Effects of L1 Co-activation on the Processing of L2 Morpho-syntax in German-Speaking Learners of English

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1. Introduction: The L1 grammar in L2 sentence processing

It is generally assumed in generative SLA that properties of the L1 grammar influence, at least to some extent, grammatical representation of the L2, especially at initial stages of acquisition. We adopt the Full Transfer (Schwartz & Sprouse, 1996) model in assuming that the initial state of L2 knowledge is in fact identical to the final state of L1 knowledge. Development of the L2 grammar then depends on parsing of input. Mismatches between the input and the current state of grammatical knowledge motivate change in L2 representations in order to license grammatical parses of the target language. The L1 grammar, however, acts as a potentially serious obstacle in the process of L2 development as there are cases where the "current grammar may appear to accommodate the L2 input adequately" (White, 2003: 268). This raises interesting questions about how L1 grammatical knowledge may potentially be deployed in online L2 sentence processing. One way of adapting the Full Transfer model to sentence processing is to assume simultaneous co-activation of L1 and L2 grammatical properties during L2 processing (see Sharwood Smith & Truscott, 2006 for a discussion of such an approach within their MOGUL framework).

However, the extent and nature of any cross-linguistic grammatical influence in L2 processing is contentious. For example, Clahsen & Felser (2006) propose that non-native processing involves only shallow syntactic representations. If L2 processing involves significantly less syntactic detail than native language processing, this precludes any role for the L1 syntax in L2 sentence processing. By contrast, the Competition Model (Bates & MacWhinney, 1982) assumes, in common with FT, that transfer plays a crucial role in second language acquisition. Unlike FT, however, the Competition Model assumes an emergentist, connectionist model of language development without any independent level of abstract syntactic representation. Recent work on bilingual processing has suggested that bilinguals may indeed co-activate syntactic properties of the non-attended-to language even when functioning in a monolingual mode (Vaughan-Evans et al, 2014; Sanoudaki & Thierry, 2014).

In the work presented here, we investigate whether transfer during L2 sentence comprehension is affected by co-activation of L1 syntax by examining how native speakers of German process number agreement in English wh-questions. The paper is organized as follows: the next section discusses studies of syntactic co-activation in L2 processing. Section 3 then surveys the relevant properties of German and English which are investigated in the experiments outlined in Section 4. Section 5 discusses the results in light of models of grammatical transfer.

2. Syntactic co-activation in L2 sentence processing?

Co-activation has been extensively studied in bilingual lexical processing, with the weight of evidence showing that lexical access is non-selective in bilinguals (see Dijkstra, 2005). Spivey & Marian (1999, p. 283) summarize this as meaning that "bilingual listeners do not appear to be able to deactivate

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the irrelevant mental lexicon when in a monolingual situation". Given this evidence of co-activation of a bilingual's two languages at the lexical level, a logical question for bilingual processing is whether bilinguals also activate their grammatical systems in parallel while functioning in a monolingual mode.

In order to look for potential effects of syntactic co-activation, recent studies have analyzed the processing of what have been called "cross-linguistic garden paths" (Jacob 2009) or "cross-language conflicts" Kaan et al (2015, p. 801). These can be defined after Kaan et al (2015, p. 801) as constructions in which "a particular sequence of words corresponds to a particular construction in the L2 (e.g., an object relative) but to a different construction in the L1 (e.g., a subject relative) when translated word-by-word." Because such strings are compatible with different L1 and L2 syntactic structures, co-activation can be identified by misinterpretation of L2 clauses in line with what is licensed by the L1 syntax, or by processing difficulties at points in the clause where the surface form becomes incompatible with the co-activated L1 syntax.

Jacob (2009) studied the phenomenon on the basis of L1 German-speakers' processing of full and reduced relatives in subordinate clauses as in (1) and main clauses as in (2).

(1) When the barmaid (who) Damian deceived and betrayed attempted to steal the spoons nobody paid attention.
(2) The barmaid (who) Damian deceived and betrayed attempted to steal the spoons when nobody paid attention.

In a sentence like (1), the initial reduced relative, i.e. the version without *who*, is a word-by-word equivalent to a German SOV structure (*Als die Bardame Damian hinterging und betrog…*), while the full relative and the version with an initial main clause as in (2) are not. Co-activation of the German grammar while learners read these sentences would be indexed by longer reading times after the reduced relative, when the clause is no longer amendable to a German parse. Jacob found that in L1 German-speaking learners' reading times, there was a significant interaction of type of relative clause (reduced vs. full) and type of clause beginning (subordinate vs. main). Thus, reading times were longer on the initial reduced relative, the structure for which a co-active German grammar can assign a different parse. This is interpreted as an effect of the parser accessing L1 syntax because neither native English speakers nor L1 French-speaking learners of English showed similar reading time patterns. Importantly, however, Jacob only obtained this apparent transfer effect in code-switching versions of his experiment, in which German speakers read both English and German sentences as part of the same task. In a monolingual mode, the interaction was not significant. One could therefore question whether this is simply an effect of being in code-switching mode rather than a general co-activation effect in L2 processing.

