THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF GERMANIC AND SLAVIC LANGUAGES AND LITERATURES

THE EFFECT OF COGNATES ON REAL-TIME L2 COMPREHENSION

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SPRING 2019

A thesis
submitted in partial fulfillment
of the requirements
for baccalaureate degrees
in Agricultural Sciences and Philosophy
with honors in German

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ABSTRACT

Previous research suggests that L1 and L2 speakers are subject to interference from a number of conflicting linguistic cues (e.g., singular vs. plural number information on nouns and verbs) during comprehension (e.g., Patson & Husband, 2015), and that L2 populations are particularly susceptible to this interference (Cunnings, 2017). At the same time, L2 comprehension is facilitated by the presence of L1-L2 cognates, leading to more nativelike processing (e.g., Hopp, 2017). Using the visual world paradigm, the current study extends this research to investigate whether the presence of cognates can reduce interference during real-time sentence comprehension among L1 German-L2 English speakers. Thirty-two L1 German-L2 English speakers in Braunschweig, Germany listened to sentences with subject-verb anomalies (e.g., **The blackboard for the schools really were too old to use*). Sentences varied according to whether the local noun and the verb were singular or plural and whether the local noun was a cognate (*school*) or a noncognate (*office*). We tracked participants' attention to images of sentence referents (e.g., a screen with four pictures: a blackboard, two blackboards, a school, or two schools) during comprehension using visual world eye-tracking. This was paired with an offline interpretation measure where participants selected the image matching the sentence subject. Offline measures showed more looks to plural subjects in conditions with more plural cues with no significant difference between cognate and noncognate conditions. Online measures showed more looks to a plural subject in cognate rather than noncognate conditions. Together, these results highlight ways in which cognates can have a subtle impact on real-time language processing, even when their impact on the final interpretation of a sentence is minimal.

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ACKNOWLEDGEMENTS

I would like to thank all of the people, groups, and organizations who have helped in the process of researching and creating this honors thesis: Carrie Jackson, Laurel Brehm, Holger Hopp, the Partnerships for International Research and Education (NSF-PIRE II, OISE-1545900; P.I.: J.F. Kroll) grant awarded to the Center for Language Science at Penn State, the Second Language Acquisition Lab at Penn State and its members (especially Jennifer Rhee for helping to create research stimuli), the Eye-Tracking Lab at Technische Universität Braunschweig and its members, and my family and friends.

Chapter 1

Introduction

For many, learning a second language can be a challenge. Most people learn their first language (L1) at home, listening to their parents using it and eventually learning to produce the language themselves. Many probably do not even remember learning their L1, as they were too young, although their language skills are finessed and refined throughout their schooling. Learning a second language (L2) can take place at any stage of life. However, unless living in a bilingual household, L2 learning does not usually happen until children are at least in grade school. Many researchers claim that L2 acquisition often proceeds differently than L1 acquisition (Bley-Vroman, 1989). By the time someone is learning a second language, they usually have fully acquired their first language. This may influence the way in which someone acquires a second language and the ultimate outcome of the acquisition process. There is a lot of research in the realm of L2 acquisition, with much of this research focusing on the ways in which L1 and L2 language acquisition differ, and ways in which L2 speakers can achieve nativelike proficiency in their L2.

In the present study, we used the visual world paradigm to track how real-time language processing of English sentences by L1 German- L2 English speakers influences listeners' final interpretation of a sentence. Thus, in the present study we observed two kinds of data: online processing and final sentence comprehension. Online processing provides a window into what information listeners attend to while listening to the entire sentence. In contrast, sentence comprehension provides insight into listeners' final interpretation of the sentence and its meaning. These two types of data are used in this study to observe signs of interference and interaction between the L1 and L2 in L1 German-L2 English speakers. Further, we examine how lexical-level factors, such as cognate status (i.e., words that have the same phonological form and meaning in both languages), may affect the overall amount of processing

interference for L2 speakers. By determining the rate of interference due to cognate status, we can apply this information to pedagogical practices to decrease overall interference in students learning a second language.

Interference in L1 & L2 Processing

Research shows that L1 speakers exhibit evidence of interference from agreement attraction (e.g., Wagers et al., 2009). Agreement attraction occurs when the number or grammatical gender of one word in the sentence is incorrectly applied to another. For instance, in the sentence *The book next to the candles were going to be donated,* the attraction occurs at the plural verb, in that the verb is marked for plural number (i.e., *were*), reflecting the plurality of the local noun right next to it (i.e., *candles*) rather than the grammatically singular subject of the sentence (i.e., *book*) to which it belongs. When L1 speakers read sentences with conflicting number information between the subject and the verb, and agreement attraction between the local noun and the verb (i.e. *The key to the cabinets were…*), they are more likely to misinterpret the sentence as having a plural subject than in sentences with no conflicting number information (i.e. *The key to the cabinet was…*) when asked to identify whether the subject of the sentence is singular or plural (Brehm, Jackson, & Miller, 2018; Patson & Husband, 2015).

