Is language processing identical in monolinguals and early, balanced bilinguals?

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1. Introduction

This study investigates language-processing differences between early, balanced, adult bilinguals and monolinguals. Specifically, the study examines two questions: 1) whether there are differences between English monolinguals and early, balanced Spanish-English bilinguals in language processing speed and accuracy and, 2) whether Spanish syntactic knowledge influences processing in English. Late learners of a second language have been shown to present language-processing deficits in comparison to early learners of a second language who display native-like performance (Birdsong, 1999; Johnson & Newport, 1989). However, this result is based only on the accuracy of early bilinguals' grammaticality judgments. Accuracy may not be sufficiently sensitive to reveal real-time processing differences between early bilinguals and monolinguals. A bilingual may be able to compensate for any differences in accuracy with increased processing time. Therefore, processing speed may be a more sensitive measure of a bilinguals' language ability. To address this question, both accuracy and reaction time in performing grammaticality judgments are evaluated for early, balanced bilinguals.

Despite the fact that early bilinguals demonstrate impressive grammaticality judgment accuracy, they do not perform identically to monolinguals in other instances. Cross-linguistic influences have been demonstrated at phonological, lexical, and syntactic levels (Chan, 2004; Hartsuiker et al., 2004; Loebell & Bock, 2003; Marian et al., 2004; Meijer & Fox Tree, 2003;). At the syntactic level, some of the differences between early bilinguals and monolinguals are demonstrated in sentence interpretation tasks (Bates et al., 1999; Kilborn, 1989; Hernandez et al., 1994; Liu et al., 1992). Bilinguals and monolinguals use different strategies in identifying the subject of a sentence. Strategy use varies as a function of proficiency level as balanced bilinguals tend to use amalgamated strategies or a combination of the strategies that are effective for each of their languages, while dominant bilinguals have a tendency to transfer strategies from their dominant language to their other language. This research provides valuable information about the differences between bilinguals and monolinguals in syntactic processing. However, this type of investigation fails to determine if the processing is based on general cognitive mechanisms that function across languages or if the syntactic systems of the two languages are directly influencing one another.

Cross-linguistic influence that occurs specifically at the syntactic level has been discovered in the early stages of development. Some of bilingual children's productions mimic the features of their other language and are not present in the speech of monolingual children (Austin, 2005; Müller & Hulk, 2001; Sánchez, 2004; Serratrice, Sorace, & Paoli, 2004). Cross-linguistic influence in adults has been found in late bilinguals who demonstrate transfer from L1 to L2 (Chan, 2004), in heritage speakers who are strongly exposed to L2 and present language attrition or loss in their first language as influenced by the features of L2 (Montrul, 2004; Zapata et al., 2005), or during tasks that require alternating between two languages, as demonstrated in priming research (Meijer & Fox Tree, 2003; Loebell & Bock, 2003; Hartsuiker et al., 2004).

Since early and late bilinguals' performance is not equivalent, cross-linguistic influence may affect these groups differently. Late bilinguals may be more susceptible to syntactic interference because their first language is dominant and thus has a strong influence on their second language. In the case of heritage speakers, their L2 has become their dominant language, exerting a strong

influence on the first language. This interpretation is consistent with the Ivy Hypothesis, which states that bilinguals utilize higher syntactic structures from their stronger language during processing in their second language, resulting in performance that could be considered consistent with cross-linguistic interference (Bernardini & Schlyter, 2004). Early, balanced, adult bilinguals should not be influenced in this way because they do not have a stronger language per se. However, this group has not been investigated for direct syntactic interference between the languages. In addition, studies involving switching between two languages do not provide evidence for a cross-linguistic influence in a completely natural situation. Bilinguals tend to communicate in one language at a time; when they do code switch, it does not typically take the form of alternating between languages on every sentence. Interference resulting from studies that require bilinguals to alternate between languages on every sentence may be the product of conceptual influences in which syntactic information from one language feeds into a conceptual system that influences the syntactic system in the other language, rather than a direct influence between the two syntactic systems.

The present investigation evaluates overall processing speed and cross-linguistic syntactic interference during processing in only one language for early, balanced, adult bilinguals. In addition, this study investigates a variety of language structures to determine the areas of the syntax that are susceptible to interference.

