CLI and Cognitive Control in the L3 Initial State

Megan M. Brown*

Boston University

Introduction

Within the topic of adult language acquisition, the last two decades have brought about a growing interest in the unique acquisition experience of third language (L3) learners, and the complications that arise from having two potential sources of cross-linguistic influence (CLI) at the onset of L3 acquisition. Several researchers claim that the linguistic factors such as typological similarity (Rothman 2010) and order of acquisition (Bardel & Falk 2007) serve as the preliminary factors in determining the source language for CLI. Results of studies testing these claims, however, demonstrate mixed and inconsistent results (Puig-Mayenco, González Alonso & Rothman 2018).

Some more recent research in the L3 literature has suggested that in addition to linguistic factors, individual cognitive differences between L3 learners should be considered as an additional factor which could influence CLI at the initial state of L3 acquisition. The consideration of individual cognitive variation is critical to the larger field of L3 research in that finding a way to control for individual cognitive differences could help to create more accurate models of L3 acquisition, which can make clearer, more testable predictions for individual learners. This paper outlines the results of a pilot study which considers individual variation in cognitive control, as measured by a Flanker Task (Eriksen & Eriksen 1974), as a potential predictor of success in the acquisition of L3 grammatical gender and number. While no significant correlation between Flanker Task score and success in the L3 gender and number tasks was found in these results, this paper outlines the need for additional research in this domain and consideration of additional types of cognitive tests.

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1 Background

1.1 Cognitive Factors in L3 Research

As mentioned above, the vast majority of research and models related to L3 acquisition published in the last two decades have focused almost exclusively on how linguistic factors impact the process of initial state CLI in L3 learners. Examples of this include the Typological Primacy Model, the L2 Status Factor Model, and the Linguistic Proximity Model of L3 acquisition. The Typological Primacy Model (TPM: Rothman 2010), claims that the most typologically similar language to the L3 is transferred in its entirety to serve as the exclusive source of influence for the initial L3 grammar. The L2 Status Factor Model (L2S: Bardel & Falk 2007), meanwhile, claims that neuro-linguistic similarities between the L2 and the L3 arise as a result of both languages having been acquired after the critical period. L2S claims that this similarity leads to the transfer of the L2 to serve as the exclusive source of CLI for the initial L3 grammar, regardless of typological similarity. The Linguistic Proximity Model (LPM: Westergaard, Mitrofanova, Mykhaylyk & Rodina 2017) claims that, rather than wholesale transfer of a particular grammar at the very start of L3 acquisition, language acquisition is cumulative and that individual segments of linguistic information are transferred from either language only when the current L3 grammar is incapable of accounting for the input.

While the models outlined above differ clearly from each other in terms of their claims and predictions, Green (2017), criticizes these previous L3 acquisition models for their failure to account for individual variability. Green emphasizes that much of the variation found between L3 learners with similar language backgrounds is likely the result of individual cognitive differences, and that accounting for these differences is vital to developing sufficient models of L3 acquisition. The first L3 acquisition model to explicitly include extralinguistic factors that vary between speakers with the same language background was Slabakova's (2017) Scalpel Model. Overall, the Scalpel Model makes very similar claims to those of LPM regarding the overall accessibility of languages known to the L3 learner, predicting that all previously known languages are accessible for CLI to the L3, and that individual segments of linguistic information are transferred, rather than an initial whole transfer of an entire grammar. The Scalpel Model differs from LPM, however, in its claim that experiential and input factors, in addition to typological similarity, are able to influence the determination of what linguistic features transfer from which previously known languages. While Slabakova notes that her list of potential extra-linguistic influences is certainly not complete, she suggests, processing complexity, misleading input, construction frequency, and frequency of use of the L1 and L2 as examples of the extra-linguistic variables which could potentially influence L3 transfer (Slabakova 2017). This paper will attempt to further investigate the ideas outlined in the Scalpel Model by considering a cognitive factor of particular interest to Green (2017), cognitive control.

1.2 Cognitive Control

Broadly speaking, the term cognitive control refers to an individual's ability to regulate thoughts and actions in accordance with internal behavioral goals (Braver 2012). For bi- and multilinguals, this includes the task of correctly speaking in a particular language while avoiding interference from the non-target language(s) (Branzi, Della Rosa, Canini, Costa & Abutalebi 2016). In other words, bi- and multilinguals must ignore irrelevant linguistic information (i.e. knowledge of a non-target language) when processing target language input. In the context of L3 acquisition, individual differences in cognitive control could significantly influence to the degree to which each of an L3 learner's previous languages may contribute to CLI and syntactic development.