While there is evidence of interference in number-agreement attraction for L1 speakers, Cunnings (2017) suggests that L2 speakers are more susceptible than L1 speakers to such interference. For instance, in Tanner et al. (2014), L1 Spanish-L2 English speakers read grammatical and ungrammatical sentences (i.e. *The winner of the big trophy has/*have proud parents*) and had to judge whether sentences were grammatical and semantically coherent while their brain activity was measured using event-related potentials (ERPs). The results showed

greater variation in N400-P600 results among highly proficient L2 English speakers, compared to the expected P600 effect traditionally exhibited by L1 English speakers. An N400 effect—a negative going waveform that peaks 400 milliseconds after the onset of a stimulus—indexes processing at a semantic level, which researchers have interpreted as a sign of a shallower level of processing often associated with less-proficient L2 speakers (Steinhauer et. al., 2009). The P600 effect—a positive-going waveform that peaks 600 milliseconds after the onset of a stimulus—indexes processing at a grammatical level, or the need to reanalyze the syntactic structure of a sentence, which is more typical in advanced L2 speakers or L1 speakers (Steinhauer et. al., 2009). This suggests that even highly proficient L2 speakers are affected in different ways by interference, as shown by a higher number of Tanner et al.'s L2 participants exhibiting an N400 effect in response to subject-verb agreement violations. That the type of ERP response correlated with participants' responses on a questionnaire probing their motivation for learning English also highlights that the level of interference can be modulated by individual differences across participants, including personal motivation and working memory.

In a related study, Foote (2010) showed that L1 English-L2 Spanish speakers exhibit integrated knowledge of subject-verb agreement through their awareness of ungrammaticalities. Groups of early- and late-learning L2 Spanish speakers were asked to read grammatical and ungrammatical sentences in Spanish. Both groups showed slower reading times for ungrammatical sentences (e.g., *Veo que tu Padre son de Texas. "*I see that your father are from Texas*."*), suggesting an overall sensitivity to ungrammatical Spanish sentences containing a mismatch in number between the subject and the verb. At the same time, this level of sensitivity varied according to distance between the subject and verb targets. For instance, the L2 speakers showed greater sensitivity to agreement mismatches in sentences with a subject in closer

proximity to an ungrammatical verb. In contrast, when reading sentences with a greater distance between the subject and an ungrammatical verb, L2 speakers were less aware of the ungrammaticality, as measured by reading times.

Jegerski (2016) also showed that highly proficient L1 English-L2 Spanish speakers exhibit a level of sensitivity to agreement attraction similar to that of L1 Spanish speakers. In a reading task, highly proficient L2 speakers of Spanish and L1 Spanish speakers read grammatical sentences, but with a local noun phrase that did not agree in number with the verb (e.g. *El testigo de los abogados tiene mala fama en el barrio*. "The witness of the lawyers has a bad reputation in the neighborhood.*"*), similar to sentences involving attraction in the L1 comprehension literature (e.g., Brehm et al., 2018; Patson & Husband, 2015). The results showed similar reading times for the L1 and highly proficient L2 speakers of Spanish, suggesting that at advanced proficiency levels, L2 processing can proceed similarly to L1 processing. This also suggests that L2 speakers do not just rely on semantic meaning or plausibility information to process sentence meaning, but rather they access knowledge of the full syntactic structure of a sentence during real-time sentence processing. Because of the similarity between L1 and L2 processing of agreement attraction sentences, differences in processing between L1 and L2 speakers may not be the result of fundamental differences in how L1 versus L2 speakers process morphosyntactic information during reading comprehension, but rather their knowledge of differing morphosyntactic structures.

Cunnings (2017) suggests that the differences in processing between L1 and L2 speakers is a result of memory retrieval issues. In order to process a sentence, a speaker must remember L2 syntactic structures and semantic meanings, which becomes more taxing when the speaker knows more languages because it is possible that information from the L1 can interfere with

retrieving and processing L2 linguistic information. This would mean that differences between L1 and L2 processing stem from memory differences between L1 and L2 speakers rather than a failure to build syntactic structure in the L2. This would also help explain individual differences in L2 language processing, as there are individual differences in memory capacity. Memory capacity also explains differences between highly proficient L2 speakers compared to less-proficient L2 speakers, as more proficient L2 speakers have had more exposure to and experience with using the L2 than less-proficient L2 speakers, which would strengthen their memory of their L2.

