Visual processing of verb-second (V2) word order in second language acquisition: ERP Evidence from French-Swedish successive bilinguals

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Introduction

Background and rationale The present project is centered on second language acquisition in the field of cognitive neuroscience of language. It will address the general issue of how languages interact, i.e., Cross-Linguistic Influence (CLI). More precisely, we are interested in the transfer of linguistic information between a first (L1; here French) and a second language (L2; here Swedish). We will focus on the processing of syntactic information of word order. The justification of selecting this pair of languages (i.e. French-Swedish) with respect to the question of word order processing is motivated as follows. Typologically, Swedish, like most Germanic languages, uses a verb-second (V2) word order, meaning that the finite verb of a clause or sentence is placed in second position with a single major constituent preceding it, while French does not. Consequently, the aim of our project will be to examine how second language learners adapt their parsing strategies for processing a L2. The parsing strategies used by the bilinguals when confronted with a linguistic phenomenon, i.e. V2 word order, that does not exist in their L1, will be considered as a function of different linguistic and extra-linguistic factors. In order to approach this question, we plan to conduct an EEG pilot experiment using the paradigm of violation (presence of word order incongruities in the critical Swedish sentences), while subjects read syntactically correct (V2) or incorrect (V3) sentences.

This study represents a follow-up to Andersson, Sayehli, and Gullberg (2018) which examined English-Swedish and German-Swedish bilinguals.

Key research question: How does language background affect syntactic processing in L2?

General hypotheses: Based on the previous research using this paradigm, our hypothesis is that L2 learners will not demonstrate native-like processing of syntactic features that do not exist in their L1. We propose that this effect is modulated by language experience as well as cognitive functions, such that the better a speaker is in a language, the more attention is mobilized when confronted with an error.

Methods

Method is designed to replicate that of Andersson et al (2018).

Participants

Our subjects will be French-Swedish successive bilinguals living in France.

For the purposes of the master's thesis, we will test 12 participants between the ages of 18 and 35 who learned Swedish as adults. All participants must be right-handed native speakers of French. Participants who are left-handed, older than 35, or had significant exposure to Swedish before adulthood, or who report neurological deficits or current psychiatric medication will be excluded. If time and resources permit, we will collect 18 additional participants (for a total of 30), such that we will have a sample size equal to that of the original study.

Procedure and stimuli

Procedure We are using the same stimuli and procedure as Andersson et al (2018), with the addition of a test of executive functioning. An experimental session will be divided into the following parts:

1. Participant signs consent form in native language, and is randomly assigned to one of two groups.
2. Participant is fitted with an EEG cap while they fill out a questionnaire regarding their language background, handedness, and socioeconomic status (approximately 15 minutes).
3. Participant completes the Acceptability Judgment Task (AJT) during EEG recording. Participants are presented with sentences in the L2 which they must judge as acceptable or unacceptable, indicating their response with a button box (approximately one hour). In addition to scalp electrodes, mastoid electrodes will be used for reference, and electrodes will be placed above and below the left eye, as well as at the outer canthi of both eyes to detect eye movements for purposes of artifact rejection.
4. Participant completes a Swedish proficiency test (approximately 10 minutes).
5. Participant completes the Sentence Completion Task (SCT), selecting the correct order for the subject, verb, and object in sentences of various types in the L2 (30 minutes, timed).
6. Participant completes two tasks assessing executive functioning: Stroop & Navon.
7. Participant completes an English proficiency test (approximately 10 minutes).
8. Participant is thanked, appropriately debriefed, and remunerated for their time.

Total session time should be just under 2.5 hours.

Stimuli All linguistic stimuli deployed (i.e., those in the AJT and SCT) are those used in the Andersson et al (2018) study. Because these same stimuli were found to be valid for native Swedish speakers as well as other populations of L2 learners, we will not pre-test our stimuli.

1. **Acceptability Judgement Task (AJT):** According to their group assignment, participants will receive one of two sets of stimuli, i.e., the same set of sentences but counterbalanced so that sentences having the illegal V3 word order in one list have the legal V2 word order in the other, and vice versa. Each list will have 480 sentences of the types Grammatical V2 (160), Ungrammatical V3 (160), and Fillers (160). To control for wrap-up effects, critical sentences have a final phrase between 0-5 words. Sentences are presented word by word on the center of a computer screen (white font on black background) with each word on the screen for 300ms with an inter-stimulus interval of 200ms. Final words include full stops.