Kaan et al's (2015) study of potential cross-language conflict also investigated relative clauses and rested on a similar logic to the experiment we outline below. They looked at advanced proficiency L1 Dutch-speaking learners of L2 English and tested reading times and thematic interpretations of sentences such as (3) to (6).

(3) Mark may know the instructor who the students **have** avoided since last semester.
(4) Mark may know the instructor who the students ***has** avoided since last semester.
(5) Mark may know the instructor who the student **has** avoided since last semester.
(6) Mark may know the instructor who the student ***have** avoided since last semester.

The cross-linguistic conflict derives from the fact that Dutch relative clauses have an identical constituent order. However, the equivalent Dutch structure is ambiguous without any agreement marking, as in (7), and can be disambiguated to either SO or OS order by agreement on the auxiliary. Thus, the ungrammatical English clause in (4) has a grammatical word-by-word counterpart in Dutch, see (8).

(7) Mark kent misschien de leraar die de student **heeft** vermeden sinds het afgelopen semester.
(8) Mark kent misschien de leraar die de studenten **heeft** vermeden sinds het afgelopen semester.

If cross-language conflict affects L2 processing, learners were expected not to notice the ungrammaticality in sentences like (4), which map onto a grammatical Dutch order and they were therefore expected not to slow down at the ungrammatical auxiliary compared to native speakers. Learners would also have longer reading times when the clause is disambiguated to the English OS order, which is less frequent in Dutch. Finally, in comprehension questions probing thematic interpretation, learners should provide more SO interpretations as this is the default reading in the equivalent Dutch clauses. Kaan et al found no online effects of cross-language conflict. In between-group analyses where participants were matched for reading speed, the learners did not differ in terms of sensitivity to grammaticality compared to the native speakers. Intriguingly, however, there was more evidence for L1 influence in the offline comprehension questions. Learners provided the target OS interpretation significantly less often than native speakers and assigned SO interpretations more often for ungrammatical sentences such as (4), where a Dutch subject-initial equivalent would be grammatical. As with Jacob's study, the results are equivocal with respect to co-activation of L1 syntax. There seems to be no evidence of online activation, with between-group differences more adequately accounted for by reading speed. The apparent L1 effects in sentence interpretation may have been the result of resorting to an L1 default after experiencing processing difficulty caused by ungrammaticality (Kaan et al, 2015, p. 823).

The final study we review does find evidence of online syntactic co-activation, but in early bilinguals, rather than late L2 learners. Vaughan-Evans et al (2014) examined brain responses of Welsh-English bilinguals to English non-words which either followed phonological mutation rules consistent with Welsh grammar, or were aberrant forms. In a sentence such as (9), the word-by-word equivalent in Welsh would require a phonological mutation of the initial phoneme in *contents* from /k/ to /g/ (Welsh *cynnwys* becomes *gynnwys*). The Welsh equivalent to (10) does not require the mutation

(9) Each book starts with a page listing its contents / gontents (MUTATED) / dontents (ABERRANT)
(10) The lid was lifted to examine the contents / gontents (MUTATED) / dontents (ABERRANT)

Vaughan-Evans et al studied the Phonological Mismatch Negativity (PMN) responses of bilinguals as they read sentences such as (9) and (10). The PMN is an ERP "sensitive to lexical processing modulated by phonological expectation formed on the basis of the initial letter of a word" (Vaughan-Evans et al, 2014, p. 8333). If the Welsh grammar is co-activated while reading in English, the PMN response should be reduced in response to a mutated form in a context where the Welsh grammar would require it in (9) compared to either aberrant non-words or mutated forms in a context where Welsh would not license the mutation, as in (10). The findings are in line with the predictions as words which follow the Welsh mutation pattern elicited less negative PMN amplitudes than aberrant words in mutation contexts. This is interpreted as "evidence for spontaneous and anomalous transfer of syntax between languages, even at the level of subtle morphosyntactic changes elicited by a rule alien to English" (Vaughan-Evans et al, 2014, p. 8335).