It is predicted, based on the results of Johnson and Newport (1989), that no differences will be revealed between bilinguals and monolinguals in the accuracy of their grammaticality judgments. However, the bilinguals could produce slower reaction times than the monolinguals based on the general influence of bilingualism or circumstances specific to the bilingual group. It is also predicted that the bilinguals will experience cross-linguistic interference. To test this hypothesis within the grammaticality judgment task, the participants will be presented with conflicting sentences in which the grammatical rules of the two languages differ and converging sentences in which the grammatical rules of the two languages are in agreement. It is predicted that the bilinguals will produce higher reaction times than the monolinguals on the conflicting sentences than on the converging sentences, thus providing evidence for cross-linguistic syntactic interference.

2. Method

2.1 Participants

Forty-seven English monolingual (M = 20.0 years, SE = .3) and 28 Spanish-English bilingual (M = 19.7 years, SE = .28) undergraduate students participated in the study. The bilingual participants acquired both languages at an early age (Spanish: M = 1.41 years, SE = .69 and English: M = 3.79 years, SE = .68) and were proficient in both languages as verified by self-report and proficiency exams. The participants were recruited through the psychology department subject pool and given course credit for their participation.

2.2 Stimuli and Apparatus

The sentences presented in the experiment were recorded in English and were designed to be reasonably simple in length and complexity (see Appendix A). The sentences and the Spanish and English proficiency exams (obtained from the University of Michigan) were recorded and edited on a Dell Inspiron 3500 laptop computer using GoldWave Digital Audio Editor (version 5.6.0.23). The sentences were then converted to Sound Designer II files on a one GHz G4 Macintosh PowerBook. The experiment was presented on the same computer in PsyScope for

Mac OSX, resulting in an experimental test of about 10 min in length and proficiency exams approximately 30 min in length each. The participants listened to the experiment through Koss Optimus Pro-135 headphones. The key pressed and reaction time in ms were recorded for each sentence and proficiency exam question.

2.3 Design

There were 96 sentences total. Half of the sentences were categorized as "conflicting" and half were categorized as "converging". In the conflicting sentences, the grammatical rules for Spanish and English were in opposition. Therefore, if the conflicting sentence was directly translated into Spanish, it would elicit a different grammaticality judgment in each of the languages. In the converging sentences, the grammatical rules for Spanish and English were in agreement. Therefore, converging sentences elicit the same judgment in either Spanish or English. Half of the sentences of each type were grammatical and half were ungrammatical. Each of the 48 conflicting sentences had a matching converging sentence that had the same grammaticality value in English (i.e., both were grammatical or ungrammatical), employed the same type of sentence structure, and contained the same verbs and nouns. The only difference between the matching sentences was the manipulation that caused the sentence to be conflicting or converging. Noun phrase (e.g. I agree that Bill is a nice guy.), determiner phrase (e.g. Our neighbor really likes to talk to people.), verb subcategorization phrase (e.g. *The woman wants her daughter eat cake.), preposition phrase (e.g. *This glass is easy of to break.), negation phrase (e.g. Neither Sam nor Sally wanted to hear them.), and wh-question (e.g. *When is going to fix his car Sam?) word order were manipulated to produce the conflicting and converging sentences. The sentences were split into two equal blocks. The first block contained 24 conflicting and 24 converging sentences with four sentences of each type drawn from each of the six potential structural manipulations. Half the sentences were grammatical. The other member of the matching conflicting-converging pair for each sentence appeared in block two. The order of block presentation was randomized between subjects and the order of sentence presentation within each block was also random.

2.4 Procedure

The participants were first asked to fill out a consent form and a bilingualism questionnaire requesting information about their language history, knowledge, and use of Spanish and English. For the grammaticality judgment test, the participants were asked to press one key if they thought the sentence heard was grammatical and another key, if they thought the sentence was ungrammatical. Participants were asked to respond as quickly and as accurately as possible. First, four practice sentences were presented and feedback was provided followed by the first block of sentences. After the first block, a break was permitted, but few participants reported taking a break. The second half followed the same procedure as the first half.

