) sensitive to inflectional information (Gunter & Friederici, 1999) and is associated with secondary syntactic processes such as sentence reanalysis and repair (Friederici, 1997) and processes inhibiting incorrect representation due to difficulty with syntactic integration (Kaan, Harris, Gibson, & Holcomb, 2000).

Few ERP studies have investigated the neurofunctional differences in linguistic semantic and syntactic processing in bilinguals. The ERP study by Fischler, Boaz, McGovern, and Ransdell (1987), where the N400 component was measured in English/Spanish bilinguals during a semantic decision task, failed to find any cross-linguistic effect of semantic priming. The study revealed a reduction in N400 amplitude for within-language repetitions, but no effect for the cross-language repetitions. In other words, the prior repetition of a word in a given language (for instance, English) failed to influence the processing of its Spanish translation, thus supporting the view of two independent lexical stores. This result fits in neatly with the differential pattern of bilingual brain activation in semantic violation studies on the N400 component. Meuter, Donald, and Ardal (1987) found that N400 was greater over the left parietal sites than over the right for the second language (L2) of French/English speakers, while it was bilaterally symmetrical for their first language (L1). Ardal, Donald, Meuter, Muldrew, and Luce (1990) examined different groups of bilinguals of different native languages—French, English, Chinese, Spanish, and Korean—finding N400 to be greater over the right parietal side in monolinguals and over the left side in bilinguals. In a more recent study, Weber-Fox and Neville (1996) investigated the influence of bilingual proficiency on hemispheric lateralization of linguistic brain areas, testing a large sample of Chinese/English bilinguals who had been exposed to English at different stages of their development. The test involved only the English language, not Chinese. The authors found a delay in N400 latency for bilinguals exposed to English after the age of 10, but no differences in the amplitude or topography of N400 on comparing bi- and monolinguals.

In the present experiment, ERPs and reaction times (RTs) were recorded in two groups of young monolinguals and Italian/Slovenian bilinguals. The subjects had to decide on the correctness of visually presented short sentences. All the participants in the study were highly fluent in Italian, and the bilinguals were also very fluent in Slovenian, being for the most part university students belonging to the Slovenian minority living near the Italian/Slovenian border, having Italian nationality, and attending the Italian University in Trieste. Some taught Italian in Slovenian schools. Thus, all the bilinguals had an excellent command of both languages and a high proficiency level. Because of this, we hypothesized that any difference in the brain activation of the monolingual and bilingual groups could be ascribed solely to polyglotism, and not to acquisition age or proficiency level. The aim of the present investigation was manifold. First of all, we wanted to study the neurolinguistic organization of brain structures by comparing the ERP response of “early” (or “infant”) bilinguals with that of monolinguals, both tested in the same language (Italian). Secondly, our aim was to compare the spatio-temporal activation of brain areas in bilinguals during the reading and comprehension of two different languages, both acquired precociously (Italian and Slovenian) and of a high proficiency level. Thirdly, we investigated possible inter- and intrahemispheric differences in brain activation during word processing as a function of the specific word (violation) type, namely “correct,” “semantically incorrect,” and “semantically and syntactically incorrect.” On the basis of previous literature data, we hypothesized a difference in the specific role of the two cerebral hemispheres and of the anterior and posterior language-sensitive brain areas in the processing of first and second languages. As the primary aim of the study was to compare how a bilingual brain processes words belonging to two different languages, also comparing it with a monolingual brain subjected to an identical stimulus, we did not adopt the classical paradigm of the presentation of sentences known as rapid serial visual presentation (RSVP), which would have allowed a more specific study to be made of the semantic and syntactic aspects of linguistic processing (of noncritical words also). Given our different aim, the study called for a paradigm that would satisfy, as far as possible, the need to control, and balance perfectly within groups and conditions, a series of linguistic factors related only to terminal words on which the electroencephalogram (EEG) was time-locked for the purposes of ERP averaging.

The present study set out to achieve an insight into the spatio-temporal activation, indexed by ERP components, of the two cerebral hemispheres in bilinguals and monolinguals during the processing of Italian and Slovenian. Both languages are phonologically transparent, Slovenian being more complex than Italian at the morphosyntactic level due to its being a highly inflected language.

RESULTS

Behavioral Results

Overall, the RTs were much faster for the monolingual group (675 msec) than the bilingual (Italian 759 msec, Slovenian 726 msec).

Reaction Times

Monolinguals/Bilinguals—Italian. The analysis of variance (ANOVA) on mean RTs to Italian terminal words confirmed the difference in response speed between the
two linguistic groups, as indicated by the significance of the group factor (see Table 1 for statistical significance). Furthermore, ANOVA showed the effect of word type due to slower RTs in responding to semantic errors (compared with correct words or syntactic errors) for both groups (Figure 1).

**Bilinguals—Slovenian/Italian.** The within-group ANOVA for the bilinguals yielded the significance of word type. Post hoc comparisons showed that the RTs were significantly slower to semantic errors in both languages.

In addition, the interaction of Word type × Language and post hoc comparisons indicated that the RTs to correct and syntactically incorrect words were faster ($p < .01$) in the Slovenian condition (correct = 704 msec, syntactically incorrect = 702 msec) than the Italian condition (correct = 750 msec, syntactically incorrect = 752 msec), whereas the RT did not differ with regard to semantic error across the two languages (Italian = 773 msec, Slovenian = 771 msec). The ANOVA also yielded the triple interaction Word type × Language × Hand. Post hoc tests indicated that bilingual individuals had a preference for the left hand only during the processing of Slovenian words. In particular, the fastest RTs were produced to correct Slovenian words (with the left hand), and the slowest responses to Slovenian semantic errors (with the right hand). No hand preference whatsoever was found for Slovenian syntactic errors or any word in the Italian condition (see Figure 1).

### Correct Responses

**Monolinguals/Bilinguals—Italian.** The between-groups ANOVA performed on the percentage of correct response gave rise to the significant effect of the hand. Hit percentage was higher when readers used their left hand. However, the quasi-significant double interaction of Hand × Group indicated that this effect was almost entirely due to the monolingual group. Post hoc comparisons proved that only the monolingual group had any advantage in using the left (96%) versus the right (88.5%) hand, whereas no difference was found for the two hands for the bilingual group (left 90%, right 88.5%).

**Bilinguals—Slovenian/Italian.** The within-group ANOVA performed on the bilingual’s behavioral response showed the effect of word type. Post hoc comparisons...
indicated a lower percentage of correct recognition of semantic error than of syntactic error and correct words. The double interaction of Word type × Language proved that the bilinguals recognized a higher percentage of semantic errors in the Italian language, and a higher percentage of syntactic errors in the Slovenian language, whereas there was no difference between the two languages for correct words (see Figure 2). The ANOVA also yielded a significance of Word type × Language × Hand. The bilinguals in the Italian language produced the highest percentage of correct categorization for syntactic error using the right hand while the worst performance produced with the same hand was for semantic error ($p < .05$). In the Slovenian language, they produced the highest percentage of correct categorization for syntactic error using the left hand, while the worst performance produced with the same hand was for semantic error ($p < .01$).

An analysis of correct response showed a preference for the left hand by the monolingual group in Italian and by the bilingual group for Slovenian, the bilingual showing, instead, preference for the right hand in the Italian language. Consistent with this was the RT analysis for the bilingual group: It showed a left-hand preference for the Slovenian language and no hand preference for Italian. These data could be interpreted in the light of the so-called interference hypothesis that hypothesizes that if the hemisphere controlling the two-choice (index/medium finger) motor response is also involved in linguistic processes, the performance is worse than if there is no involvement (e.g., Waldie & Mosley, 2000). Thus, favoring the left-hand would reveal a left hemisphere involvement in linguistic processing, whereas favoring the right would reveal right hemisphere involvement.