In sum, the jury remains out on L1 effects in L2 processing. As with previous studies, the selection reviewed here finds some evidence of L1 influence in the form of the application of syntactic properties from the language not in use. However, the evidence is far from decisive. The strongest evidence comes from the ERP results from Vaughan-Evans et al, but recall that this was a study of early bilinguals rather than late L2 learners. The extent to which co-activation of L1 and L2 syntax might be at work in L2 learners remains unclear. Against this background, we study comprehension patterns and brain responses of late L1 German-speaking L2 learners of English while they comprehend sentences which are potential cross-language conflicts. Next, we review these relevant linguistic properties before outlining the experiments.

3. Word order and number agreement in German and English wh-questions

English and German differ in their settings of headedness and verb movement parameters. VP and IP in German are head-final while English is consistently head-initial. German main clauses instantiate a verb second (V2) requirement. English does not instantiate lexical verb movement. These grammatical differences give rise to word order differences in subordinate clauses, verb placement relative to adverbs and negation and fronting/topicalization structures, among others.

In wh-questions, however, differences in the grammatical structures of German and English are not consistently manifested in the surface string. English simple tense main clause subject questions and compound tense object questions have identical linear orders to German interrogatives, see (11)-(14).

(11) Which animal bites the dog?
(12) Welches Tier beißt den Hund?
which animal bite-3PS the-ACC dog
(13) Which animal has the dog bitten?
(14) Welches Tier hat der Hund gebissen?
which animal has the-NOM dog bitten

Unlike English, German has no word order distinctions for subject vs. object questions and relies instead on case marking (as in 12 and 14), or number agreement to determine thematic interpretation. This sets up potential cross-language conflicts for German-English bilinguals. As illustrated in (15) – (18), ungrammatical agreement patterns in a range of English structures have grammatical word-by-word equivalents in German.

(15) *Which animal bite the cats? - Welches Tier beißen die Katzen?
(16) *Which animal does the cats bite? - */?Welches Tier tut die Katzen beißen?[1]
(17) *Which animals has bitten the cat? - *Welche Tiere hat gebissen die Katze?
(18) *Which animals have the cat bitten? - Welche Tiere haben die Katze gebissen?

Drawing on the same logic as Kaan et al (2015), English clauses such as these can be used to explore the possibility of syntactic co-activation in L2 processing; if L1 German-L2 English learners co-activate German syntax while processing English, they will be able to license grammatical parses of clauses such as (15) and (18), and assign an object and a subject reading to them, respectively. They will not, however, be able to parse sentences such as (16) and (17). The next section outlines the background to the research question in more detail and fleshes out the predictions for the experiments reported in 4.1 and 4.2.

4. The Current Study

Previous research of offline comprehension patterns has shown that L1 English-L2 German learners (Grüter, 2006) and L1 German-L2 English learners (Rankin, 2014) misinterpret those wh-questions which are cross-linguistic conflicts between the two languages. Such results are in line with the idea that the L1 grammar assigns a parse to the L2 input. The current study expands on these previous results by including (un)grammatical number agreement in the wh-questions and online measures of processing.

The linguistic facts discussed above can be exploited to explore the effects of grammaticality interacting with L1-(in)compatibility. The English wh-questions used as stimuli in Experiments 1 and 2 are categorized as grammatical or ungrammatical and as L1-compatible or L1-incompatible (i.e. depending on whether the clause would be grammatical in a word-by-word translation into German). This categorization is illustrated in Table 1.

[1] The status of this type of do-support structure in German is unclear. It is prescriptively unacceptable but does occur in a range of regional varieties. A structure as in (16) will therefore be grammatical for some speakers, ungrammatical for others and grammatical but prescriptively avoided for others. For the sake of simplicity, we will count it as ungrammatical here.

Table 1: Categorization of stimuli used in experiments

	L1-Compatible	*L1-Incompatible*
Grammatical	Which animal chases the squirrels?	Which animal do the squirrels chase?
Ungrammatical	*Which animal chase the squirrels?	*Which animal does the squirrels chase?

German grammar could license a parse of ungrammatical/L1-compatible clauses. However, the ungrammatical/L1-incompatible clauses are ungrammatical in both English and German. If the L1 syntax is co-activated, we therefore predict a general effect of L1-compatibility in the comprehension and processing of English clauses as outlined in (i) and (ii):

i) L1 German speakers can assign a syntactic representation to ungrammatical but L1-compatible clauses and thus use the agreement pattern to arrive at a sentence interpretation. Experiment 1 tests this on the basis of offline comprehension with the prediction that L2ers will rely on agreement for thematic interpretation more often in ungrammatical/L1-compatible clauses.

ii) In L1 German speakers, ungrammatical/L1-compatible clauses will evoke a lower P600 ERP component (associated with processes of syntactic reanalysis, see Rossi et al 2005) compared to ungrammatical/L1-incompatible clauses, as L1-compatible clauses may be assigned a grammatical parse by the active German grammar. Experiment 2 tests this on the basis of electrophysiological measures with the prediction that amplitude of P600 in response to ungrammaticality will be modulated by L1-compatibility.