The last word is followed by a blank screen for 700ms, after which three question marks appear until the acceptability judgment is made. Triggers are sent to the EEG time-locked with the critical word, i.e., the subject—the point at which the word-order violation could first be detected.

2. **Sentence Completion Task (SCT):** Each sentence consists of a lead-in fragment followed by boxes with words or word combinations that must be put in order by ranking them from "1" to "3" so that the sentence is grammatical. In experimental sentences (60), the lead-in fragment consists of one of two adverbials. Half of the sentences have long prefields with additional prepositional modifiers. Experimental sentences are intermingled with fillers (180), consisting of four sentence types: topicalizations (90), questions (30), SVX sentences (30), and negated sentences (30). Sentences are pseudo-randomized such that no more than three sentences from the same condition can appear in series.

3. **Swedish proficiency test:** Word and Grammar subsection of Swedex targeting the B1 level of the Common European Framework of Reference for Languages.

4. **English proficiency test:** Oxford placement test 2

Measures

Critical measures

1. Performance on AJT (percent correct)

2. RTs on AJT

3. ERPs during AJT (targeting frontal P300, and posterior P600 components)

4. Performance on SCT

Control measures

1. Handedness

2. Language history

3. Socioeconomic status

4. Measure of executive functioning

5. Swedish proficiency

6. English proficiency

Predictions

Since French is -V2, we would predict the ERPs to resemble those of the native English speakers in the original Andersson et al study, i.e., less native-like than the German learners. Because their participants were deliberately matched for proficiency, that study did not find any effect of proficiency level on online responses. We predict that given a range of proficiency levels, we will see a) an overall decrease in amplitude of ERPs in all time windows, and b) a decrease in difference between conditions in the 500-700ms range (i.e., P600 response). We further predict that the P300O, thought to sign involvement of attentional resources, will be modulated both by language proficiency and executive functioning.

Analyses

For the AJT data, response accuracy will be measured by computing d-prime (d') scores.

For the EEG data, data will be high-pass filtered above 0.5 Hz, and low-pass filtered below 40 Hz to reduce high-frequency noise. Data is then divided into 1,100 ms epochs of 1,000 ms post-stimulus onset, and a 100 ms pre-stimulus baseline. Visual artifact rejection will be conducted using the FieldTrip toolbox, using the 'summary' method, with follow-up reviews in the 'channel' and 'trial' methods for verification.

Following the visual artifact rejection, data will be subjected to Independent Component Analysis (ICA) using the 'runica' routine implemented by the EEGLAB toolbox. The topographies and time courses of the components output by the ICA will be visually inspected to determine which represent ocular and motor artifacts, and subsequently removed. The data will be visually inspected after component removal to ensure that no more artifacts remain.

Mean amplitude will be taken for each of the following post-stimulus time windows: 300-500, 500-700, 700-900, and 900-1000ms. We will then use a repeated measures ANOVA with the within-subject factors:

1. Word order (V2/V3)
2. Hemisphere (right/left)
3. Lateral position (lateral/medial)
4. Anterior/Posterior position (frontal/ fronto-temporal/ temporal/ central/ parietal/ occipital)

Language group (native vs. L1 French) will be the between-subjects factor.

To examine the relationship between proficiency or other variables and ERP, average difference amplitudes will be calculated (V2-V3) for each electrode in the selected time windows. We will then use Pearson's correlations to examine relationships between our difference amplitude measures and offline measures.

The native Swedish data was reprocessed on the same machine using the same pipeline as the L2 data to ensure that everything worked properly and was comparable between populations.

To further probe the ERP in the future, source reconstruction analyses will be conducted on the native Swedish data, as well as the collected L2 data in the time windows of interest. We also hope to conduct exploratory clustering and classification analyses.

Interpretation

If the Pearson's correlations confirm a relationship between offline executive functioning and proficiency tasks, and the amplitude of the ERP in the 300-500ms and 500-700ms windows respectively, then our hypotheses about proficiency and attention are verified. Both of these relationships should have positive correlations.

Expected contributions

Study (paradigm, stimuli, etc.) originally designed by Annika Andersson, Susaan Sayehli, and Marianne Gullberg, who collected baseline data from native Swedish speakers. Jeremy Yeaton will be responsible for recruitment, data collection, pre-processing, and analysis. Mathilde de Saint Leger will provide support with preparation of stimulus delivery. Frédéric Isel will provide critical guidance and support throughout the process, particularly during analysis and interpretation.