**Electrophysiological Results**

For each subject, electrode, and hemispheric sites, distinct ERP averages were computed as a function of the linguistic group (monolinguals and bilinguals), the language (Italian and Slovenian), and the word type (correct, semantically incorrect, or syntactically incorrect). Moreover, ANOVA was applied to each ERP component, with the factors and levels being described in the Methods section.

**N1 Component**

Monolinguals/Bilinguals—Italian. The ANOVA, performed on the N1 mean area values (recorded at F34, C34, P34, T56, and O12 sites between 140 and 200 msec), revealed an electrode effect indicating greater N1 amplitudes at the posterior temporal and occipital sites for both linguistic groups (see Table 2 for statistical significance). The Electrode × Hemisphere significant interaction showed greater N1 response at the left hemispheric posterior temporal and occipital sites. Although there was a tendency in that direction (monolinguals: left hemisphere = −2.63, right hemisphere = −0.39; bilinguals: left hemisphere = −2.19, right hemisphere = −1.79), no significant effect of group per se or in interaction with the hemisphere was found at this latency level.

Bilinguals—Slovenian/Italian. The ANOVA performed on the bilingual group revealed a significant effect of language due to the greater N1 response to Italian words (−2 µV) than to Slovenian (−0.97 µV). The ANOVA also showed an effect of electrode. As in the preceding analysis, the post hoc comparisons indicated greater N1 amplitude at the posterior temporal and occipital sites. This amplitude proved to be greater over the left

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**Figure 2.** Percentages of correct categorizations obtained for the two linguistic groups to Italian and Slovenian terminal words as a function of word type and response hand.
hémisphère for both languages, as demonstrated by the
significance of the main factor, hémisphère. However,
post hoc comparisons for the Language × Hemisphere
interaction showed that while N1 to Slovenian terminal
words was much greater at the left recording sites
(−1.59 μV) than the right (−0.35 μV), the responses to
Italian words did not differ significantly (left hémisphère = −2.19; right hémisphère = −1.79 μV). At this pre-
semantic level, the ERPs were not significantly affected by
the word type factor, suggesting that between 140 and
200 msec, the lexical information is still not accessed and
the brain is still processing the word orthographic form
(Bentin, Mouchetant-Rostaing, Giard, Echallier, & Pernier,
1999). This strong effect of language on hémisphéric
activation in the bilingual group could be explained by
assuming an experience-based word form system able to
recognize real fonts that might differentiate Slovenian
words from Italian ones at very early processing stages.

Figure 3 shows the topographical mapping of the
brain activation, recorded between 160 and 180 msec
poststimulus latency (N1 component), during the ortho-
graphic analysis for the two languages of the bilinguals.
The red circle indicates the right occipital area that was
specifically active during the reading of Italian material,
but not of Slovenian.

**N2 Component**

Monolinguals/Bilinguals—Italian. The ANOVA per-
formed on the N2 mean area values (recorded at F34,
C34, P34, T56, and O12 sites between 200 and 340 msec) revealed a significant effect for the Electrode factor. Both groups had a negative peak that reached its maximum amplitude at the posterior temporal and occipital sites. At this latency, the first effect of word type appeared, such effect being greater negativity for incorrect terminal words than for correct ones. Indeed, N2 to syntactic error (−0.67 μV) was significantly bigger than N2 to semantic error (−0.49 μV, p < .05) or correct words (+0.36 μV, p < .01). Between-groups ANOVA also showed an interaction of Word type × Hemisphere × Group. Relative post hoc comparisons (N2 in Table 3)

Table 3. N2 Mean Amplitude Values (with Standard Errors) Recorded at Left and Right Hemispheric Sites as a Function of Linguistic Group and Word Type

<table>
<thead>
<tr>
<th>Language</th>
<th>Correct</th>
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<td>Group</td>
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<tr>
<td>Monolingual</td>
<td>0.41 (0.63)</td>
<td>0.97 (0.67)</td>
<td>0.09 (0.64)</td>
<td>−0.1 (0.64)</td>
<td>−0.66 (0.56)</td>
<td>−0.38 (0.53)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilingual</td>
<td>−0.09 (0.55)</td>
<td>0.14 (0.54)</td>
<td>−1.12 (0.61)</td>
<td>−0.81 (0.60)</td>
<td>−0.75 (0.50)</td>
<td>−0.86 (0.50)</td>
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indicated that, in monolinguals, semantic error produced a greater negative response over the right hemisphere than over the left (Figure 4a), whereas syntactic error mostly activated the left hemisphere (Figure 4b). The difference maps (Figure 5) show the topographical distribution of the enhanced negativity to semantic and semantic + syntactic error within this latency range. The syntactic–semantic difference map series (Figure 5, right) shows the topography of the additional negativity in response to terminal words that are also syntactically incongruous. This negativity is distributed more over the left temporal area than the right in monolinguals, while in the bilinguals, the pattern is almost inverted for the Slovenian language (Figure 4d); no other response was evident in the latter group for Italian. Post hoc comparisons also showed that the bilingual N2 response to semantic incongruence was of greater amplitude in the left hemisphere than in the right (Figure 4c and e).

**Bilinguals—Slovenian/Italian.** The within-group ANOVA on bilinguals also revealed a significant electrode effect, indicating greater N2 amplitudes at the posterior temporal and occipital sites. The interaction of Language × Hemisphere showed that, as for the N1 component,
N2 to Slovenian terminal words was much greater at the left recording sites (−0.27 μV) than the right (+0.47 μV) ($p < .05$), no significant asymmetry emerging for response to Italian words (left hemisphere = −0.71, right hemisphere = −0.57 μV). In addition, the post hoc tests indicated greater N2 response to Italian words than to Slovenian words over the right hemisphere ($p < .01$).

**N4 Component**

*Monolinguals/bilinguals—Italian.* Between-groups ANOVA performed on N4 mean area values (measured at F34, C34, P34, T56, and O12 sites between 340 and 540 msec) revealed an electrode effect, with N4 being greater at the posterior temporal and occipital sites. The ANOVA also revealed an effect of hemisphere, with the N4 component being much greater over the right hemisphere (−0.56 μV) than over the left (+0.49 μV). Electrode × Hemisphere interaction also proved significant. Post hoc comparisons indicated greater amplitudes of the N4 component at the right posterior temporal and occipital sites. The significant factor word type indicated much higher N4 values to semantic error (−1.11 μV) than to syntactic (−0.79 μV) and to both error types than to correct words (1.79 μV).
Bilinguals—Slovenian/Italian. The ANOVA performed on the N4 values of the bilingual group for Italian and Slovenian revealed the significance of the electrode effect, showing almost the same pattern of results as for the homologous split-plot ANOVA.

The significant effect of word type indicated greater N4 response to semantic error (−1.78 μV) than to syntactic (−0.85 μV) and to both error types than to correct words (−0.69 μV). The interaction of Word type × Language, $F(2,12) = 4.49, p < .035$, also proved significant. Post hoc comparisons showed that in Slovenian N4 was much greater for semantic error than for syntactic, while in Italian there was no difference in N4 for these errors (Figure 6). Furthermore, for both semantic and syntactic errors, the N4 response differed significantly as a function of language, being more negative for Italian terminal words than for Slovenian (see maps in Figure 7). The difference maps (Figure 7) show the topographical distribution of the N400 response to semantic error, displaying a mainly centro-parietal distribution as described in the literature, but with hemispheric asymmetries involving the temporal and frontal areas.