Following the experimental test, the bilingual participants took the Spanish and English proficiency exams to confirm listening comprehension competence in each language; the order of these exams was randomized across subjects. Participants were provided with paper versions of the exams, in case the presentation of an item was missed, but were asked to focus on listening rather than reading. After the experiment was complete, the experimenter explained the purpose of the study to the participants.

3. Results

Two of the 96 sentences were excluded from the analysis due to ambiguity in determining the correct grammaticality judgment. Only correct responses were analyzed for the reaction time results.

3.1 Reaction Time Results

A 2 (Type: Conflicting vs. Converging) by 2 (Grammaticality: Grammatical vs. Ungrammatical) by 2 (Language: Monolingual vs. Bilingual) repeated measures ANOVA was performed on the reaction time data measured in ms, with language as the between subjects measure. The ANOVA revealed a main effect of grammaticality, $F(1,75) = 27.17$, $p < .001$ with faster overall reactions times produced for the ungrammatical sentences than for the grammatical sentences (see Table 1). A type by grammaticality interaction was significant, $F(1,75) = 4.46$, $p < .05$. A paired t-test across both language groups revealed that although reaction times were similar for the grammatical conflicting and converging sentences, $t(76) = -.29$ $p = .78$, on the ungrammatical sentences, subjects were faster to judge converging sentences than conflicting sentences, $t(76) = 2.51$ $p < .05$ (see Table 1).

Table 1
Mean Overall Reaction Time for Sentence Grammaticality and Sentence Type

Sentence Type	Grammaticality	
	Grammatical	Ungrammatical
Conflicting	992.46 (41.08)	881.12 (38.08)
Converging	998.63 (38.53)	820.76 (35.14)
Overall	995.8 (38.38)	853.6 (34.82)

Note. Reaction time is measured in ms and standard error is in parentheses.

Lastly, the ANOVA revealed a main effect of language, $F(1,75) = 4.12$, $p < .05$ with bilinguals producing slower overall reaction times than monolinguals (see Figure 1).

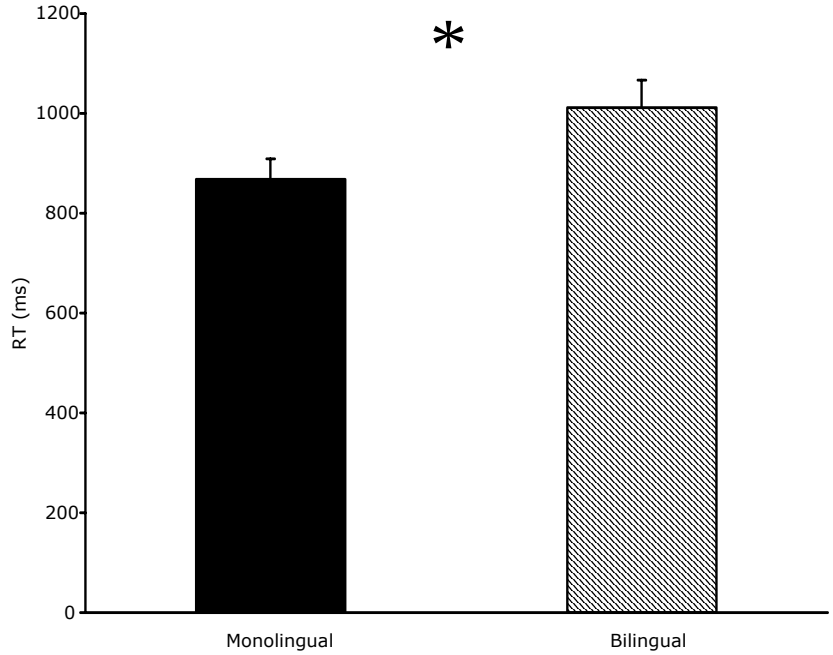

Figure 1. Mean reaction time (+SE) for monolinguals (n = 30) and bilinguals (n = 47).

