Original scientific paper

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Written sentence comprehension in L1 and L2

Abstract

In order to understand meaningful utterances, a number of heterogeneous pieces of linguistic information must be processed and integrated by the human language comprehension system. The comprehension of language is more than the identification of word meanings. Without syntactic processing, without the recognition of syntactic relations between the contextualized words sentence comprehension would not be successful.

The paper presents the results of a psychophysical bilingual study carried out on 97 Hungarian users of English as a second language. The subjects were shown L1 and L2 sentences, and they were expected to make decisions regarding the acceptability of the sentences. From the 240 test sentences 120 were correct and 120 were semantically incongruent or syntactically violated. Reaction time and rate of acceptability judgment were measured and compared in both languages between the groups that were created based on the subjects' language proficiency (C1 or highly proficient and B2 or intermediate) level, and on the age of second language acquisition (early or late).

With non-parametric statistical analyses, we found significant differences in L1 and L2 between semantic and syntactic processing both in reaction times and acceptability judgments in most cases. Our results support the greater role of language proficiency as opposed to the age of L2 acquisition in successful written sentence processing.

1. Introduction

Bilingual language processing is always more complicated than monolingual, and this is influenced by a number of factors (cf. Grosjean 1998). In order to understand meaningful utterances, a number of pieces of heterogeneous linguistic information must be processed and integrated by the human language comprehension system. The goal is to extract the meaning of a given message, i.e. seemingly the semantics of a given word string. However, the comprehension of language is more than the identification of word meanings. Without syntactic processing, without the recognition of syntactic relations between the words we would not go far since this is a necessary precondition for normal sentence comprehension.

1.1. Models of Language Comprehension

Two mainstream models have been elaborated on for language comprehension. Both agree that syntactic and semantic information have to be integrated within a minimal duration of time in order to achieve rapid understanding. What they differ in is the time allotted to information processing. Interactive models suggest that semantic and syntactic information are processed as soon as they are available, in an interactive manner (MacWhinney and Bates 1989; Marslen-Wilson 1984). On the other hand, modular models assume that the parser constructs the syntactic structure bottom-up, independent of semantic information, based on the syntactic structure required by the word categories, and semantic retrieval comes only second (Smith and Tsimpli 1995; Frazier 1988; Fodor 1983).

In Friederici's neurocognitive model (Friederici 2002) three phases are separated. During Phase 1, at the initial stage, local phrase structure building based on word category information takes place. Only in Phase 2 do semantic and further syntactic processes come into play, when syntactic and semantic as well as thematic relations between the words are checked in a parallel way. The final stage (Phase 3) is the result of these parallel processes, which is gained by the interaction of these information types, and which allows for the final interpretation.

1.2. Bilingual Language Processing

Psycholinguistic research into L2 acquisition has been focusing mainly on storage hypotheses, on language representations, on the organization of the lexical and conceptual systems and bilingual lexical access (cf. De Groot 2011; Pavlenko 2009; Singleton 1999; Kroll and Stewart 1994; De Groot 1992). Little has been discovered about how language comprehension takes place in L2.

Recently, bilingual language processing has also been studied using behavioural studies and ERPs. First, Lenneberg's critical period hypothesis (Lenneberg 1967) was checked by Weber-Fox and Neville (1996). The authors refer to a number of behavioural studies that examine the delays in primary and secondary language acquisition and which support the claim that the ultimate proficiency attained for various linguistic skills (phonological, semantic, grammatical, syntactic) largely depends on the age of language acquisition. Previously, Neville et al. (1992) in an ERP experiment with deaf and hearing English subjects came to the conclusion that syntactic processing was more sensitive than semantic to the age

of exposure to language. In Chinese–English bilingual conditions (Weber-Fox and Neville, 1996), with regard to semantic judgments, there was no difference between monolinguals and bilinguals when age of exposure was less or equal to 13 years. Subjects whose age of exposure to the second language was greater than 16 performed less successfully in the semantic violation test. However, phrase structure judgment accuracy significantly correlated to age of exposure; the younger the subject was when the exposure to the second language started, the more successfully he/she performed in the test. In summary, syntactic processing is more sensitive to age of exposure than semantic, but neither of them correlates to years of experience. However, Rossi et al. (2006) claim that L2 syntactic processing may not just depend on the age of acquisition, language proficiency may also have an impact on it. They carried out a sentence comprehension test among German learners of Italian and Italian learners of German, and they found that native-like syntactic processing profiles could be seen in late proficient L2 learners. Kotz et al. (2008) studied Spanish–English early bilinguals' L2 (English) syntactic knowledge and examined to what extent their performance is comparable with that of native readers of English. The offline behavioural results showed no significant differences between L2 readers and native readers of English. However, the online test demonstrated some discrepancies, which might be due to the time pressure during the acceptability judgment. At the same time, the ERP study showed similar online syntactic parsing to that of native speakers of English.