Figure 4. (continued)
P600 Component

Monolinguals/bilinguals—Italian. The between-groups ANOVA performed on the P600 values recorded at the lateral frontal (F78) and posterior temporal electrodes (T56), between 540 and 680 msec poststimulus, indicated a much greater component at the posterior sites than at the anterior, this being supported also by the significant Electrode factor. In addition, the P600 values were greater for syntactic error (4.54 μV) than for semantic error (3.33 μV, \( p < .01 \)) and correct words (3.98 μV, \( p < .05 \)), as indicated by the word type factor.

Bilinguals—Slovenian/Italian. ANOVA performed for the bilingual group as a function of languages showed the electrode effect with P600 as being much greater at the lateral frontal site than at the posterior temporal. Again, word type turned out to be significant, with P600 to syntactic error (3.76 μV) being much greater than the responses to other word types (semantic error = 1.79 μV; correct = 2.86 μV). The interaction of Word Type × Hemisphere, \( F(2,6) = 3.555, p = .06 \), almost reached significance as, overall, the greater amplitude of P600 to syntactic errors, rather than to other stimulus types, was much more pronounced in the left hemispheric sites. However, the significant interaction of Language × Electrode × Word Type in the bilinguals revealed this positive deflection to be observed only at the posterior temporal sites for Slovenian syntactically incorrect words, not for Italian syntactically incorrect words (see waveforms in Figure 4d and maps in Figure 8).

DISCUSSION

The study investigated whether linguistic comprehension activates the same brain areas at different stages of...
word processing in monolinguals and bilinguals; this was done by recording ERPs to correct or incorrect terminal words while the participants were engaged in deciding word appropriateness for the whole sentence. The monolinguals were presented with a set of 200 Italian sentences; the bilinguals were presented the same set of Italian sentences together with a different set of 200 Slovenian sentences of comparable difficulty.

Figure 7. Temporal series of difference maps of brain activation obtained by subtracting ERP responses to correct words from those to semantically incongruent words. The red areas indicate the scalp distribution of N400 response to semantic incongruence recorded in the monolingual and bilingual people examined.

Figure 8. Temporal series of difference maps of brain activation obtained by subtracting ERP responses to correct words from those to syntactically incongruent words. The red areas indicate the scalp distribution of P600 response to syntactical incongruence recorded in the monolingual and bilingual people examined.
In general, the bilinguals turned out to be slower than the monolinguals in responding to linguistic stimuli, regardless of the language. Such a finding has already been described in the literature (Green, 1986) and was interpreted in relation to a possibly different neurofunctional organization of linguistic functions in polyglots.

**Between-Groups Differences in Hemispheric Lateralization: Hand Preference**

Analyses of correct response revealed a left-hand preference in the monolinguals in responding to Italian words and in the bilinguals responding to Slovenian words, plus, for the bilinguals, a preference for the right hand in responding to Italian words. These findings might be explained in the light of the so-called interference hypothesis advanced on the basis of behavioral studies. According to it, the percentage of correct responses and the speed of response are higher when the hemisphere mainly involved in a given task is not also engaged in controlling contralateral motor response. Therefore, a left-hand advantage in performing a motor response to lateralized stimuli would reveal left-hemisphere predominance in linguistic processing, whereas a right-hand advantage would reveal right hemisphere involvement. According to this hypothesis, our data indicate a greater involvement of the left hemisphere in monolingual linguistic processing, whereas in the bilinguals, the left hemisphere would be dominant for Slovenian material and the right hemisphere for Italian. In line with this interpretation, the bilingual group showed faster RTs to Slovenian words for the left hand, whereas in responding to Italian words, no hand preference was found. Overall, the behavioral data suggest a greater involvement of the right hemisphere in the linguistic processing of Italian (compared to Slovenian) in apparently highly fluent Slovenian/Italian bilinguals, suggesting a possible “preference” for Slovenian (L1) as the mother tongue. It is very important to note that this preference did not produce overall faster RTs for L1 than for L2, but was subtly revealed in the electrophysiological responses, for example, by very small or absent N400 or P600 to syntactically incongruent Italian words.

**Orthographic Analysis**

As a whole, the ERP data also indicate the presence of strong inter- and intrahemispheric differences in the timing and topography of brain responses as a function of linguistic group and language (L1 and L2). Among the differences, there appears in the bilinguals an involvement of the right lateral occipital area in the orthographic analysis of Italian words, as reflected at the scalp by the topographical distribution of the early-latency N1 component. In this regard, neuroimaging studies (see the review by Fiez and Petersen, 1998, on monolinguals; Polk et al., 2002) have described a left-sided activation of occipital and occipito-temporal cortices during orthographic processing of single words, the so-called word form system (Petersen, Fox, Posner, Mintun, & Raichle, 1988), that is specifically sensitive to real fonts as opposed to false fonts. In the present study, and consistent with the above findings, the occipito-temporal scalp sites, which might reflect the activation of brain areas underneath, showed a bilateral response in the N1 latency range (about 160–180 msec poststimulus) during the processing of Italian words and a left-sided response during Slovenian word processing in the bilinguals. In our view, this indicates that the word form system might be able to discriminate between different languages on the basis of orthographical analysis at very early stages of visual processing. In polyglots, this early detection would enable the reader to address the specific knowledge proper to a given language (i.e., graphemic/phonemic conversion rules, lexicon, etc.) in order to comprehend the material.

**Semantic and Syntactic Processing in Monolinguals**

Analyses of later ERP potentials revealed the onset of negative responses (N2 and N400) to incongruent words as early as 200 msec, followed by a later positivity (P600), such responses being differentially sensitive to the semantic and syntactic aspects of the word processing as it progressed over time. The responses were also differentially distributed over the frontal and occipito-temporal electrode sites of the two hemispheres as a function of the linguistic group and languages (see waveforms in Figure 9 for a comparison of conditions). In monolinguals, the N2 at the posterior temporal and occipital electrode sites was greater for incorrect terminal words than for correct terminal words and especially so for words with syntactic error rather than semantic error. It is worth noting that this increased negativity was right-sided for semantic error and left-sided for syntactic error. In the following temporal window, the negativity became strongly lateralized to the right hemisphere, and greater for semantic error than for syntactic and for both types of error than for correct words. Difference maps obtained by subtracting the area of brain activation to semantically incongruent words from that of correct words showed that the effect had a centro-parietal source, with an important involvement of the right temporal and frontal sites (see maps in Figure 7). These findings are consistent with electrophysiological literature that reports, for monolingual speakers, an involvement of the right hemisphere in semantic processing and, possibly, in N400 generation (Kiefer, Weisbrod, Kern, Maier, & Spitzer, 1998; Hagoort, Brown, & Swaab, 1996; Kutas, Hillyard, & Gazzaniga, 1988; Kutas, Van Patten, & Besson, 1988; Kutas & Hillyard, 1982). Other studies have provided evidence of N400 bilateral generation in the anterior temporal lobe.
In these studies, intracranial electrodes were used to record field potentials while the subjects viewed sentences that could end either normally or with a semantically anomalous word. The anomalous sentence-ending words elicited a large negative field potential with a peak latency, near 400 msec, focally distributed bilaterally in the anterior medial temporal lobe, anterior to the hippocampus, and near the amygdala. The authors advanced the hypothesis that the most likely neural generator of this field potential might be in the region of the collateral sulcus and anterior fusiform gyrus. The data are in good agreement with the distribution of negativity to semantically incongruent words that we found in our ERP study, the maximum amplitude being at the lateral occipital/temporal scalp sites. However, the subtraction of the ERP to congruent words from the ERP to semantically incongruent words resulted in a centro-parietal distribution, with some right frontal and right temporal involvement in monolinguals. Unfortunately, because of ERP limitations in source localization, it is difficult to ascertain whether this scalp-recorded neural activity reflects the activation of underlying cortical areas.