4.1. Experiment 1: Offline Comprehension

4.1.1. Participants

Experiment 1 was administered to 19 (3 M/ 16 F) instructed L1 German-speaking learners of L2 English and 9 (5 M / 4 F) native English-speaking controls. All learners self-reported German as their only native language. The learners were following a degree program in English Studies at an Austrian university. In order to gain entry to the degree program, the learners had sat a proficiency exam placing them at least at the B2 proficiency level (= 'independent user') on the Common European Framework of Reference (CEFR). At the time of testing, the learners were in their third semester of university-level instruction and all had passed an interim proficiency test placing them at B2+/C1 level (= 'proficient user'). Participants also provided self-ratings of their proficiency on a 5-point scale ('basic' to 'advanced'), which is summarized together with other biographical details in Table 2.

Table 2: Biographical information on participants in Experiment 1

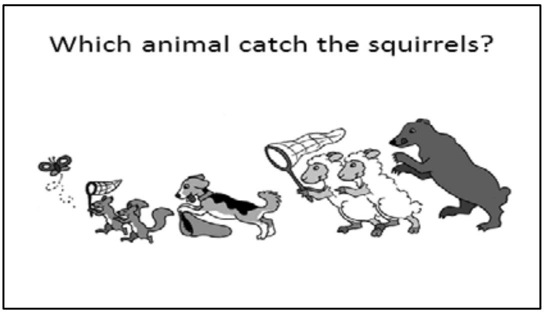
Age	**Age of Acquisition**	**Length of Instruction**	**Proficiency Self-Ratings**			
			Reading	Writing	Speaking	Listening
23.2 (20-33)	8.5 yrs (6-10)	14.1 yrs (10-24)	4.3	3.6	4	4.4

4.1.2. Methods & Materials

Experiment 1 was a picture interpretation task adapted from Grüter (2006). It was administered in a classroom setting, using information projected onto a white screen in MS PowerPoint format. Preliminary information explained the nature of the task and informed participants that they would see scenes which depicted groups of animals chasing or catching each other. Each scene would be accompanied by a question displayed above the picture (see Figure 1). The participants' task was to provide the answer to the question by circling responses on a multiple choice answer sheet. A total of 16 question/picture trials were presented in two blocks of 8 trials each. The 16 questions were equally distributed between the four cells in Table 1, crossing L1-compatibility and (un)grammaticality. Block One had questions in the simple present tense preceded by explanation that the pictures would depict what the animals do every day. This was to provide context for the present tense. Block Two had questions in present perfect tense, preceded by an explanation that the pictures would show what the animals have done recently. Each trial was presented for 8 seconds with a blank screen shown for 500ms between trials.

Responses to grammatical questions were coded as 'target', 'non-target' or 'don't know.' Responses to ungrammatical questions were coded as 'agreement', 'word order' or 'don't know.' This draws on the logic used in Competition Model studies, which manipulate possible cues for thematic interpretation and investigate whether speakers rely on word order, case, animacy, etc. To exemplify, as an answer to the trial in Figure 1, one could choose 'butterfly', i.e. an agreement-driven response, or 'dog', i.e. a word order-driven response.

Figure 1: Example of trial from Experiment 1 (images were presented in color)



4.1.3. Results

Performance on grammatical questions was at or close to ceiling for both the L2 and native-speaker groups. The learners chose non-target responses at a rate of 4.4%. The native speakers never chose non-target responses but they did choose the 'don't know' option in 1.8% of cases. The learners perform similarly on comprehension of wh-questions with grammatical agreement and have no specific problems in parsing English wh-questions.