Other studies with different neuroimaging procedures gained conflicting results. Kim et al. (1997) in an fMRI study found the age of second language acquisition to be crucial, whereas Perani et al. (1998) found that proficiency level matters regardless of acquisition age. Proverbio et al. (2002) in an ERP and reaction times study of acceptability judgments investigated and compared Italian–Slovenian bilinguals and Italian monolinguals. The reaction times were much faster for the monolingual group. For the bilingual group RTs were significantly slower with regard to semantic violations in both languages. Under syntactic violation conditions, judgments were faster in Slovenian than in Italian, but there was no difference between the languages in terms of the judgments of semantic violations. The accuracy analysis showed no difference between the languages with regard to correct response percentages, but did show faster and more accurate judgment of semantic violations in Italian and syntactic violations in Slovenian.

Weber and Lavric (2008) tested 18 German–English highly proficient bilinguals and compared their results with those of monolingual English subjects. Their results support the previous results since judgment accuracy is higher for the syntactically anomalous sentences

than for the correct and semantically anomalous sentences. Under all conditions, L1 scoring was higher than L2 results. Weber and Lavric, just like Kotz (2009) emphasize the importance of syntactic transfer between L1 and L2 as it may critically influence L2 syntactic knowledge acquisition.

1.3. The aim of the study, hypotheses

In our study, we present and analyse the results of a bilingual psychophysical test carried out among Hungarian dominant Hungarian-English bilinguals. In the first part of the study we check our hypothesis related to linguistic typology. We assume that the nature of sentence comprehension for agglutinating languages, i.e. for instance Hungarian, might be of a different character from that of non-agglutinating languages, e.g. English (cf. Frauenfelder and Schreuder 1992). We expect

1. faster and better syntactic processing in the agglutinative language, due to the faster recognition and checking of morphosyntactic constraints of the local phrase;
2. longer semantic than syntactic processing in both languages; however, in L1 semantic processing occurs faster than in L2, due to language dominance;
3. differences depending on L2 proficiency level, especially in semantic processing.

2. The study, methods

2.1. Participants

97 Hungarian dominant Hungarian-English bilingual participants took part in the study (27 males, mean age: 32.18 and 70 females, mean age: 30.25). All participants were right handed, had normal or corrected to normal vision and no known neurological history. They all lived in Hungary at the time of the experiment and their language proficiency was either minimum B2 or C1 in English, based on the CEF categories. 34 of them were early and 63 late bilinguals (relying on the literature, we considered an early bilingual to be a person who started the acquisition of English before age 11 (cf. Weber-Fox and Neville 1996; Kim et al. 1997). They were either university lecturers or students of English for whom reading in both languages was an everyday activity.

2.2. Material

Linguistic material from the two languages was presented to the subjects. The two languages differ typologically and genetically.

Hungarian is a non-Indo-European language, and like other Finno-Ugric languages is agglutinative, which means word meanings are modified by adding different and multiple endings or suffixes to the words, rather than using prepositions as, for example, in English. In Hungarian, word order is flexible, unlike in English; the case endings give the words' roles within the sentence (cf. English where it is their position that dictates their role). Hungarian morphology is very rich, with 18 cases, agreements in several areas of grammar, and no passivisation (É. Kiss 2002). There are no genders in the grammar of Hungarian. Hungarian does not use plural for units and multiples with their quantity given.

English is an Indo-European language belonging to the West Germanic group with minimal inflection as compared to other Indo-European languages and with a relatively strict SVO word order.

The test material consisted of 240 sentences: 60 English and 60 Hungarian correct sentences (they served as controls) and 30 semantically and 30 syntactically anomalous sentences in both languages, respectively. Along with our own sentences, previously designed tests were used as sources to provide for a number of sentences with semantic and syntactic violations used in this study. (Gósy 1996, Gósy 1997, Osmanné, Bánréti 1997, Németh 2006).

Sentences with syntactic violation: word order, e.g.

English: (1) *I cut Max's with apple caution.* (correct: I cut Max's apple with caution.)

Hungarian: (2) *A beszél +get +ett nő magá+ban.*

(correct: A nő beszélgetett magában.)

The talk +3rd person singular+past tense woman herself to.

(correct: The woman talked to herself.)

Semantically anomalous sentence types: critical word in mid-position:

English: (3) *I've lost my **temperature** for a moment.*

(correct: I've lost my temper for a moment.)

Hungarian: (4) *Most **nyal+nak** a hóvirág+ok.*

(correct: Most nyílnak a hóvirágok.)

Now lick +3rd person plural the snowdrop+plural.

(correct: Now snowdrops are blooming.)

2.3. Procedure

All the participants filled in a questionnaire relating to their linguistic configuration, their attitude towards their languages, their linguistic biography, the language of the home, the time devoted to L2, their reading habits, etc.

A custom made program (MATLAB, MatLab Inc.) that runs on a PC was used for the experiments. Sentences were presented on a white background, using black characters (Arial, font size 14) in the middle of the screen. The viewing distance was set to be the approximately normal viewing distance of a computer screen (~ 50 cm).

Participants received written instructions at the beginning of the experimental session. This ensured that every subject received the same instruction. The task was to make acceptability judgments about the sentences, i.e. to decide whether the sentences that were on the screen of the computer were acceptable or unacceptable. No instruction was given about in what sense the sentences could be correct or incorrect.