**Semantic and Syntactic Processing in Bilinguals**

Significantly, the bilinguals showed a left-sided lateralization of negativity between 200 and 340 msec poststimulus for semantic error. In addition, the N2 component to Slovenian terminal words in this group was, on the whole, much larger at the left sites, while there was no significant asymmetry for the response to Italian words. In the N4 latency range, negative response to word incongruence became much greater over the right hemispheric sites. It is worth noting that in the bilinguals N4 was sensitive to syntactic violations in Slovenian, but not in Italian. Consistently, P600 was almost absent for Italian syntactic violation. The difference maps obtained by subtracting brain activation to semantically incongruent words from that to syntactically incongruent words between 200 and 340 msec poststimulus showed that the effect involved the left temporal and occipital areas in monolinguals, whereas it was more anteriorly distributed and right-sided in bilinguals (see maps in Figure 5). The present results are quite consistent with recent neuroimaging findings in the literature (Dehaene et al., 1997). In our view, this lends support to the robustness of our topographical inferences, despite the ERP limitations in neural source localization. This pattern of almost inverted hemispheric lateralization is also supported by the significant hand preference factor, as emerges from the RT data. The findings suggest that the overall pattern of brain activation and hand preference shown by the bilinguals for Slovenian is very similar to that of the monolingual Italian group.

In general, both linguistic groups were slower in responding to semantic error than to syntactic error. This could be interpreted as a sign that the semantic incongruence was more difficult to detect than the syntactic one, the latter being more redundant in a way as it includes also a word type error. Interestingly, although the bilinguals were much slower in responding to semantic error (in Italian) with the left hand (right hemisphere), they were much faster with the same hand in responding to syntactic error. Such data might be interpreted as a sign that the semantic system for L2, whose activity was reflected at the scalp by negativity to semantic error, was not actually strictly right-sided, just as syntactic ability was not left-sided. This assumption is supported by other electrophysiological studies that provide evidence of a differential lateralization for N400 in monolinguals versus bilinguals (Artal et al., 1990; Fischler et al., 1987; Meuter et al., 1987).

Still, one reason for doubting this assumption is due to the ERP findings of the study by Weber-Fox and Neville (1996) who took bilingual proficiency into account, such proficiency being strongly influenced by the age of acquisition of L2 and able to modify the functional organization and the possible hemispheric lateralization.
of linguistic brain areas. They, as already noted above, examined a large sample of Chinese/English bilinguals exposed to English at different stages of their development and found no difference in the amplitude or topography of N400 in bilinguals compared to monolinguals, although they did find that the latency of N400 was delayed for bilinguals exposed to English after the age of 10. However, in our opinion, these findings alone are not sufficient to discard the aforementioned assumption as being untrue. Indeed, a possible explanation for this lack of difference could be that the individuals exposed to English very early in life (especially at 1–3 and 4–6 years) were not very fluent in Chinese, having used this language very little, both at school and at home. In these individuals, the learning of Chinese, although from an early age, was modest and approximate and, as such, did not justify functional bilingualism. Conversely, their knowledge of English was excellent, especially in reading and writing, as was evidenced in the N400 to English sentences, their N400 results differing very little from those of native English speakers.

Unlike Weber-Fox and Neville’s (1996) study, the bilinguals in our study had a profound knowledge of both Slovenian and Italian, having learned them contemporarily and at a very early age in the same social-emotional context. Thus, we can conclude that our data indicate that the knowledge and fluent use of more than one language is reflected in a differential activation of distinct brain regions devoted to linguistic processing in polyglots, there being no such differentiation in monolinguals. The specific pattern of cerebral activation concerns all stages of the processing of single words (orthographic, semantic, and syntactic stages). The present results are from early, highly proficient, fluent bilinguals, and thus indicate that the specific pattern of brain activation observed in this study is not the result of a late defective neurofunctional organization (as in the case of late, low proficiency learners).

METHODS
Participants
Nine Italian monolinguals (four men and five women, mean age 27 years) and nine Italian/Slovenian bilinguals (four men and five women, mean age 29 years) participated in this experiment as volunteers. They had normal or corrected-to-normal vision and were right-handed with a right-eye dominance. The participants in the two groups were of comparable educational level and social status. The bilinguals had all acquired Italian and Slovenian in early infancy (since birth) and were very fluent in both languages. All the participants in the study lived in Italian territory (on the outskirts of Trieste) right at the border with Slovenia and either the mother or father of the bilinguals belonged to the Italian or Slovenian linguistic cultures. According to neurolinguistic literature, the bilinguals tested in the present investigation can be classified as “early compound” bilinguals as they grew up in bilingual families and acquired both languages before the age of 5 in the

Bilingual Proficiency
As for possible differences in the bilinguals’ proficiency in Italian and Slovenian, the RTs did not show any significant difference in response times to semantically anomalous words. Still, in this group there was evidence of a significant advantage of Slovenian over Italian in responding to correct words (46 msec faster) or syntactic violations (50 msec faster). On the other hand, the accuracy analysis showed a mixed pattern of results: no difference between the two languages in the correct response percentages, faster and more accurate reporting of semantic violations in Italian and syntactic violations in Slovenian. All in all, our findings seem to suggest that, although very tine, there might have been a certain “preference” in the bilinguals for the Slovenian language (L1) especially as far as the responses to syntactic violations were concerned.

In agreement with behavioral data, the ERPs provided evidence of a differential processing of the two languages, apart from the marked differences in topographic distribution and hemispheric lateralization. Indeed, the differences were mainly related to the syntactic violation responses. In the range of N400, this component for Slovenian was greater for syntactic violations than for semantic ones, while it was of the same amplitude for Italian. In the latency range of P600 for Italian, there was no syntactic violation response at the posterior temporal site, while there was response at the lateral frontal sites. These findings might imply that despite our efforts to balance the two groups of speakers with regard to fluency, proficiency, age and modality of acquisition, and daily exposure to the two languages, there might still be some very subtle, hard-wired, differences in the linguistic proficiency of the two groups. Alternatively, one could advance the intriguing hypothesis that some of the between-groups discrepancies discussed above could be ascribed to differences in the structural properties of the two languages, these having totally different syntactic constructions. Indeed Slovenian is a richly inflected language, unlike Italian and, even more so, English. There are no articles and nouns, adjectives and pronouns are inflected for three numbers, three genders, and six cases. Verbs are also inflected for number, gender, and case, and differ by means of affixes, suffixes, and a particle placed between the verb root and the end. Thus, it cannot be excluded a priori that these features, which make the syntactic analysis of Slovenian somehow qualitatively different from that of Italian, might be partly responsible for the bilinguals’ different brain responses to syntactic violations in Italian and Slovenian.