Contrary to prediction, the language by type interaction was not significant, $F(1,75) = .66$, $p = .42$, demonstrating a lack of syntactic interference (see Figure 2). A post hoc analysis was performed on the difference scores between each of the sentence pairs (the converging sentence subtracted from the conflicting) comparing bilinguals to monolinguals. A positive score reflects slower reaction times on the conflicting sentences than on the converging sentences as an indication of syntactic interference. The analysis revealed that only 2 of the 47 sentence pairs were significant ($t(72) = 2.12$, $p < .05$, $t(52) = -2.14$, $p < .05$). In addition, only one of these two pairs was in the predicted direction with bilinguals producing higher scores than monolinguals (bilingual: $M = 407.52$ ms, $SE = 235.93$, monolingual: $M = -123.33$ ms, $SE = 128.96$). This pattern was consistent for proportional relations (reaction time on conflicting sentences as a proportion of the overall conflicting and converging reaction time), across sentence types (determiner phrase, noun phrase, negation phrase, wh-question, verb subcategorization, and preposition phrase), and under different exclusionary criteria.

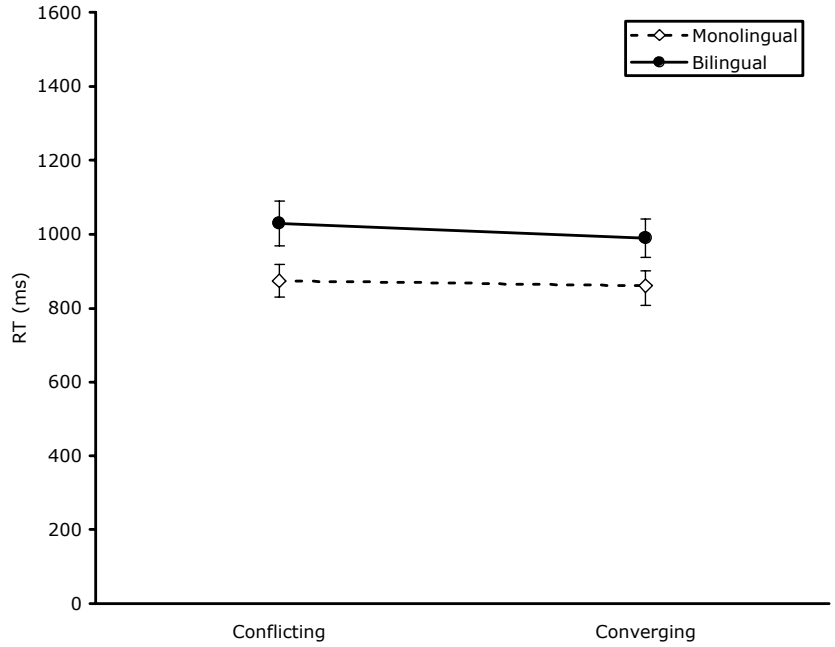

Figure 2. Mean reaction time (+*SE*) for monolinguals and bilinguals on conflicting and converging sentences.

3.2 Accuracy

A 2 (Type: Conflicting vs. Converging) by 2 (Grammaticality: Grammatical vs. Ungrammatical) by 2 (Language: Monolingual vs. Bilingual) repeated measures ANOVA was performed on the accuracy data, with language as the between subjects measure. The analysis revealed a main effect of type, $F(1,75) = 17.07$, $p < .001$ with better overall performance on conflicting ($M = 89.89\%$, $SE = .63$) than converging sentences ($M = 86.74\%$, $SE = .6$). This analysis also revealed a main effect of grammaticality, $F(1,75) = 64.92$, $p < .001$ with greater accuracy on grammatical ($M = 91.7\%$, $SE = .69$) than ungrammatical ($M = 81.98\%$, $SE = .91$) sentences.

The ANOVA failed to reveal a main effect of language, $F(1,75) = .39$, $p = .53$; bilinguals were just as accurate as monolinguals (see Figure 3).