The Flanker Task (Eriksen & Eriksen 1974) is an experimental test of cognitive control, which assesses participants' ability to ignore irrelevant or distracting information while focusing on the relevant input. This parallels an L3 learners' need to ignore irrelevant or unhelpful previous linguistic knowledge when constructing an initial grammar for the L3. This study looks to examine the degree to which performance on a Flanker Task correlates with overall success in the acquisition of an artificial L3.

1.3 Current Project

The findings discussed in this paper are part of a larger project investigating the acquisition of L3 grammatical gender and number at the true initial state of L3 acquisition (Brown 2020). While the results discussed here will specifically consider the relationship between participants' cognitive control abilities and their success in the L3 gender and number tasks, other factors of interest played a key role in the construction of the experimental stimuli. These factors included (1) the degree of typological similarity between the L3 and each of the learner's previously known languages, and (2) the presence or absence of the morpho-syntactic features of interest (grammatical gender and number) in those languages. Outlining the goals of the larger experiment from which this data was collected helps to provide context for particular methodological decisions which might otherwise seem unnecessary.

The target L3 in this project was German, a language which has a three-category grammatical gender system (masculine, feminine, and neuter) and a two-way grammatical number system (singular and plural) where both gender and number can be morphologically expressed on the indefinite determiner as well as on adjectives. The background languages of interest addressed were (a) English, which has a grammatical number system but no gender system and which is the most typologically similar language to German of the languages considered here, (b) Spanish, which is more typologically distant from German but as both grammatical gender and number systems (even if those systems may differ slightly from German), and (c) Mandarin, which is the most typologcally distant and does not have any type of morphosyntactic gender or number system. Participants had one of four language

backgrounds: L1 English/L2 Spanish, L1 Spanish/L2 English, L1 English/L2 Mandarin, and L1 Mandarin/L2 English.

While the goal of the study was to assess these participants' success in acquiring L3 German gender and number, concerns were raised regarding the fact that the expression of the grammatical gender and number in German are heavily intertwined not only with each other, but also with case and definiteness within the phrase. In an attempt to balance between maintaining the target typological relationships between the L3 and the participants' previous languages and the risk of interference from non-target German DP features in the results, this researcher chose to introduce sequential bilingual participants to a German-based artificial language which includes gender and number, but does not include the potentially distracting features of case and definiteness, a decision for which there is a precedent adult grammatical gender and number acquisition research (Brooks, Braine, Catalano, Brody & Sudhalter 1993; Wonnacott, Brown & Nation 2017; Culbertson, Gagliardi & Smith 2017; Siegelman & Arnon 2015). It should be noted that the use of an artificial language that is based on a natural human language, as opposed to a truly artificial creation, is atypical. However, there is a precedent for this approach in the L3 literature as a mothod of maintaining typological relations between the participants' known languages (González Alonso, Alemán Bañón, DeLuca, Miller, Pereira Soares, Puig-Mayenco, Slaats & Rothman 2020).

Results of this larger study found no significant relation between language background (Spanish/English vs. Mandarin/English bilingual) or order of acquisition and success on the grammatical gender or number tasks (see Brown (2020) for more details). However, individual participant's overall success in the gender and number tasks demonstrated a high degree of individual variation. This paper looks to investigate the degree to which this variation can be explained by individual differences in cognitive control.

2 Methods

2.1 Procedure

The procedure consisted of two main experimental tasks: a grammatical gender and number task in an artificial language, and a Flanker task.

In the artificial language task, participants were first trained on a set of nine actual German nouns (3 masculine, 3 feminine, 3 neuter), as well as 5 adjectives and an indefinite article, both of which agreed in gender and number with the noun using a set of artificial gender and number markers. Participants were first trained on the nouns with their corresponding articles (18 trials), followed by the addition of the adjectives (27 trials).

Participants then proceeded to the main task, in which they were presented with an image, followed by two spoken phrases. One phrase would consist of grammatical gender and number agreement with the noun on both the determiner and the adjective. The other would

consist of a gender or number agreement error on either the determiner or the adjective, as shown in the examples in 1-3 below.