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of the sentence and terminal word. Both the monolingual group and the bilingual one were shown 200 sentences in the Italian language. The bilingual group was shown a further 200 sentences in the Slovenian language, the sentences having been carefully balanced with the Italian sentences for sentence length (see Figure 10) and syntactic complexity. Terminal words were accurately balanced for length, number of syllables, frequency of use, and concreteness/abstractness. For the Italian language, word frequency of use was controlled by evaluating the scores reported in Bortolini, Tagliavini, & Zampolli (1971) and De Mauro, Mancini, Vedovelli, & Voghera (1993). The overall linguistic complexity of the sentences was balanced by presenting a larger initial set of stimuli to a sample of 20 Italian and Slovenian speakers, asking them to evaluate the difficulty encountered in assessing the correctness of each phrase on a seven-point scale. The results of this preliminary test allowed us to select Italian and Slovenian sentences of comparable difficulty (see Figure 11). Each set of stimuli included 100 correct, 50 semantically incorrect, and 50 syntactically and semantically incorrect sentences. They were randomly presented in short sequences of 3-min duration, preceded by three 500-msec warning stimuli (“ready,” ”set,” “go”). After the “go” stimuli, an interstimulus interval of 1500 msec allowed the observer to carefully adjust his/her gaze on the fixation point, waiting for the first sentence to be presented. Each sentence stayed on the screen for 1500 msec and was followed by an interstimulus interval that varied randomly between 350 and 500 msec during which the screen was dark with the exception of the fixation point. This was followed immediately by the terminal word, which stayed on the

Figure 10. Number of words/sentences in the two languages. Sentences and terminal word length was balanced across languages and word types.

same social–emotional context (Genesee et al., 1978). To test bilingual proficiency, we engaged the participants in a standard preliminary conversation in front of a native Italian and a native Slovenian experimenter who found no significant difference in oral production in either Italian or Slovenian for these individuals. Furthermore, all the bilinguals were asked to self-rate their comfort in reading, comprehending, and writing both languages. In addition, for reading and written production, no significant differences emerged for the two languages in the examined bilingual sample (N = 9). Because of problems related to EEG techniques (excessive muscular and/or ocular artifacts), two bilingual and two monolingual individuals were excluded from the initial sample, and their EEG traces were rejected before ERP averaging.

Materials and Procedure

The target stimuli were terminal words that could correctly complete a previously shown short meaningful sentence, or else words that were semantically and/or syntactically incorrect. The syntactical incongruence consisted of a phrase structure violation achieved by a word type error (see Appendices 1 and 2 for a complete list of stimuli).

The sentences, presented visually on a high-resolution PC monitor, were white on a black background and were displayed in easily readable large-size capital letters, appearing in one or two short lines centered on the foveal region. The longest sentence subtended a visual angle of about 12° and 30 in. in length and 2° and 30 in. in height. A small yellow cross (4 mm in size) was located at the center of the screen and served as a fixation point in order to minimize eye movement during the reading

Figure 11. Distribution of the frequency with which the various sentences in the two languages were judged as relatively difficult (i.e., relative difficulty in assessing their correctness) from a preliminary sample of 20 Italian and Slovenian mother-tongue subjects.
The intertrial interval was of 1500-msec duration. The order of experimental sessions (Italian or Slovenian) for bilingual participants was counterbalanced across subjects. Except for a few cases, the two sessions took place on different days, so that session duration was similar to that of the monolingual subjects.

The participants sat in a dimly lit, acoustically shielded cubicle facing a window that looked out on a high-resolution VGA computer screen 114 cm from their eyes. The participants were instructed to fixate the center of the screen and avoid any eye or body movement during the recording session. The task consisted in deciding the correctness of terminal words in relation to the previously read incomplete sentence, and in pressing a button (alternatively with the left or right hand) with the index finger in response to words judged correct and the medium finger to words judged incorrect. This allowed the recording and measuring of the speed and accuracy of response, respectively, RTs and percentage of correct responses. The order of hands to be used and of trials (different sets of sentences) was randomized within and across subjects.

Electrophysiological Recording

The EEG was recorded continuously from 28 scalp sites using tin electrodes mounted on an elastic cap (Electro-cap). The electrodes were located at frontal (Fp1, Fp2, FZ, F3, F4, F7, and F8), central (CZ, C3, and C4), temporal (T3 and T4), posterior temporal (T5 and T6), parietal (PZ, P3, and P4), and occipital scalp sites (O1 and O2) of the International 10–20 System. Additional electrodes were placed halfway between homologous anterior temporal and central sites (FTC1 and FTC2), central and parietal sites (CP1 and CP2), anterior temporal and parietal sites (TCP1 and TCP2), posterior temporal and occipital sites (OL and OR), and left and right occipital sites (OZ). To ensure that fixation was maintained, the horizontal and vertical ocularograms (EOG) were also recorded. Vertical eye movements were recorded by means of two electrodes placed below and above the right eye, whereas horizontal movements were recorded using electrodes placed at the outer canthi of the eyes. Linked earlobes served as the reference lead. The EOG and the EEG were amplified with a half-amplitude band pass of 0.1–70 and 0.01–70 Hz, respectively. Electrode impedance was kept below 5 kΩ. Continuous EEG and EOG were digitized at a rate of 512 samples/sec. Any trial contaminated by eye or body movement was rejected. Computerized artifact rejection was performed before averaging to discard epochs in which eye movement, blinking, excessive muscle potentials, or amplifier blocking occurred. The artifact rejection criterion consisted of peak-to-peak amplitude exceeding ±50 μV. The artifact rejection rate was about 5%. The ERPs were averaged offline from 100 msec before to 1000 msec after presentation of terminal words; any ERP trial associated with incorrect behavioral response was also excluded from further analysis. For each subject, distinct ERP averages were obtained as a function of group and stimulus category. More specifically, ERP averages were computed in response to correct, semantically incorrect, and syntactically incorrect Italian words for monolinguals and to correct, semantically incorrect, and syntactically incorrect words both in Italian and Slovenian for Bilinguals. The major ERP components were identified and measured automatically by a computer program with reference to baseline voltage averages lying in the range of −100 to 0 msec. The ERP components were quantified by measuring peak latency and mean area amplitude values within a specific latency range centered approximately on the peak latency of the deflection observed in the grand average waveforms. The N1, N2, and N4 negative deflections were all larger at occipito-temporal sites and peaked at about 160, 245, and 425 msec, respectively. They were quantified by computing the mean area in the time windows between 140 and 200, 200 and 340, and 340 and 540 msec at both posterior (O1, O2, T5, T6, P3, and P4) and anterior (F3, F4, C3, and C4) electrode sites. While the N400 per se was greater at the posterior sites, the brain response to semantic violation (the difference between semantic violation and correct word) had a more central and anterior distribution. The P600 component, peaking at about 605 msec, was greater at the central and frontal midline sites, but showed considerable functional differences in hemispheric distribution. It was therefore quantified in the time window between 540 and 680 msec at posterior temporal (T56) and lateral frontal (F78) sites.

Data Analysis

For each subject, RTs faster than 140 msec and exceeding the mean ± 2 standard deviations were excluded from the statistical analysis. Both RTs and error percentages were computed for the various stimulus categories (correct, semantically incorrect, or syntactically incorrect in Italian and Slovenian).

Two main types of statistical comparisons were performed on ERP and RT measures, allowing direct comparison of the monolinguals and bilinguals in processing Italian sentences (monolinguals/bilinguals—Italian) and between the processing of Italian and Slovenian sentences in the bilingual individuals (bilinguals—Slovenian/Italian).

Monolinguals/Bilinguals—Italian

Behavioral response (i.e., mean RTs and percentages of correct responses) recorded to Italian words was analyzed by three-way ANOVAs whose factors of variability were 1 between groups (monolingual or bilingual) and 2 within groups (word type: correct, semantically incorrect, and syntactically correct; response hand: left and right).
Electrophysiological measures recorded for Italian words were subjected to four-way ANOVAs whose factors of variability were 1 between groups (monolingual or bilingual) and 3 within groups (word type: correct, semantically incorrect, and syntactically; electrode site: depends on ERP component; cerebral hemisphere: left and right). Electrophysiological responses recorded in this group were subjected to four-way repeated measure ANOVAs whose factors of variability were language (Italian or Slovenian), word type (correct, semantically incorrect, and syntactically), electrode site (depends on ERP component), and cerebral hemisphere (left and right).