Trials started with the onset of a fixation spot in the middle of the screen, which was followed by a sentence chosen from the pool. The inter-trial interval was set at 2 seconds (s), the sentences stayed on the screen for 5 s (exposure time). During this time participants were required to hit the right arrow key if they considered the sentence on the screen to be correct, and the left arrow key if incorrect. If no response key was selected during the exposure time, the program did not record anything and the next trial started (fixation onset for 2 s, etc.). The task was machine paced to ensure a constant attention level of the participants.

Participants were shown 8 sentences initially to get familiar with the procedure (training phase). After a short break the 240 sentences were presented in a semi-random fashion (test phase). The program recorded correct/incorrect hits and response latency times (measured in seconds). Data were analyzed with the Statistica software (StatSoft, Inc.) using nonparametric statistical methods. Tests were classified as significant if the corresponding type error was smaller than 0.05.

3. Results

3.1. Linguistic typological analysis

3.1.1. *Reaction time (RT) results*

There was a significant difference between the reaction times in the processing of correct Hungarian and correct English sentences (2.14 (±0.53) s vs. 2.63 (±0.49) s, p=0.000)). Decisions were made faster in the Hungarian sentences (Fig. 1.). There was no difference between the processing times of Hungarian sentences irrespective of whether they were correct or incorrect. However, there was a difference between the processing times of English semantically correct and incorrect sentences (2.63 s (±0.49) vs. 2.8 s (±0.50), p=0.000) (Fig. 2.). No difference was observed in reaction time results of syntactically correct (synincorr) and incorrect (synincorr) English sentences.

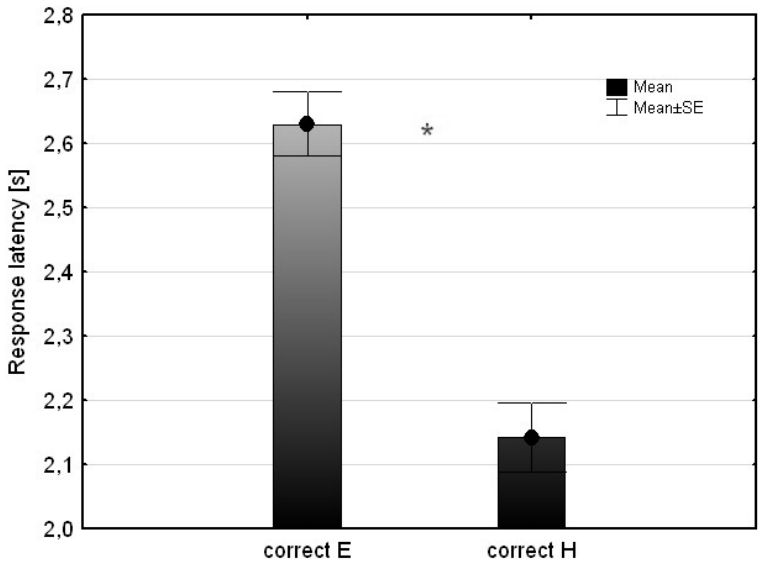

Figure 1. Reaction time results of correct English and correct Hungarian sentences

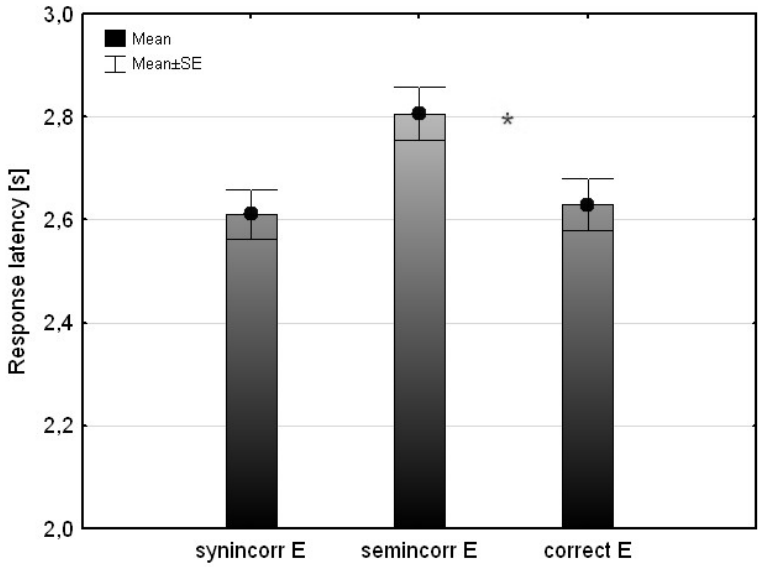

Figure 2. Reaction time results of correct and violated English sentences

3.1.2. *Acceptability judgment accuracy*

The best results were achieved in the judgments about correct Hungarian sentences (92.63%); the next best results were those of the syntactically violated Hungarian sentences (90.93%). There was a difference between the two results (p=0.005), as well as between the results of correct and semantically anomalous Hungarian sentences (92.63% and 87.35%, p=0.009) (Fig. 3.).