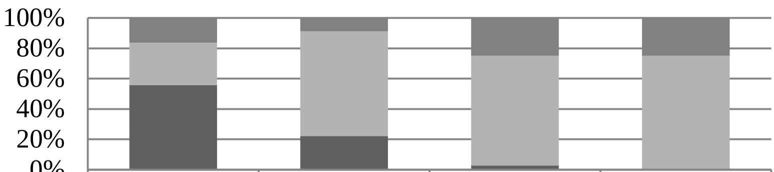
Figure 2 summarizes responses to ungrammatical questions. On the whole, native speakers provide responses in line with the thematic interpretation licensed by word order, or they choose a 'don't know' response, which perhaps indexes parsing difficulty caused by ungrammaticality. They virtually never provide agreement-driven responses. The 1.4% agreement responses by native speakers is the result of a single such response. The learners are more likely to choose the thematic interpretation licensed by the ungrammatical agreement morphology. These results are in line with previous findings in the Competition Model tradition which have found that native speakers of German are more likely to attend to morphological agreement cues when they are present at the expense of word order or animacy cues, and that this behavior transfers to L2 English (Kilborn, 1989).

Figure 2: Rate of response types to ungrammatical questions

	Learners	Natives
Don't Know	12.5	25
Word Order	48.5	73.6
Agreement	39	1.4

In terms of the predictions for L1 co-activation, the crucial comparison is between L1-compatible and –incompatible clauses. Figure 3 outlines the rate of interpretation patterns by clause-type. Learners indeed provide more agreement-driven responses to L1-compatible clauses. A 2 (Group) x 2 (Compatibility) ANOVA on the number of agreement responses to ungrammatical clauses finds a significant main effect of group $F(1, 24) = 43.89$, $p. < .01$ and an interaction of group and compatibility $F(1, 24) = 13.63$, $p. < .01$. A repeated measures one-way ANOVA on the rate of learners' agreement responses to L1-compatible vs. L1-incompatible clauses was significant $F(1, 16) = 26.52$, $p. < .01$. Learners are significantly more likely to rely on agreement for sentence interpretation in clauses where the agreement pattern could be licensed by German syntax.

Figure 3: Type of response by L1-compatibility



	Learner +L1 Clause	Learner -L1 Clause	Native +L1 Clause	Natives -L1 Clause
Don't Know	16.2	8.8	25	25
Word Order	27.9	69.1	72.2	75
Agreement	55.9	22.1	2.8	0

In sum, the results from the offline comprehension indicate that German grammar is co-activated as learners parse English wh-questions. Comprehension patterns are consistent with the German grammar 'rescuing' a parse of ungrammatical English clauses. Ungrammatical but L1-compatible clauses have interpretations in line with those licensed by German syntax. However, learners are more likely to resort to relying on word order cues to interpret ungrammatical and L1-incompatible clauses.

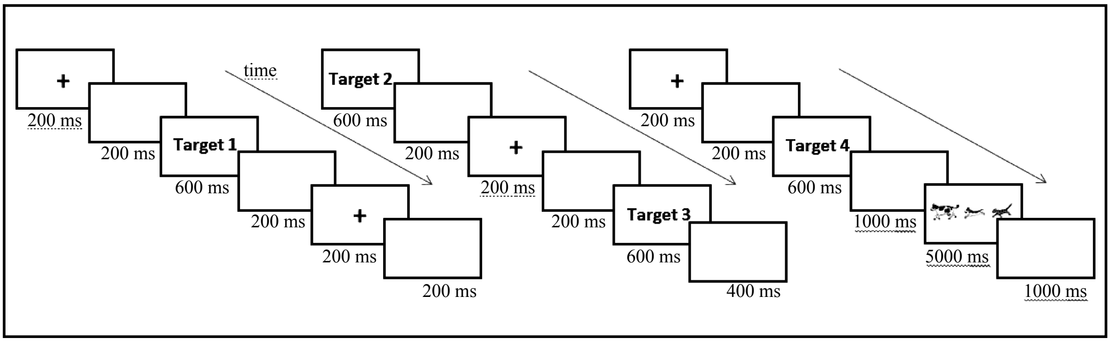
4.2. Experiment 2: ERP Study
4.2.1. Participants

The participants in Experiment 2 were 15 L1 German-speaking users of L2 English (5 F / 10 M) with an age range from 19 to 35 (mean 25.8). All participants had at least a secondary school leaving certificate, were cognitively unimpaired and with no previous history of neurological or psychiatric disorders. All had started learning English at age 8 or later. At the time of testing, the participants were no longer in formal instruction. They had a high level of English proficiency as measured by standardized proficiency tests (TOEFL or EILTS). Those participants who had not previously sat a standardized proficiency test were required to complete a reduced version of TOEFL (Test of English as a Foreign Language). Participants achieved a mean score of 20 (±2.9) out of 25.