Bilinguals—Slovenian/Italian

Behavioral response recorded in the bilingual group to Italian and Slovenian words was analyzed by three-way repeated measure ANOVAs whose factors were language (Italian and Slovenian), word type (correct, semantically incorrect, and syntactically), and response hand (left and right). Greenhouse–Geisser corrections were employed to reduce the positive bias resulting from repeated factors with more than two levels.

APPENDIX 1 (ITALIAN)

Correct

1. Ogni uomo gode di cose diverse
2. Qualcosa mi fece il solletico
3. Impara a vivere con te stesso
4. E' più degn di dare che togliere
5. Nemmeno lei si era innamorata
6. Aveva molti ammiratori
7. Nulla è troppo arduo per l'uomo
8. La luce filtrava dalle tapparelle
9. Ogni giorno passavano battelli carichi di legname
10. Si dedicò allo studio della lingua ungherese
11. Fu la prima ad intuire qualcosa di insolito
12. Continuava a fingersi addormentato
13. Era impaurita dal suo livore
14. Il museo è aperto fino a mezzanotte
15. Si godeva una tranquillità assoluta
16. Aveva un aspetto veramente orribile
17. Sua moglie telefonò al ginecologo
18. L' appartamento era interamente ammobiliato
19. Chi vuole trovarsi dovrà cercarsi
20. Le affezioni artritiche sono frequenti in autunno
21. Da allora erano passati molti anni
22. Nessun uomo malvagio è felice
23. La città era in balia dell'anarchia
24. L'Inghilterra non abbandonerà la regola maggioritaria
25. La costituzione inglese è ferreamente parlamentare
26. I piccolini giocavano con l'acqua
27. E' meglio evitare inutili ripetizioni
28. Ero in prima fila a godermi lo spettacolo
29. Il contadino raccoglierà le spighe mature
30. Il falegname costruiva dei bei mobili
31. I suoi primi progressi passarono inosservati
32. L'invidia è una cattiva consiglieria
33. La felicità non dura per sempre
34. La testa gli prevedeva moltissimo
35. I bambini meritano il più grande rispetto
36. La convivenza rafforza i vincoli d'amicizia
37. Durante il viaggio la malattia scomparsì
38. Nel bagnò c'era una vasca enorme
39. E' stato un brusco risveglio
40. Lo scrittore può cambiare calligrafia
41. La domenica dovresti riposarti
42. Faccio collezione di farfalle
43. Mi piace più la frutta del cioccolato
44. I pionieri cercavano vene d'oro

Every man enjoys different things
Something tickled me
Learn to live with yourself
It is worthier to give than to take
Not even she was in love
She had a lot of admirers
Nothing is too difficult for man
The light filtered through the shutters
Every day, boats loaded with timber sailed past
He devoted himself to studying Hungarian
She was the first to sense something unusual
He continued to pretend to be asleep
She was frightened by his nastiness
The museum is open until midnight
You enjoyed utter peace
He looked really awful
His wife rang the gynecologist
The flat was fully furnished
Anyone who wants me will have to look for me
Arthritic disorders are frequent in autumn
Many years have passed since then
No wicked man is ever happy
The city was in the grip of anarchy
England will not abandon majority rule
The English constitution is rigorously parliamentary
The young children were playing with water
It is better to avoid useless repetition
I was in the front row enjoying the performance
The farmer will harvest the ripe ears
The carpenter made fine furniture
His early progress went unnoticed
Envy is a bad counselor
Happiness does not last forever
His head was itching badly
Children deserve the greatest respect
Living together strengthens the bonds of friendship
During the voyage the disease disappeared
In the bathroom there was a huge tub
It was an abrupt reawakening
A writer may change his handwriting
On Sundays you should rest
I collect butterflies
I like fruit more than chocolate
The pioneers were seeking veins of gold

Proverbio, Čok, and Zani 1011
45. Mio zio è il più furbo del gruppo
46. I bersaglieri erano in mezzo al corteo
47. Gi furono lunghe pause di silenzio
48. Non tirava un alito di vento
49. C'è molta polvere sotto i mobili
50. Abito vicino alla prefettura
51. Vorrei sapere come fai lo strudel
52. Ditemi se preferite carne o pesce
53. Alle dieci chiudono gli sportelli
54. Quell'amico era troppo ciarliero
55. Fece una sciocchezza enorme
56. Gli occorreva un orario ferroviario
57. Amava i film polizieschi
58. Leggeva volentieri i romanzi gialli
59. Non aveva alcun interesse sportivo
60. La salsa era piuttosto cremosa
61. Scriveva su carta violacea
62. Parlava in modo molto convincente
63. Si accampò su un'isola deserta
64. Era molto determinato
65. Una frana interruppe la strada statale
66. La festa non è ancora finita
67. I negozi non erano ancora chiusi
68. La riparazione del motore è costosa
69. Capiresti tutto se stessi attento

70. Il paese non era poi tanto brutto
71. Gli proposero un esercizio difficile
72. Gli venne affidato un compito da svolgere
73. Venne assalita da una crisi isterica
74. Non era del tutto sprovvveduto
75. Aveva soltanto qualche spicciolo
76. Non si può uscire perche' è piovigina
77. Speravo fortemente che nevicassi
78. Chiese di poter dormire
79. Il bambino stava per nascere
80. Al cinema c'erano molti perditempo
81. Tutti lo amavano profondamente
82. Si baciaron appassionatamente
83. Mancano venti minuti alle otto
84. Dirigo un'impresa metallurgica
85. Non voglio mangiare lo stracchino
86. Tutti guidano prudentemente
87. Mia sorella ha molto talento
88. La cuoca infilò il pollo nel forno
89. Credo di avere diritto a questi privilegi
90. I miei momenti li dovo a lei
91. Le donne presenti erano piene di personalità
92. La segretaria le fece il resoconto della riunione
93. La ragazza non tornò al laboratorio
94. Le cause delle neurosi sono insondabili
95. Il bambino osservava la scena dalla porta socchiusa
96. Quella casa era un'oasi di pace
97. Dopo un'ora esaurirono le munizioni
98. La battaglia continuò con un corpo a corpo
99. Le scuole sono chiuse in estate
100. Vive poveramente perché è avaro

Semantic Anomaly

1. La struttura della città era troppo invidiosa
2. Mi piacerebbe che leggessi questo cane
3. Non gli restava più il minimo battesimo
4. Il marito era un suo grande prezzemolo
5. Solo una cosa richiamò la sua minestra
6. Doveva incontrarsi con il suo complice
7. I due netturbini innaffiavano la felicità

My uncle is the smartest of the group
The Bersaglieri were in the middle of the procession
There were long silent pauses
There was not a breath of wind
There was a lot of dust under the furniture
I live near the prefecture
I would like to know how you make strudel
Tell me whether you prefer meat or fish
At ten o'clock they close the counters
That friend was too talkative
He did something terribly foolish
He needed a rail timetable
He loved detective movies
She enjoyed reading detective stories
He had no interest in sport
The sauce was rather creamy
He wrote on purple paper
He spoke very convincingly
He camped on a desert island
He was very determined
A landslide blocked the state highway
The party is not over yet
The shops still had not closed
The engine repair is very expensive
You would understand everything if you paid attention
The town was not so ugly after all
They gave him a difficult exercise
He was given a task to perform
She had a hysterical attack
He was not completely unprepared
He only had some small change
You cannot go out because it is drizzling
I strongly hoped it would snow
He asked if he could sleep
The baby was about to be born
At the cinema there were a lot of idlers
They all loved him deeply
They kissed passionately
It is twenty minutes to eight
I manage a metalworking company
I do not want to eat the cheese
They all drive carefully
My sister is very clever
The cook pushed the chicken into the oven
I believe I have a right to these privileges
I owe my best moments to her
The women present all had a strong personality
The secretary gave her a report on the meeting
The girl did not return to the laboratory
The causes of neuroses are unfathomable
The little boy watched the scene through the half closed door
That house was an oasis of peace
After an hour they ran out of ammunition
The battle continued as hand to hand fighting
The schools are closed in summer
He lives miserably because he is mean