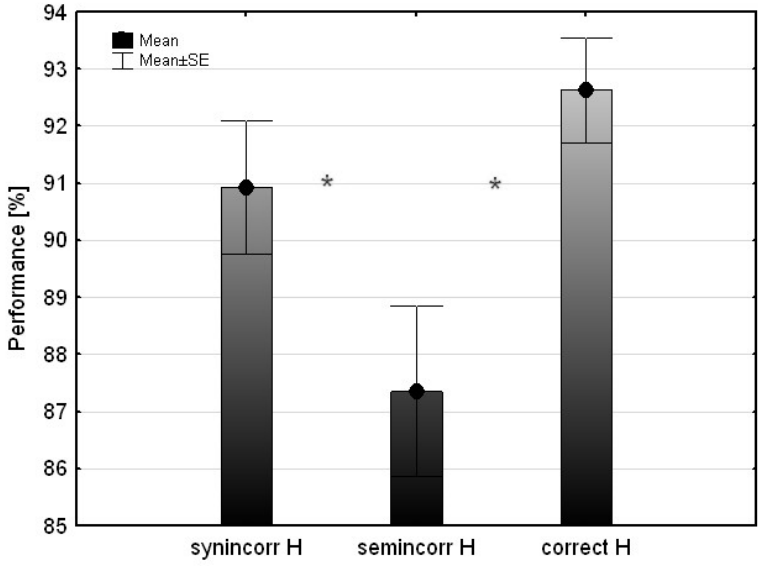

Figure 3. Judgment differences between correct and incorrect Hungarian sentences

When the judgments of correct and incorrect English sentences were compared, we found differences only between the accuracy of judgments of correct and syntactically violated sentences (80.32% vs. 75.80%, p=0.01) (Fig. 4.).

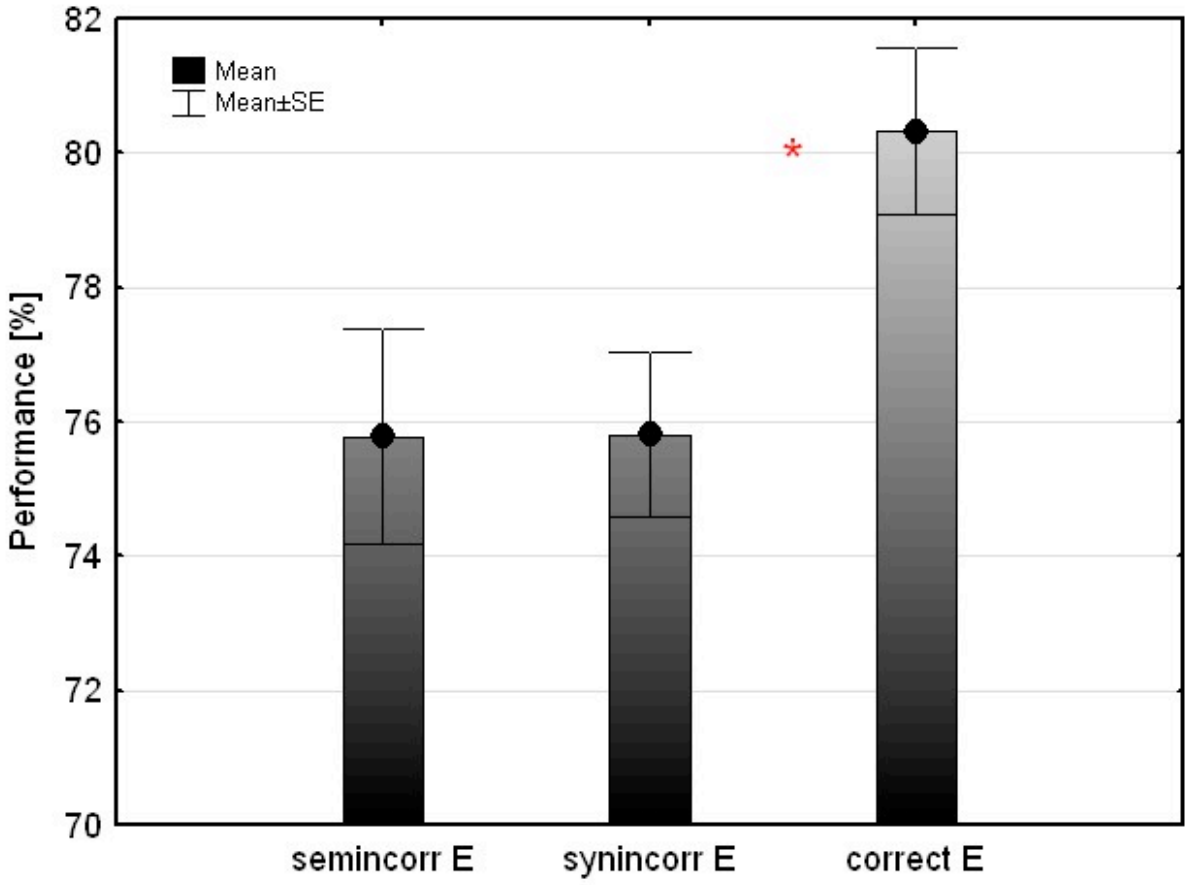

Figure 4. Accuracy of acceptability judgments in English (%)

Our data show that there are both quantitative and qualitative differences between the processing of the two languages. Bilinguals in our study process their dominant language, i.e. Hungarian, faster and better. While we observed differences between the correct and both syntactically violated and semantically anomalous sentences in L1, in L2 this difference was seen in syntactic processing. According to the neurocognitive model presented in the Introduction (Friederici 2002), first we check the local phrase, and if it seems to be fine, we go on processing. In the Hungarian language, morphosyntactic constraints help to control checking, and the recognition of regular and correct structures takes place faster than that of the irregular and incorrect ones. In a language with rich morphology, suffixes, case marking, etc. make processing easier and resolve ambiguity. In the English language, on the other hand, due to the relatively underrepresented morphology, the checking of the local phrase is more

difficult, and we need to study bigger chunks to make clear-cut and correct decisions about the structures.