4.2.2. Methods & Materials

ERPs time-locked at the onset of noun-verb agreement mismatches were recorded while the participants read a total of 288 visually presented and randomized sentences, of which the types were equally distributed between the cells in Table 1. Each wh-question was followed by a picture interpretation task (using similar pictures as in Figure 1) to which the participant had to provide an answer by manual response on a keyboard (left arrow for the animal preceding the target and right for the animal following the target). During the task procedure, the participants were told that the experiment was about their ability to accurately comprehend sentences and not about their response speed. The picture interpretation task was an adapted version of that used in Experiment 1. Each sentence constituent was preceded and followed by a 200ms inter stimulus interval except for the critical constituent (the one programmed as trigger onset, labelled as "Target 3" in Figure 4), which was followed by a 400ms inter stimulus interval. Such a length was necessary in order to restrain the evoked ERP to the processing occurring during the detection of the syntactic violation and subsequent reanalysis and to allow the ERP component to emerge without overlaps with the neural activity evoked by the following sentence constituent.

Figure 4: Progression of Experiment 2



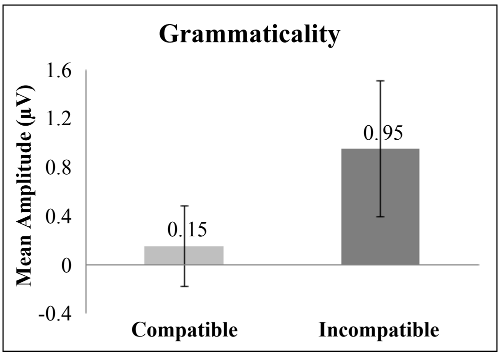
4.2.3. Results

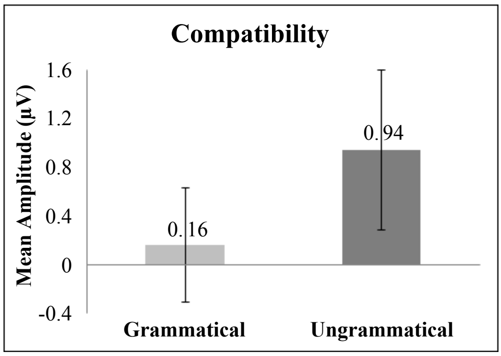
Input for statistical analyses were the mean area amplitude values of ERP waveforms for each condition in three crucial time windows (150-250, 350-450 and 500-700ms) for relevant centro-parietal electrodes. A repeated measures ANOVA, with mean area amplitude as dependent variable and the four conditions (grammatical, ungrammatical, L1-compatible, L1-incompatible) as independent factors was performed in a within subjects analysis. There were no effects in time windows 150-250ms and 350-450ms, thus excluding the presence of any ELAN, LAN or N400 effects elicited by the task. Unfortunately, due to technical issues, it was necessary to reject the data recorded from electrodes Pz, P1 and CP1 because of low activity. This deprives the results of three important channels in syntax-related research.

For the time window 500–700ms, ANOVA showed a main effect of grammaticality on electrode FCz ($F(1, 14) = 7.8$, $p < .05$). Post hoc tests using Bonferroni correction for multiple comparisons revealed that grammatical sentences (see Figure 5) elicited significantly ($p = .014$) lower mean area amplitude compared to ungrammatical (0.15 ± 0.33 mV vs. 0.95 ± 0.56 mV, respectively). The same main effect of grammaticality was found for electrodes FC1 ($F(1,14) = 5.2$, $p < .05$), FC2 ($F(1,14) = 6.1$, $p < .05$), C4 ($F(1,14) = 7.8$, $p < .05$). On all these electrodes a marginally significant effect of compatibility was also found (all *p*s < .08, see Figure 6 for electrode FCz). ANOVA showed a main effect of compatibility on electrodes CP4 ($F(1,14) = 5.5$, $p < .05$) and CP2 ($F(1,14) = 5.3$, $p < .05$), with L1-incompatible sentences eliciting a higher mean area amplitude than L1-compatible sentences. The same electrodes showed a marginally significant effect of grammaticality (all *p*s < .09). No significant interaction was found between compatibility and grammaticality as factors in any of the above mentioned electrode positions.

Both grammaticality and compatibility had a main effect on the mean area amplitude of ERPs. In particular, grammaticality and compatibility showed a similar but not interacting behavior: ungrammatical and incompatible stimuli evoked a more positive mean of area amplitude than their grammatical and compatible counterparts in the 500-700ms time window, consistent with a strong P600 component (see Figures 5 and 6). Even though these results are not entirely conclusive because of their marginality, they suggest that with an increased number of participants and a pooled-analysis of relevant centro-parietal electrodes it may be possible to evoke a stable effect of both grammaticality and compatibility on P600 amplitude. Such a claim is sustained by the fact that the same electrodes that showed high significance levels for one factor (e.g. FCz, FC1, FC2, C4 for grammaticality), almost reached significance levels for the other factor (e.g. FCz, FC1, FC2, C4 for compatibility) and vice-versa.