The structure of the city was too envious
I would like you to read this dog
He did not have the slightest baptism left
Her husband was a great parsley
Only one thing recalled her soup
He had to meet his birthday
The two street cleaners were watering happiness
8. Scenderò al primo cappotto
9. La fortuna aiuta le mollette
10. L’arrosto va cottò nel balenottero
11. Abita in un pensionato per mani
12. A volte l’illusione ottica dorme
13. In Italia l’inflazione tende a lavarsi
14. Presentami i casi che devo piovere
15. Non ho alcun consiglio da attraversare
16. Fermò la macchina di fronte alla metafisica
17. La signora proruppe in una risata petroliera
18. Gridava preso da una rabbia informatica
19. Il posto era davvero affamato
20. La condizione più misera non può respirare
21. L’uomo era sul punto di nevicare
22. I suoi genitori non lo macinavano
23. Ho messo la macchina nel limone
24. Ho raccolto le mele più stanche
25. La notte era di luna crocante
26. Egli scoccò un sorriso vegetale
27. Era risolta nelle situazioni fritte
28. Mi dedico alla distillazione dei profumi perimalosì
29. Dovevano vedersela con gente salata
30. Non bagnarono con il tuo ventaglio
31. Ho mangiato solo due pozzanghere
32. La grande sala rimase somministrata
33. Le tasse aumentano dermatologicamente
34. La neve continuava a cenare
35. Le vie della fortuna sono maleducate
36. Avanzavano verso la piazza strofinata
37. Non entrò nei monasteri sottovuoto
38. Non mangiava per non incenerire
39. Alla spedizione parteciparono 35 litri
40. La festa era sordente
41. Berrò solo un dito di assistenza
42. Voleva piantare dei clinici
43. Abbiamo viaggiato in aringa
44. Ti aspetto a casa questa storia
45. Chi non sa tacerne non sa levitare
46. Non aveva le chiavi di nuvola
47. Non voglio darvi danza
48. Quel vestito era molto inospitale
49. Ognuno ha il suo difetto che non mangia
50. I vitelli nervosi restauravano

Syntactic Anomaly

1. Fini col dimenticare i suoi uscire
2. Apparteneva a un’altra specie lavorare
3. Era capace delle decisioni più previsione
4. Era una manifestazione molto rumore
5. Viene pure a casa acqua
6. Procedevano in corridoio pranzare
7. Il raffreddamento dell’estremità è un brutto grande
8. Vivendo ricorda sempre che devi evanescere
9. Chiuse gli occhi e si biodellizzia
10. Il figlio era molto urgenza
11. Ho voglia di trovare un libro indifferenza
12. L’azzurro è il mio colore scoprire
13. I miei erano in proco di ginocchio
14. Il film era molto astuzie
15. Il paese era rischiarato dalla operativo
16. Tutte le finestre erano convinzione
17. Insisteva perché voleva riguardanti
18. Ti aspettavo con molta immaginavi
19. Troppa sincerità può portare alla salire
20. Oggi il traffico è veramente scarpe
21. Le vecchiette si sedettero in disegnare
22. I will get off at the first overcoat
23. Fortune favors the hair clips
24. The roast must be cooked in the whale
25. He lives in a guest house for hands
26. Sometimes an optical illusion sleeps
27. In Italy inflation tends to wash itself
28. Show me the cases that I have to rain
29. I have no advice to cross
30. He stopped the car in front of the metaphysics
31. The lady broke out in a petroleum laugh
32. He was shouting in informant anger
33. The place was really hungry
34. The most wretched condition cannot breathe
35. The man was on the point of snowing
36. His parents did not grind him
37. I put the car in the lemon
38. I picked the tiredest apples
39. The night was a crunchy moon
40. He broke out into a vegetable smile
41. She was determined in fried situations
42. I devote myself to distilling touchy perfumes
43. They had to come to terms with salty people
44. Don’t wet me with your fan
45. I only ate two puddles
46. The big hall was left administered
47. The taxes rose dermatologically
48. The snow continued to dine
49. The paths of fortune are rude
50. They advanced towards the rubbed square
51. He did not go into the vacuum packed monasteries
52. He did not eat to avoid incinerating
53. 35 liters took part in the expedition
54. The wound was smiling
55. I will drink only a finger of help
56. He wanted to plant clinicians
57. We travelled in a herring
58. I shall expect you at home this story
59. He who cannot keep silent cannot leave
60. He did not have the keys to the cloud
61. I don’t want to give you any dance
62. That dress was very inhospitable
63. Everyone has a defect that does not eat
64. The nervous calves restored

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APPENDIX 2 (SLOVENIAN)

Correct

1. Ustvarjalnost je sposobnost odprtega poklica
2. Gotovo se bo to dobro iztekel
3. Reči so bile zložene pod oknom
4. Od rok do ust je dolga mladost
5. Požal ne rad roge razkazuje
6. Žirafe so doma v afriških savanah
7. Že kot mlad fant si je želel oditi v mornarico
8. Kot mizarski mojster je hitro našel službo
9. Ponekod so se vztegvalo visoke vzpetine
10. Po dolgem pričakovanju je priložnost prišla
11. General jih je nameraval zapustiti
12. Prizor je bil zares krut
13. Vsi prebivalci so bili srečni
14. Lanska zima je bila res zelo ostra
15. Tovariši so pripravljeni na pogovor
16. Napravila je nekaj pokrajinskih posnetkov
17. Zamisljeno je strmelo v temno nebo
18. Zima se je spremenila v pomlad
19. Profesor mu je dal denar za poštenost
20. Iskati so morali druge sodelavce
21. Dalesce je bil od svoje domovine
22. Želel je spoznati tudi druge del otoka
23. Prišel je čas za križarjenje
24. Na travniku se je vzvijelo drevu
25. Nenadoma je plezalec izgubil ravnotežje in padel
26. Začela je naklepali kruto maščevanje
27. Otrok je zalučal čepico na naslanič
28. Prestrašeni ljudje so zakričali od groze
29. Dlake so se mu naježile
30. Neumen fant ni dolgo premišljal
31. Kar na lepem je zbolela
32. Natakarska so privabili bliže
33. Naslednje jutro je bil silno Žežen
34. Na tleh je ležal kakor mrtev
35. Useadel se je na balkon
36. Princ je bil bogat in imeniten
37. Fant je zlatega denarja vreden
38. Otrok je bil pretiran raznežen
39. Navadni daljnjegledi se dajo raztegniti
40. Kralj je glasno odgovoril v svoji materničini
41. Utegnili so mu vzeti potni list
42. Kupili so jetrno pašeto in sardine
43. Nihče ga ni vprazal za vizum
44. Vojak je odšel na bojišče
45. Založil je dragulje in posestva
46. Naročil je tablico s hišno številko štiri
47. V skupnost so sprejeli novega člana
48. Doma je vladal otočen mir
49. Lastnina je bistveni vir vsega zla
50. Delavec ne spoštuje gospodarja
51. Sodobna vzgoja gre v to smer
52. Otrok si je želel postati astronaut
53. Iz ust mu je zaštrkli grižljaj
54. Čelasti mu je zlomila pest
55. Vse to je bilo izključeno
56. Mati je bila zelo ljubezniva
57. Brat je bil neverjetno len
58. Bila je zagorela in brezskrbna
59. Njegovo ime je bilo kratko
60. S časom je postajal nevarnejši
61. Naglašeni samoglasniki so dolgi ali kratki
62. Avto je bil dobro prebarvan
63. Organizacija je bila politična in ekonomska
64. Njene oče so postale svetle
65. Ta večer naj bo v spomin
66. Kljub vseemu so bili nedolžni
67. Zanemarili ni nobene prilike
68. Sklenili so premirje s sultanom
69. Njegova koža je bila trda
70. Mimo njega je prišel gospodar
71. Stavbo je gledal z vrha
72. Gostitelj je postregel trudnega gosta
73. Uspeh jim je olajšal zivljenje
74. Tujič se je prikupil hčerk
75. V ječah je bilo polno velikih pajičev
76. Dandanes se to pogosto dogaja
77. Študentje so se hoteli vrniti
78. S starši ni mogoče govoriti
79. Ni dopustil najmanjše svobode
80. Med čakanjem se je gital
81. Po dolgem času se je pes pomiril
82. Včasih je nadarjenost pomenila božji piš
83. Voznik je počasi zapeljal
84. Zljutraj ni več deževalo
85. Ves sem se zmedel
86. Naslednjega dne jo je zapustil
87. Gledala je posem nedolžno
88. Fant in dekle sta si segla v roko
89. Vsii vojaki so radi kadili
90. Esesovec se je smejal
91. Morala sva se odločiti
92. Ribič je stanoval blizu morja
93. Nisem ga mogel razumeti
94. Ni mu hotel povedati ničesar
95. Čupa je zaplavala po zalivu
96. Ničesar ni mogel ukreniti
97. Ded je že davno preminil
98. Miza za biljard je bila prav velika
99. Kapetan se je zelo zabaval
100. Obleke so se sušile