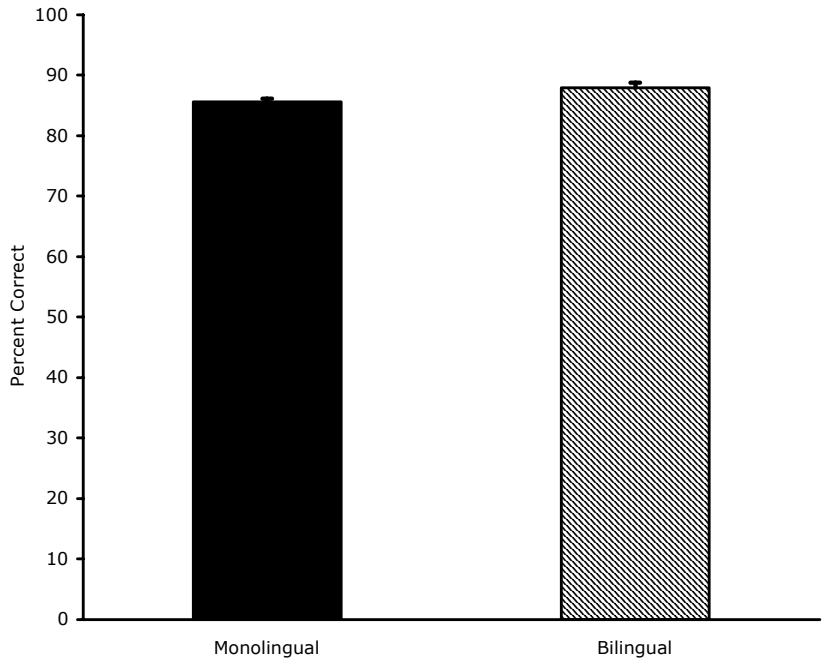

Figure 3. Mean overall accuracy (+*SE*) for monolinguals and bilinguals.

In addition, the accuracy data did not produce evidence for syntactic interference, as demonstrated by a lack of type by language interaction, $F(1,75) = .84$, $p = .36$ (see Figure 4). In fact, a post hoc analysis performed on the difference score between the sentence pairs (the converging sentence subtracted from the conflicting) comparing bilinguals to monolinguals revealed that only 2 of the 47 pairs were significant ($t(75) = -2.14$, $p < .05$, $t(75) = -3.07$, $p < .05$). This indicates that monolinguals outperformed bilinguals on converging over conflicting sentences as an indicator of syntactic interference for only two of the sentence pairs. This pattern was consistent across sentence types (determiner phrase, noun phrase, negation phrase, wh-question, verb subcategorization, and preposition phrase) and under different exclusionary criteria.

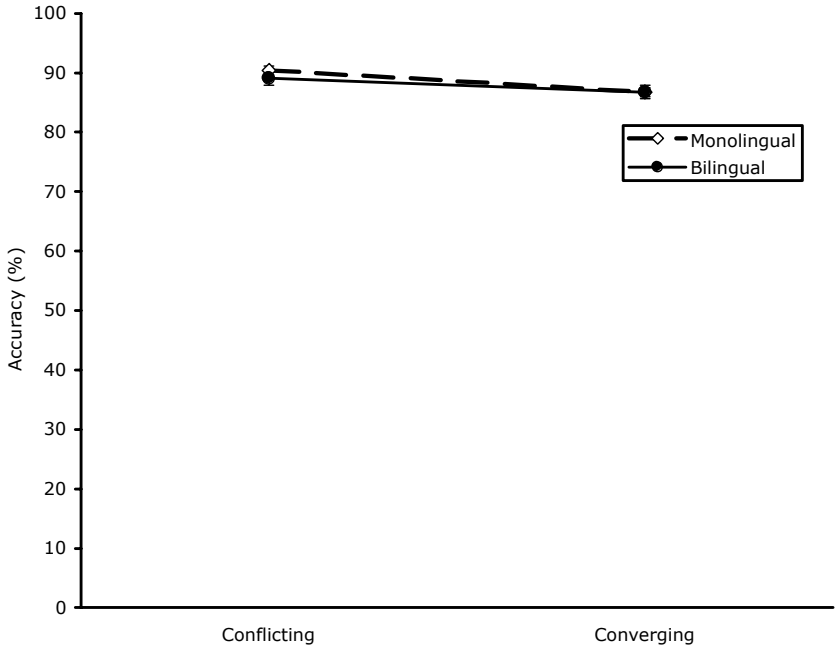

Figure 4. Mean accuracy (+*SE*) for monolinguals and bilinguals on conflicting and converging sentences.