Figures 5 & 6: Mean area amplitude of ERPs in the 500-700ms time window on FCz, pooled by grammaticality and compatibility.

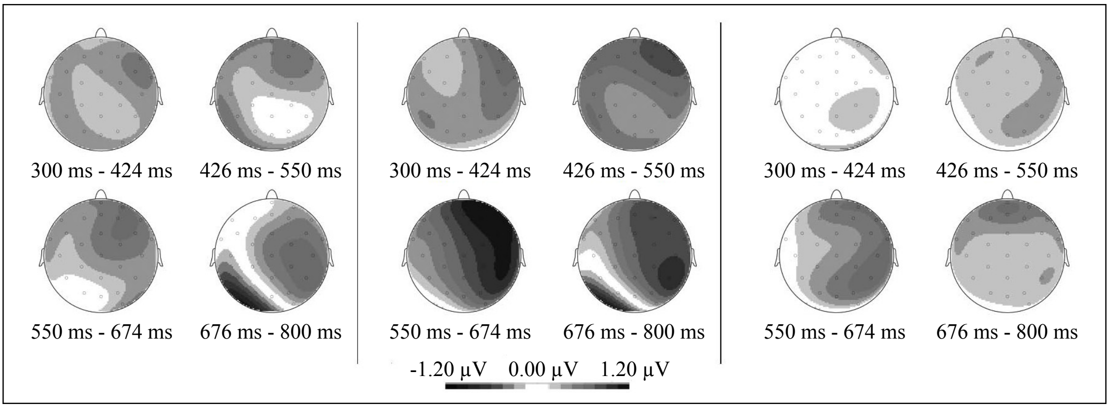




The lack of an interaction appears to suggest that compatibility also modulated ERP responses to grammatical sentences. While scalp distribution maps (see Figure 7) show that ungrammatical/ incompatible sentences elicited higher P600 than grammatical/compatible ones, the lack of interaction between the factors is an unexpected and surprising result. We assume that this may be a statistical issue which would be resolved in a larger sample. However, we also note that such a result may in fact be compatible with an assumption of co-activation to the extent that grammatical but L1-incompatible clauses would be unparsable by a co-activated German grammar and therefore in some sense 'more ungrammatical' for L1 German-L2 English speakers than grammatical sentences which are also L1-compatible. This is, of course, entirely speculative and must remain an issue for further research.

Nevertheless, the results indicate that ungrammatical interrogative sentences evoked a P600 component mainly located in the right centro-parietal hemisphere (see Figure 7 for a scalp distribution across conditions). This finding is consistent with previous research on the processing of grammatical agreement violations by native speakers (e.g. Osterhout and Mobley, 1995; Friederici et al, 1996; Rossi et al, 2005) and is in line with recent L2 research which has similarly found that agreement violations elicit a P600 in L2 learners (e.g. Alemán Bañon et al, 2014). Thus, L2 speakers show online effects of sensitivity to grammatical violations. The second and more relevant finding in terms of potential L1 co-activation is the presence of a positive voltage distribution connected with the degree of L1-compatibility. Ungrammatical but L1-compatible clauses evoked a lower positive response compared to ungrammatical and L1-incompatible sentences, suggesting that P600, as an index of neural effort due to syntactic reanalysis, is modulated in advanced second language speakers by the degree of compatibility of the L2 stimulus clause with an L1 grammatical representation. This finding accords with the comprehension results in suggesting that ungrammatical English clauses which have a grammatical counterpart in German are processed differently by L2ers in comparison to ungrammatical clauses for which the L1 grammar cannot license a representation.

Figure 7: Difference in scalp voltage distribution across conditions. Between ungrammatical and grammatical/L1-compatible conditions (left), between ungrammatical/L1-incompatible and grammatical/L1-compatible conditions (middle) and between L1-incompatible and L1-compatible ungrammatical conditions (right). P600 was enhanced on right-centro parietal hemisphere in the ungrammatical/L1-incompatible condition (middle, right).



5. Discussion and Conclusion

These results must be interpreted with some caution. The experiments are small-scale, with a modest number of L2 participants, and no L1 control group in the case of Experiment 2. Nevertheless, the results seem promising in providing convergent evidence for L1 effects both in offline behavioral measures and online neurophysiological measures.