In our data, there is no difference between the reaction times in the processing of correct and semantically anomalous sentences, but there is some difference between the judgments. In the syntactic processing we see the opposite: there is a time related but no achievement related difference between the accuracy of the acceptability judgments when processing correct and incorrect sentences. In order to see clearly whether the reason why there are differences between the processing of L1 and L2 is of typological character, we analyse our data from another point of view. In the coming sub-chapter, we study our results with respect to L2 language proficiency levels of the participants.

3.2. *Analysis according to language proficiency*

3.2.1. Participants

According to their L2 proficiency level, we created two groups of participants and their results. In the advanced level (’ad.’ in the figures) group we had 69 people with at least C1 level of English proficiency, and in the intermediate (’int.’) group there were 28 people with B2 level of English proficiency.

3.2.2. Results

There was a significant difference in the reaction times between the two groups in the processing of correct English sentences (2.55 s vs. 2.81 s p=0.043) (Figure 5.).

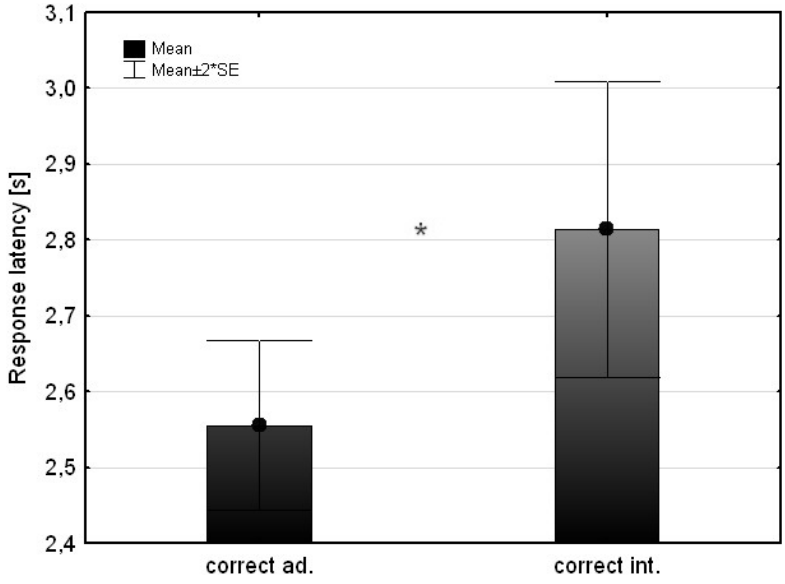

Figure 5. Reaction time results in C1 and B2 level groups (s)

Figure 6. shows the accuracy rates of the two groups.

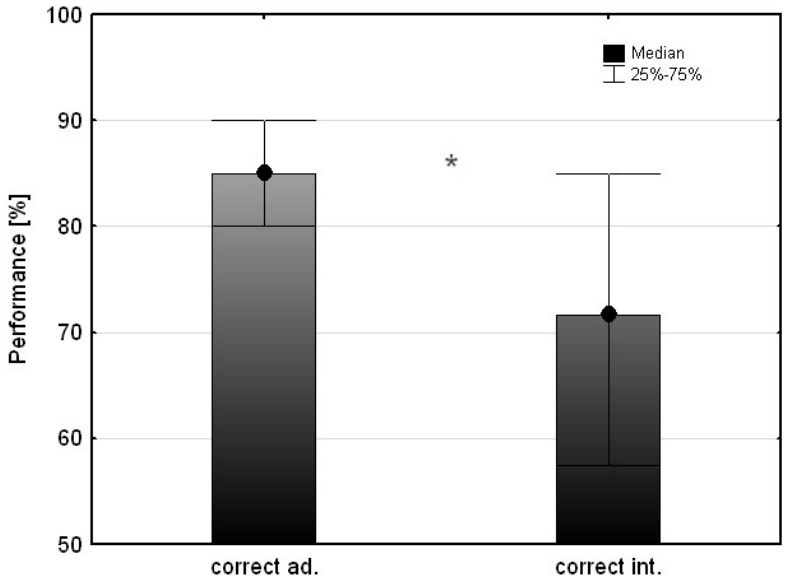

Figure 6. Accuracy rates of C1 and B2 level groups acceptability judgments (%)

The processing of correct sentences – just like in the case of that of the syntactically violated ones – took longer and provided worse results in the group with lower language proficiency.