(1) Erblicken ern-e rot-e Gabel
Behold Det$_{[Fem/Sing]}$ red$_{[Fem/Sing]}$ fork$_{[Fem/Sing]}$
'Behold a red fork' (Grammatically correct)

(2) Erblicken ern-**et** rot-e Gabel
Behold **Det$_{[Neu/Sing]}$** red$_{[Fem/Sing]}$ fork$_{[Fem/Sing]}$
'Behold a red fork' (Grammatical gender error on determiner)

(3) Erblicken ern-e rot-**in** Gabel
Behold Det$_{[Fem/Sing]}$ **red$_{[Pl]}$** fork$_{[Fem/Sing]}$
'Behold a red fork' (Grammatical number error on adjective)

Participants were asked to select which utterance was grammatically correct. For the purpose of this project, participants were given two separate scores[1] based on (1) the number of grammatical gender error questions with correct responses and (2) the number of grammatical number questions with correct responses. These key experimental conditions were presented among an array of control questions with lexical errors in the noun or adjective. There were a total of 68 grammatical gender questions and 55 grammatical number questions. The imbalance between the number of grammatical gender an number questions is partially due to the need to account for all possible types of errors in a three category gender system compared to a two category number system.

In the linguistic Flanker Task (Eriksen & Eriksen 1974), participants were presented with a string of five letters. They were asked to pay attention only to the letter in the center and to ignore the letters on either side of the central target letter which were "flanking" it. Participants were asked to press one button if the letter on the center of the screen was an X or a C, and the other button if the central letter was a V or a B. Meanwhile, the flanker letters on either side could be either helpful (matching the target response, such as in "XXCXX" where the flanker letters are in the same response category as the target), distracting (opposite the target response, such as in "VVCVV" where the flanker letters are in the opposite response category as the target), or neutral (the flanker letters are not associated with either response, such as in'AACAA"), examples of each are provided in 4. There were a total of 50 questions in the task, divided roughly evenly across the three conditions.

(4) Directions: Press the button on the **left** if the central letter is an **X** or a **C**, press the button on the **right** if the central letter is an **V** or a **B**

a. C C X C C
The flanking letters encourage pressing the left button

[1]Additional analyses, such as (a) whether a given noun had similar or opposite gender in Spanish compared to German and (b) whether the gender/number error occurred on the article or the adjective were also considered in the larger-scale study discussed in Brown (2020), but are within the scope of this paper.

b. W W X W W
   The flanking letters are not associated with pressing either button
c. B B X B B
   The flanking letters distract from pressing the left button

2.2 Participants

A total of 18 sequential bilingual participants (15 female, 4 male: mean age = 20.88 years, age range = 18-28 years) with no previous German experience were part of this pilot data analysis. As noted above, participants fell into one of four language background categories: L1 English/L2 Spanish, L1 Spanish/L2 English, L1 English/L2 Mandarin, or L1 Mandarin/L2 English. However, as noted above, Brown (2020) found no significant differences between the different language background groups. Instead, only individual differences in Flanker task score will be considered here.

3 Results

In the artificial language task, participants' overall success varied widely. The average participant score for the grammatical gender task was 58% accuracy, with a standard deviation of 8% and a range from 42% to 78% accuracy among individual participants. For grammatical number, the average score was 56% with a standard deviation of 11% and a range from 30% to 85%. In short, for both the grammatical gender and number tasks, some participants performed relatively well at the task and were able to successfully apply the grammatical gender and number features while other participants performed at or below chance. The results of the Flanker task also varied between individual participants, with an average score of 89% accuracy, a standard deviation of 12%, and range from 46% to 100%.

Scores on the grammatical gender and number tasks were each tested for a correlation with scores on the Flanker Task. Results of two Pearson correlation tests found no significant correlation between participants' score on the Flanker test and their scores in identifying gender ($r(16) = -.058$, $p = 0.82$) or number ($r(16) = -.201$, $p = 0.42$) errors in the language learning task. No relationship was found between successful acquisition of L3 gender or number and score on a Flanker Task, as demonstrated in Figures 1 and 2.

4 Discussion

This paper looks to test to role of individual differences in cognitive control (as measured by a Flanker task) as a predictor of success in the initial state of L3 acquisition of grammatical gender and number in a German-based artificial language. Cognitive control could play especially critical role in the process of L3 acquisition (as opposed to adult language acquisition more generally) in that L3 learners are in the unique situation of needing to take