Vaughan-Evans et al (2014, p. 8335) say that their results from Welsh-English bilinguals “suggest that transfer relies on abstract syntactic representations rather than lexical–phonological associations and lend strong support to theories positing rule-based representation of syntax.” Applying this thinking directly to our results would lead to the assumption that the learners activate an abstract V2/OV syntactic representation in tandem with a presumably target V3/VO English representation. This accords well with a Full Transfer perspective and it would seem to account for the findings as those English clauses which are amenable to a V2/OV parse are the ones which show evidence of L1 influence in comprehension and neuro-cognitive processing. From a generative perspective on L2 development, this provides an interesting take on the idea quoted in the introduction from White (2003, p. 268) that in some cases “the L1 grammar may accommodate L2 input adequately”. It seems that there is evidence that the L1 grammar is in fact attempting to accommodate L2 input online; of course, this involves ungrammatical input, which learners will not typically be exposed to, but previous results suggest that a similar effect be at work in thematic interpretation of grammatical clauses (see Grüter, 2006; Rankin, 2013, 2014).

However, the results are not entirely compatible with the generative notion that an abstract grammar is involved in L2 parsing and development. Consider the finding that learners prefer an agreement-driven over a word order-driven response to (19) at rates of 67.7% vs 17.6%, which is almost the mirror-image of their interpretation of (20), with rates of 17.6% for agreement vs. 76.5% for word order. Each of these sentences has the same syntactic structure (WhP-aux-DP-V), which is perfectly compatible with a V2/OV parse. Thus, activation of the L1 German grammar leaves the difference unexplained. The difference seems to relate to the questionable status of the German *tun*-support construction in word-by-word translation of (20) compared to (19), the translation of which is perfectly acceptable in German.

(19) Which animals have the dog chased?
(20) Which animals do the dog chase?

If a generative take on transfer cannot fully account for the results, perhaps they are compatible with a Competition Model approach? At one level, this is the case in so far as German speakers seem to be influenced by morphological cues for English sentence interpretation even though this is an unreliable cue in English compared to word order. Once again, however, one might question why there is a differential effect of L1-compatibility on comprehension and neuro-cognitive processing: if German speakers seek to use agreement cues in comprehension and show neuro-physiological responses to ungrammaticality, shouldn't they do this regardless of the degree of similarity between English and German clauses? Recent work from the Competition Model perspective has addressed this sort of issue. Tolentino and Tokowicz (2011) review the role of similarity in a range of L2 processing research which used ERP and fMRI methods. They operationalize cross-linguistic similarity precisely as "correspondence (or lack thereof) between specific L1 and L2 structures based on word-by-word translation" (p. 93). Their review indicates that cross-linguistic similarity is an important variable in bilingual processing which also interacts with age of acquisition, proficiency, etc. However, they caution that an issue in their study is that much of the research they review did not explicitly control for L1-L2 similarity, thus making a meta-analysis of L1-L2 similarity somewhat less straightforward. In addition, it is difficult to reconcile our results with one of their main findings that "(morpho)syntactic structures that exist in both languages but that differ in their specific implementation (i.e., dissimilar constructions) suffered from some degree of crosslinguistic competition and negative transfer" (Tolentino and Tokowicz, 2011, p. 119). This appears to suggest that dissimilar constructions give rise to processing difficulties. However, it was *similar* constructions which were subject to transfer and non-target-like behavior by L1 German-L2 English learners, while their comprehension of L1-incompatible (i.e. *dissimilar*) structures was comparable to native speaker performance in that they resorted to a word order-driven interpretation. As already mentioned, the lack of a native control group undermines any strong claims based on the results from Experiment 2, but here again the neuro-physiological response was modulated by L1-compatibility in the 'wrong' direction: the P600 component was stronger for ungrammatical sentences which are *dissimilar* to German, suggesting that ungrammatical sentences *similar* to German did not undergo the same degree of neural processing for the reanalysis of syntactic violations. Nevertheless, it seems that relative L1-L2 morpho-syntactic and/or lexical similarity is a crucial factor and deserves much greater attention. We concur with Tolentino & Tokowicz's (2011, p. 121) claim that "[c]ross-language similarity can no longer be ignored in bilingualism studies and should therefore be experimentally controlled for".

For the time being, any conclusions must remain tentative. While our results provide evidence of L1 influence in L2 processing and comprehension, further research will be needed to establish how robust this effect is and to what extent it generalizes to other populations. Recall that studies reviewed in Section 2 return at best mixed results. This suggests that any effects of co-activation are likely constrained by a range of variables, including language mode, language dominance, age of acquisition, and doubtless others. Nevertheless, if our results are generalizable to any extent, there does seem to be some level of L1 co-activation at work in L2 processing.

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