The results of the reaction times in the processing of syntactically violated sentences can be seen in Figure 7. There is a difference between the two groups not only in the reaction time (p=0.008) but also in the accuracy of their decisions (Figure 8.).

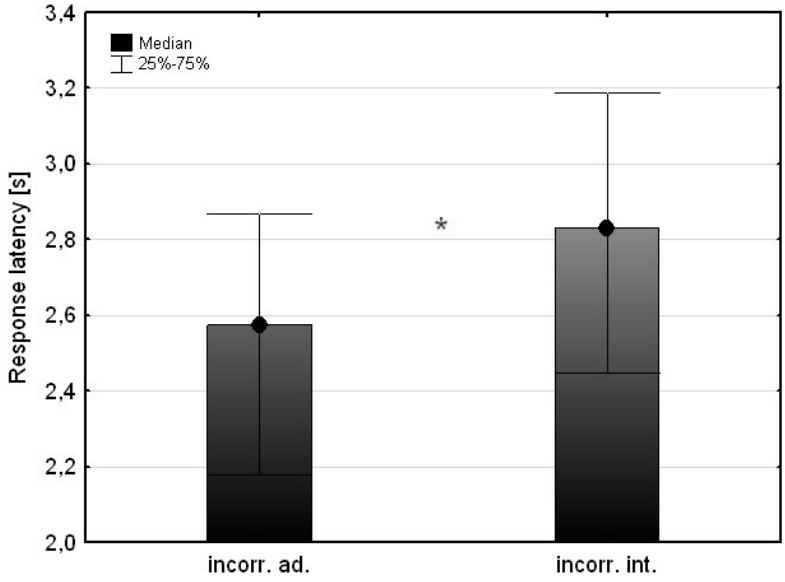

Figure 7. Results in the syntactically violated sentences (s)

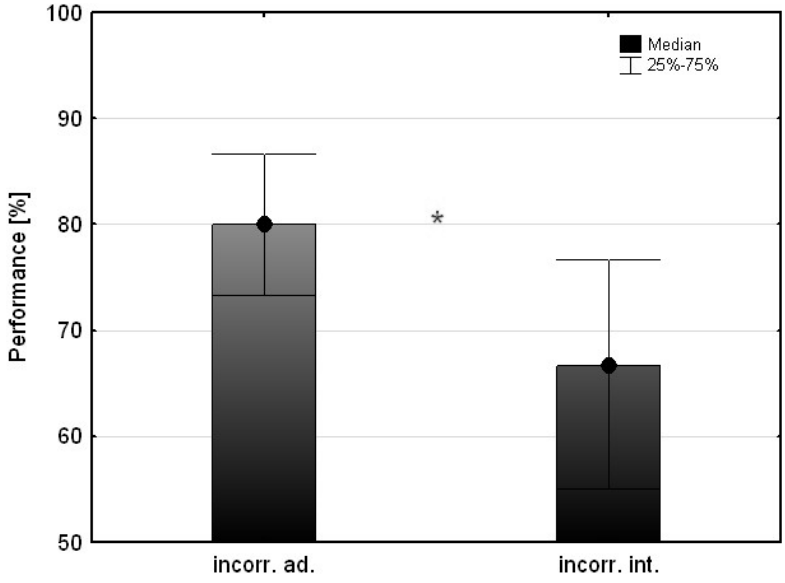

Figure 8. Results in the syntactically violated sentences (%)

In the processing at the semantic level, there is also a difference between the two groups. In the advanced group, the reaction time was shorter for the correct sentences than for the semantically anomalous sentences (2.55 s vs. 2.75 s, p=0.000) (Figure 9.). However, we did not see such a difference in the intermediate group.

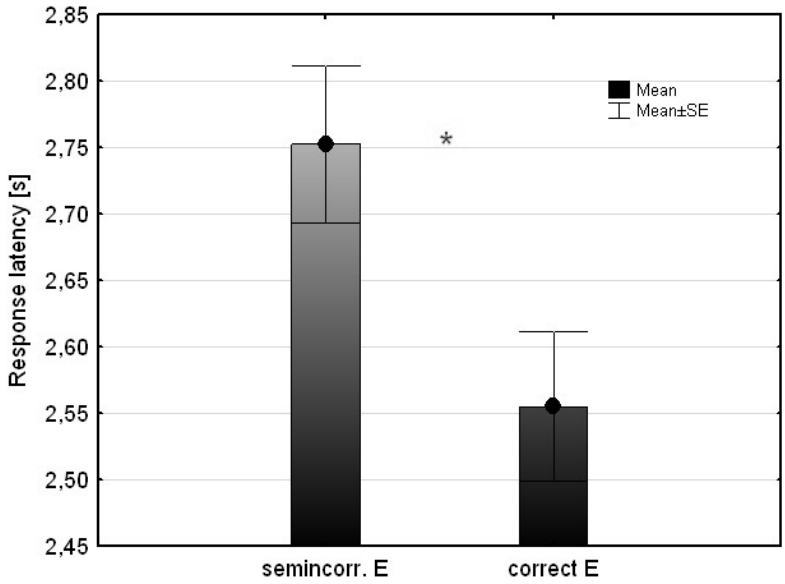

Figure 9. Time-related results for the correct and semantically anomalous sentences in the advanced group

We could observe a negative correlation in both groups between the reaction time and the accuracy of judgments in the processing of correct sentences (Figures 10. and 11.). The sooner the decision is made, the better the results.