4. Discussion

Two main findings emerged from this study. First, early, balanced bilinguals produced slower overall reaction times to the sentences suggesting that bilingualism may lead to effects in processing speed even for early, proficient acquirers. This is the first known result to-date indicating a processing effect in early, balanced bilinguals. This effect occurred despite the fact that the bilinguals performed with native-like accuracy on the grammaticality judgment task, confirming Johnson and Newport's (1989) findings. According to the Competition Model, it is possible that the bilinguals were using amalgamated strategies, comprised of a combination of strategies that are most reliable for both languages, which are not as effective in either language as those of a monolingual, thereby resulting in higher overall reaction times (Hernandez et al., 1994). These strategies would be applied regardless of whether the sentence is conflicting or converging, resulting in the same pattern of performance as monolinguals across sentence types.

The second main finding is that bilinguals and monolinguals did not present different patterns of performance for the conflicting and converging sentences. This result was consistent across numerous analyses. Hence, our results provide no evidence for cross-linguistic syntactic interference in early, balanced bilinguals during processing only in English.

There are a number of potential explanations for this second finding. First, the group of bilinguals participating in the current study may not experience interference while processing only in English. It is possible that we would only find transfer from English to Spanish and not vice versa because English is the dominant, higher status language spoken by the majority of members of the community. For this reason, the participants may be slightly more dominant in English, at least in the formal manner that is tested in the grammaticality judgment task. The English and Spanish proficiency exams were formed with different types of questions and could not be compared directly to each other. Therefore, it is possible that the bilinguals may be slightly more dominant in one of the languages. If their formal English skills are more dominant,

then the influence of Spanish may not emerge in a task that is testing grammatical processing exclusively in English. The sentences presented in this study consist mainly of manipulations in word order. Word order is quite rigid in English and therefore, errors in word order can be highly salient. Conversely, Spanish is more flexible in the acceptability of order within constructions and therefore, English may be less syntactically susceptible to grammatical influence from Spanish than Spanish is to the influence of English. The effect of asymmetric cross-linguistic influence has been demonstrated, under some circumstances in bilingual children (Austin, 2005; Müller & Hulk, 2001). For example, object omission occurs more consistently in Germanic than in Romance languages resulting in greater production of object drop for bilingual children in their Romance language over monolinguals in the same Romance language (Müller & Hulk, 2001). This demonstrates that one language may have an asymmetrical influence on another for factors relating to the structure of the language rather than language dominance within the bilingual. This effect may be relevant for the bilinguals in this study. Follow-up investigation will address this issue by examining syntactic interference from English while processing in Spanish.

The second possibility for the lack of syntactic interference could be the result of the types of sentences used in the test. Both monolinguals and bilinguals produced high accuracy scores across all types of sentences. This may reflect the ease with which the judgments were made. Therefore, it is possible that the sentences were not difficult enough to generate interference from the other language. However, it is unknown whether or not these sentences are representative of the types of sentences heard during normal communication. If so, it may be that, in general, early, balanced bilinguals find it easy to communicate in both of their languages and do not experience on-line interference.

In addition, the manipulations between the conflicting and converging sentences consisted mainly of changes to the core syntax. The core syntax consists of basic features of the grammar for a particular language that are fixed and are not influenced by other factors such as pragmatics. Current research has suggested that the core syntax is relatively insulated, whereas aspects of language that occur at the semantic- or syntactic-pragmatic interface are more susceptible to cross-linguistic influence (Müller & Hulk, 2001; Sánchez, 2004; Serratrice et al., 2004; Zapata et al., 2005).

The third possibility is that syntactic interference does not occur during processing in only one language. It may be that the language systems are fairly separate unless they are engaged or activated together. If this were the case, then interference would be more likely to occur during situations in which both languages are likely to be utilized, such as those that require the bilingual to alternate between languages (Meijer & Fox Tree, 2003; Loebell & Bock, 2003; Hartsuiker et al., 2004). This conclusion would support Grosjean's (2001) theory of language modes and it may be possible that a bilingual only experiences interference when they are processing in "bilingual mode".

In conclusion, this study demonstrates that early, balanced, adult bilinguals display native-like accuracy on grammaticality judgments. However, this group produced slower reaction times than monolinguals suggesting that they are not native-like in the speed at which they process language. In addition, early, balanced bilinguals do not experience syntactic interference from Spanish during processing only in English. Continued investigation will evaluate possible explanations for this result.

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