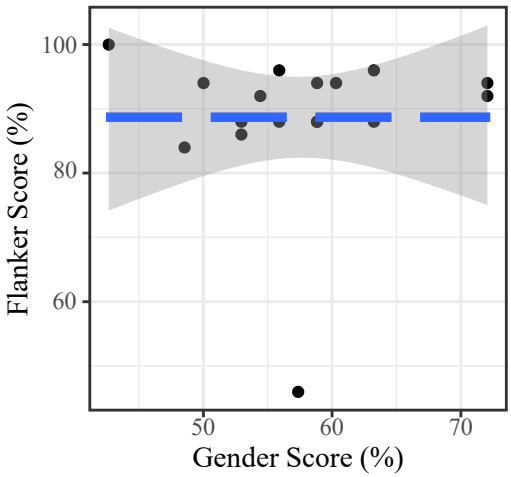

Figure 1: Gender score vs. Flanker score

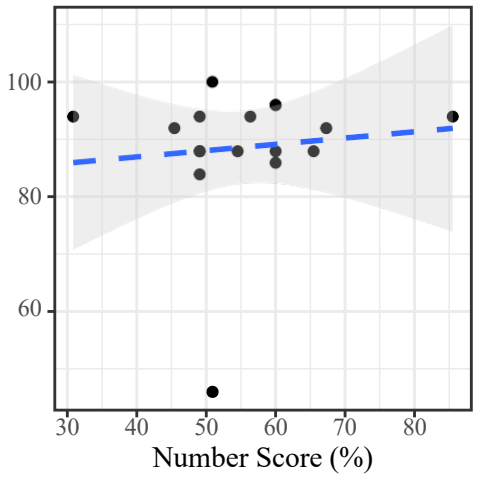

Figure 2: Number score vs. Flanker score

advantage of certain previously acquired linguistic knowledge while actively suppressing information from the other language as they develop their L3 grammar, a task which is likely to involve cognitive control to some degree. The role of cognitive control, as well as other extralinguistic factors, in the initial success of L3 learners is of critical importance to understanding the initial steps of the language learning process in multilingual adults.

As outlined in Section 3, no significant correlation was found between successful acquisition of either gender or number in the artificial L3 and score on the Flanker Task. One possibility is that these results are reflecting a lack of any actual relation between cognitive control and initial state CLI in the process of L3 acquisition. This finding would fall in line with the predictions of several L3 acquisition models such as TPM, L2S, and LPM, all of which predict only strictly linguistic factors to influence initial state CLI.

That being said, recent research has presented a wide array of evidence for a strong relationship between aspects of L2 acquisition/bilingualism and cognitive control measures (Branzi et al. 2016; Xie 2018; Pérez, Hansen & Bajo 2019; Luquea 2021). If it is the case that cognitive control plays such a critical role in L2 acquisition, then despite the findings of this work, it remains incredibly likely that cognitive control would play an important role in L3 acquisition and trilingualism as well. Therefore, it is possible that the lack of significant findings in this pilot data was not, in fact, a true reflection of the workings of the trilingual mind. Instead, it can be argued that this lack of significant findings could be the result of (1) the small participant pool in this work, or (2) the methodological choices made by this author.

In terms of the small participant pool, data collection in this study was interrupted due to the COVID-19 pandemic, and as a result, data collection within the larger L3 gender and number acquisition project remains ongoing. Meanwhile, it is important to keep in mind that the Flanker task, like any other experimental cognition task, is not a direct measure of

cognitive control, but instead it is an external tool which is used in an attempt to measure an internal psychological phenomenon. It could be the case that the Flanker task used in this experiment is simply not the ideal test for measuring the degree to which individual cognitive differences influence CLI in L3 acquisition.

In order to truly come to any conclusions in regards to the role of individual cognitive differences in initial state L3 transfer, additional research is needed using a variety of cognitive tasks, linguistic features, and language combinations. Besides the Flanker task, cognitive control tasks which have been used in the L2 literature, and could potentially be modified for trilingual participants include, but are not limited to the Stroop task, (Stroop 1935) which, like the linguistic Flanker task, is designed to test cognitive inhibition in a linguistic context, and the "go, no go" task (Donders 1969), which tests a participant's ability to suppress a response in contexts where that response is inappropriate given the stimulus. An investigation of the relationships between an L3 learner's performance on these and other cognitive tasks and their success in early L3 acquisition could help to form a more complete and individual-based understanding of L3 acquisition.

Conclusion

The newly growing field of L3 acquisition research has recently called attention to the need for consideration of extralinguistic cognitive factors in the development of L3 acquisition and initial state transfer models. This paper looks to contribute this this gap in the literature by investigating the role of individual differences in cognitive control on the acquisition of grammatical gender and number in an L3. This is tested by examining participants' success in acquiring grammatical gender and number in a German-based artificial language, and assessing whether participants' success on those grammar tasks correlate with their results on a linguistic Flanker task. While the results as presented here find no statistically significant correlation in the data, this author notes that this lack of significant findings could be the result of methodological choices, rather than reflecting an actual lack of an relationship between cognitive control and L3 acquisition of grammatical gender and number. Additionally, this paper brings to attention the current gap in the L3 acquisition literature in terms of the consideration of individual cognitive differences as a potential predictor of successful transfer of relevant syntactic knowledge from previously known languages to the initial L3 grammar, and makes suggestions for future studies which may fill this gap.

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Boston University
mbrown14@bu.edu
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