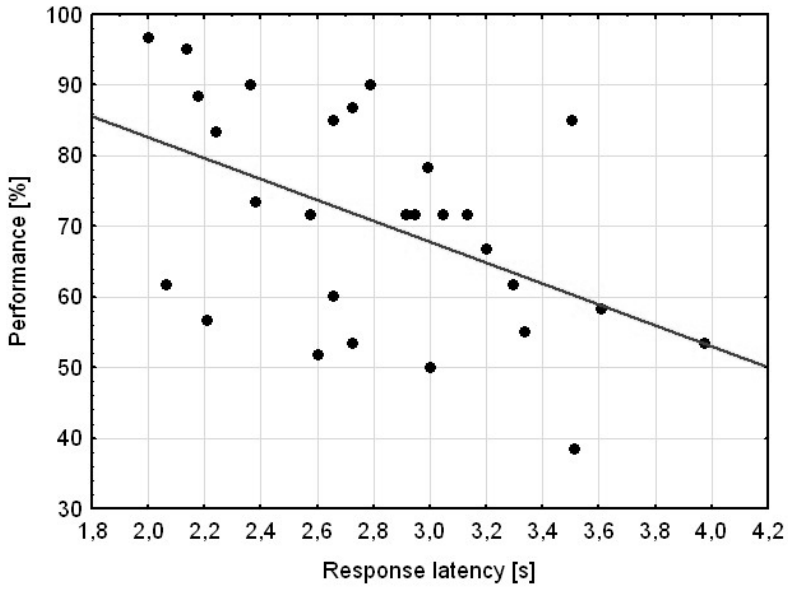

Figure 10. Reaction time and acceptability judgment correlations of correct sentences (B2 level)

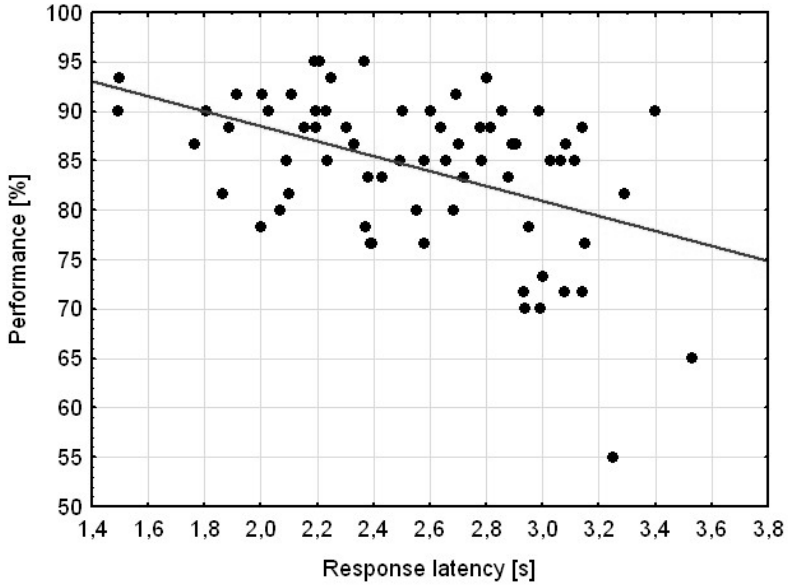

Figure 11. Reaction time and acceptability judgment correlations of correct sentences (C1 level)

There was no such correlation of the incorrect sentences in either group.

4. Discussion

We gained different results in our bilingual written sentence comprehension test compared to the monolingual ones known from the literature. While the best results were 99%, 98.4% and 98.2% in the monolingual studies, our users of English as a second language achieved 94.4%, 92.5% and 87.7%. The bilinguals' performance seems to be behind that of the monolinguals, but the task is more complex since the bilinguals have to make decisions in both of their languages. This means that both languages are equally activated, and the participants have to check both their lexicons and grammars in order to make acceptability judgments, which is time consuming. At the same time, the best results were gained in the judgments of L1 sentences, which proves that the dominant language for our participants is Hungarian even though they use their L2 as much as their L1, if not more. Since they are university teachers and students, they use English on a daily basis: they give lectures, read literature, etc.

In the accuracy of judgments we can also see differences between monolinguals and bilinguals. While monolinguals were the most successful in the recognition of incorrect sentences, our bilinguals performed best in the identification of correct sentences in both their languages.

The difference between the accuracy in decisions of correct and syntactically violated sentences might be explained by the greater tolerance and flexibility of bilinguals. They are used to the two languages having impact on each other, thus to cross-linguistic influences. As a result, they concentrate rather on the content instead of the form.

The decreasing order of the percentage of answers provided to all sentence types (correct and incorrect) is as follows:

1. correct Hungarian (94.48%)
2. syntactically incorrect Hungarian (92.54%)
3. semantically incorrect Hungarian (87.77%)
4. correct English (84.96%)
5. semantically incorrect English (79.60%)
6. syntactically incorrect English (78.65%).