Semantic Anomaly
1. Zdaj obrnem v vratih piškot
2. Lahko noč vam vsem kupim
3. Kruh iz peči sladko zapoje
4. Boljša je prva zamera kot rdeča
5. Pohlevenih ovac gre mnogo v en predpask
6. Jabolko ne pade daleč od telovadbe
7. Visokoletenčo nizko zadiši
8. Godci so zaigrali veselo enačbo
9. Južni del gorovja je bil prijazen
10. Zemeljske plasti so se zalajale
11. Žrelo vulkana je bilo zamerljivo
12. Vzdirnil je se tisoč metrov prijetno
13. Snežna plast je zatemnila utrujenost
14. Greben se je vlekel do poglavja
15. Iz dimnika se je smejalo
16. Stric je planil iz pudinga
17. Kmet je previšno stopil v oranžado
18. Končno so policiji le zasijali
19. V previšn razdalji mu je klobasa
20. Časnikar je bil izredno železen
21. Polja so bila lačna
22. Rane so bile povsem skrbne
23. S tem je naša zgodba oprana
24. Hiša je bila kar se da temnopolta
25. Čas je mineval res krilato
26. Odgovoril je zelo prašno
27. Zadeva je bila zares pahljačasta
28. Pojedel je krožnik odlične gostilne
29. V vrti je držal lok in poljube
30. Prišel je pred temi značaji
31. Zdravilo mu je zmanjšalo krvne stare
32. Za nas je prišel zgodovinski dežnik
33. Desnica mu je ostala nesramna
34. Mir je bil nazobčan
35. Lokal je bil zelo nadarjen
36. Površina je bila temno razmnožena
37. Kuharica je bila zanesljiva in prepečena
38. Rezultati so zelo živčni
39. Izhodišča so bila razburjena
40. Nebo je bil možno in vzgojno
41. Sin se je zadovoljil z njegovo zahteko
42. Kreplja ga je neomejena odvratnost
43. Dekle je v temni noči zadonelo
44. Glavna vrata so se izmislila
45. Polglašno petje jo je privolilo
46. Prišla sta dva klicaja
47. V meni je nekaj odpeljalo
48. Govoril je zelo mokro
49. Bojevali so se zelo sladko
50. Mrzla groza ga je prismečala

Syntactic Anomaly
1. V antiki so pesniki prosili muze za blehatal
2. Veliko psihologov se ukvarja z nenadoma
3. Danes mi gre vse gostuje
4. Drugo jutro je spet stajalo pošten
5. Vrabcil se podijo od njive do zaprito
6. Redne nege zobne ščetko
7. Otroci so trepetali od gotovo
8. Počasi se dalač prazgodovina
9. Prazne hiše se miš hitro potok
10. Po počitku je nadaljeval pitna
11. Gospodinja je pela vzlilknil
12. Le pogumno potraj na vlažno

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13. Storklje delajo gnezda zraven ugriznil
14. Pri delu je bil zelo predanost
15. Ded je smrl mimorodopata
16. Moral si je oddahniti preden bi filozofija
17. V jami je bilo treba zelo deževati
18. Oče mu je večkrat korenine
19. Verjetno je bil ves njihov trud odstopuje
20. Vročina je bila včer prevajali
21. Žrtev potresa so ostale zavzetost
22. Njegova dela so zelo učijo
23. Pisateljeve zgodbe so zelo sedel
24. Stvar mi ni ne pomembnost
25. Pripravila je gnezdo za svoje nenasloma
26. Želeli so si obnoviti zalogo koristen
27. Ladja je plula tik ob posmehljivo
28. Volkovi so izglinili v začudena
29. Niso se dali dolgo skrivnostna
30. Svak je z veseljem povprečno
31. Mraz ga je potica
32. Nekdo mu je prišel kokoš
33. Stražarja je nekdo prijetnost
34. Po kosilu je sela neprekrlicno
35. Oče je ležal ves zabava
36. Naslednja noč je bila piše
37. Junak je trepetal pred neprekrlicno
38. Ni se hotela posvetiti svoji spona
39. Ob priliki je se oglasil na oze
40. V žepu je imel kos pozorna
41. Človek je bil z drugega brezupno
42. Ogledal si je predstavo neke igre
43. Ključek je odpiral vsaka udoben
44. Sam si je utiral pot čez nemiren
45. Nova veza ni obrodila pričakuje
46. Želel si je v prihajali
47. Navdih je nacionaln in sprevidel
48. Oba sta zelo gugalnica
49. Veden se je izredno čebula
50. Zbogelj je en dan zakajeno

Note that, often, the English translation does not, and cannot, properly reproduce the kind of semantic and syntactic anomalies present in Italian sentences. The translation of the sentences has been provided in an effort to give the general meaning of the sentences to the widest possible audience of readers. An example is given in the following sentence:

Italian: «Non gli restava più il minimo battismo.»
English: “He did not have the slightest baptism left.”

In Italian, the terminal word is the noun “battismo” (baptism), which is semantically incongruent with the adjective “minimo” (slightest). A congruent final might have been “il minimo dubbio” (the slightest doubt).

In English, the terminal word “left” is the past participle of a verb, which, unfortunately, reproduces a totally different grammatical construction.

Acknowledgments

We thank the three anonymous referees for their very helpful comments on a previous version of the manuscript. We also thank Marco Morbin, Laura Sgubin, and Elena Hrovatin for their help with the Slovenian material. We are also grateful to Ian Mc Gilvray and Barbara Carey for editing the final version of this article. A. M. P. was supported by 60% and 40% grants from Ministero dell’Università e della Ricerca Scientifica and A. Z. was supported by a grant (R. L. 14-2001/2002) from the Institute of Neuroscience and Bioimaging of CNR.

Reprint requests should be sent to Alice Mado Proverbio, Department of Psychology, University of Milano-Bicocca, Piazza dell’Ateneo Nuovo 1, 20126 Milan, Italy, or via e-mail: mado.proverbio@unimib.it.

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