When comparing the orders in the two languages, we can state that the recognition of incorrect sentence types is different. In the Hungarian sentences, syntax comes first and then semantics, while in the English ones it is the opposite. In the Hungarian sentences the monolingual pattern is followed, however, in L2, the processing strategy is different. Hungarian – being an agglutative language – demands greater constraints at the grammatical level, and these constraints guide the language user at an early phase of processing and help with acceptability judgments (Lengyel 1984, Pléh 1998). So in Hungarian, primarily the local phrase is checked and then comes the semantic content while in English, the primary stress is on semantics as the local structure alone does not provide a great help in terms of processing.

The reaction time results also support that the dominant language is Hungarian: decisions made about the Hungarian sentences irrespective of whether they are correct or incorrect take a significantly shorter time than those for the English ones. Here is the increasing order of reaction times:

1. correct Hungarian (2.08 s)
2. syntactically incorrect Hungarian (2.12 s)
3. semantically incorrect Hungarian (2.13 s)
4. correct English (2.54 s)
5. syntactically incorrect English (2.57 s)
6. semantically incorrect English (2.69 s)

The primary checking of the local structure can be shown in the reaction time results as well, as after the correct sentences, the second shortest (and most successful) decision is

the processing of the syntactically incorrect sentences. The results were similar in terms of English relating to reaction time, unlike those relating to the accuracy of judgments.

As Gósy (1999) states, we need the temporal analysis of syntactic and semantic processing in order to understand the whole process of sentence comprehension. Our time-related analysis showed that bilinguals are more successful in their more dominant language – in our case in L1, and there was no difference between the processing time of correct and violated sentences. In L2, a difference was shown between the processing of correct and semantically incorrect sentences. The syntactic structures were processed within the same amount of time irrespective of their correctness or incorrectness, but semantic processing took significantly longer if the sentences were anomalous. This means that the monitoring system of L2 structures signals sooner if the phrase is structurally violated. Decisions about semantic incongruencies are often rash since even if a longer period of time is devoted to semantic processing, not enough time is given to make accurate judgments.

In terms of L2, we can state that there is a negative correlation between the processing time and accuracy of judgments of correct sentences irrespective of language proficiency. However, there was no such correlation in the judgments of incorrect sentences. In the processing of correct sentences, in both groups the results show that the sooner the decision is made, the better the results.

5. Conclusions

There are qualitative and quantitative differences in the processing of the two languages of the bilingual person. The participants of our study processed their dominant language in a shorter time and with better results. In the Hungarian language, the checking of morphosyntactic constraints controls the processing and this is why there is no temporal difference between the recognition of regular and irregular structures. The same concerns the checking of L2 syntax as well, and so there is no difference between the recognition times of correct and incorrect structures.

Semantic processing takes longer than syntactic in both languages. In L2, correct sentences are recognized more successfully than the anomalous ones.

Language proficiency plays a crucial role in syntactic processing. While there is a negative correlation between the time devoted to processing and the accuracy of judgments in the comprehension of correct sentences, in incorrect sentences we observed nothing like this.

Nor did we observe correlations between time and accuracy of judgments in the processing of semantically correct and incongruent sentences. Good or bad decisions are made independently of time devoted to processing.

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Zusammenfassung

Um sinnvolle Äußerungen zu verstehen, muss das menschliche Sprachverstehenssystem eine Reihe heterogener linguistischer Informationen verarbeiten und integrieren. Sprachverstehen geht über die Identifikation von Wortbedeutungen hinaus. Satzverstehen gelingt nicht ohne syntaktische Verarbeitung und das Erkennen syntaktischer Verbindungen zwischen kontextualisierten Wörtern.

Der Beitrag stellt die Ergebnisse einer psychophysikalischen zweisprachigen Studie vor, die unter 97 ungarischen Nutzern des Englischen als Zweitsprache durchgeführt wurde. Den Versuchspersonen wurden L1- und L2-Sätze gezeigt, deren Akzeptabilität sie beurteilen mussten. Von den 240 Probesätzen waren 120 korrekt und 120 semantisch inkongruent oder syntaktisch verletzt. Die Reaktionszeit und der Grad der Akzeptabilitätsbeurteilung wurden gemessen und in beiden Sprachen zwischen den Versuchsgruppen verglichen, die entlang der Kriterien Sprachkompetenzniveau (C1 oder fortgeschrittene Kenntnise und B2 oder gute Mittelstufe) und Zeitpunkt des Zweitspracherwerbs (früh oder spät) gebildet wurden.

Mittels verteilungsfreier statistischer Analysen haben wir in L1 und L2 in den meisten Fällen signifikante Unterschiede zwischen semantischer und syntaktischer Verarbeitung mit Blick sowohl auf die Reaktionszeiten als auch auf die Beurteilung der Akzeptabilität festgestellt. Unsere Ergebnisse stützen die größere Bedeutung der Sprachkompetenz im Verhältnis zum L2-Erwerbsalter bei der erfolgreichen Verarbeitung schriftlicher Sätze.

Schlüsselwörter: Satzverarbeitung, Reaktionszeit, Bewertung der Richtigkeit, syntaktische Verletzung, semantische Anomalie, Sprachkompetenzniveau L2