Cognates in a Sentence Context

There is a lot of interest in the field of second language acquisition into the role of cognates, which are words that are the same between two languages or that come from the same root word, and the effect of cognate status on L2 processing. Schwartz and Kroll (2006) showed that cognates in low-constraint sentence contexts can aid L1 Spanish-L2 English speakers. Participants read sentences as they appeared one word at a time on a screen and were asked to repeat a target word from the sentence aloud after it appeared on the screen, the target word being either a cognate or a noncognate. The sentences were either high semantically constrained sentences, meaning that the sentences were semantically specific so that there were few lexical options at the point participants encountered the target word, (e.g. *Before playing, the composer first wiped the keys of the **piano** at the beginning of the concert*) or low semantically constrained sentences, meaning that the sentences were semantically vague so that there were many lexical options at the point participants encountered the target word (e.g. *When we entered the dining hall we saw the **piano** in the corner of the room*.). Participants showed stronger cognate facilitation effects (i.e. faster reaction times for cognate target words than noncognate target words) in low-constraint

sentences. The faster reaction times in low-constraint sentences suggests that both languages were active, leading to greater activation of cognate words, resulting faster reaction times. Participants were less susceptible to activation from both languages in the high-constraint sentences, which contained more semantic information that might, in turn, help to constrain which languages were active, thereby reducing the advantage for cognate over noncognate words. While other research has shown the cognate facilitation effect in tasks involving the recognition and production of individual words (Dijkstra, 2005), the results from Schwarz and Kroll suggest that even in the context of an L2 sentence, the L1 is still active (see Duyck, Van Assche, Drieghe, & Hartsuiker, 2007, for similar findings). Even when there is an entire sentence to provide context for which language to recall, faster reading times for low-constraint, cognate sentences provide evidence that both languages are still active, even when reading and producing sentences in a single language.

Hopp (2017) looked at the effect that cognate status could have on L2 processing and syntactic structure building by looking at reading times of L2 speakers in sentences with cognate and noncognate verbs. L1 German-L2 English speakers were asked to read sentences that appeared word-by-word on a computer screen. The sentences included a reduced relative clause (e.g. *When the doctor Sarah ignored tried to leave the room the nurse came in all of a sudden*), which are often difficult for both L1 and L2 speakers to interpret correctly because they get confused as to who the subject of the sentence is (i.e. Sarah, when the subject of the sentence is actually *doctor*). Reduced relative clauses are a complex structure in English that feature a subject-object-verb word order more typical of German embedded clauses. In this manner, the participants were exposed to a syntactic structure more typical of their L1, while the sentence itself was in their L2. The target sentences were split into three critical regions, with the first region containing either a cognate or noncognate verb (i.e., *ignored*). For the L1 German-L2 English speakers, the initial first-pass reading times were faster for the sentences containing a cognate verb than a noncognate verb in the first region. These results show evidence of verb cognate facilitation, paralleling and extending cognate effects seen at the level of word retrieval (i.e., Schwartz & Kroll, 2006,

Duyck et. al., 2007). They also show evidence of increased L1 activation in sentences containing a cognate and syntactic structure compatible with the L1. This suggests that lexical-level cognate facilitation may enhance effects of L1 syntactic interference, as it may lead to increased activation of corresponding L1 syntactic structures.

Miller (2014) similarly showed cognate facilitation effects within a sentence context in L1 English-L2 French speakers. In the study, L1 English-L2 French speakers and L1 French speakers read complex French sentences that contained English-French cognates (e.g. *Vincent adore le gorille a qui Cecile a envoye le petit Cadeau chez lui jeudi matin. "*Vincent adores the gorilla to whom Cecile sent the small gift at his house Thursday morning"). The L1 English-L2 French speakers read the sentences containing cognates faster than similar sentences containing noncognate words. Cognates are easier to retrieve during L2 processing because they share form and meaning across both the L1 and the L2, leading to a processing advantage over noncognate words. The L1 speakers, however, showed faster reading times in noncognate sentences. These results parallel the results of Hopp (2017), providing further evidence that cognate status can influence syntactic structure building during L2 comprehension.

Visual World Paradigm in L2 Processing

The visual world paradigm is a popular method used to investigate real-time processing among L1 and L2 speakers. Using this methodological paradigm, it is possible not just to analyze user-selected response data, but researchers can also track participants' eye movements while they listen to linguistic stimuli. This offers a more insightful interpretation into what participants are actually doing as they are processing linguistic input in real time.

Brehm, Jackson, and Miller (2019) compared offline and online measures in L1 English speakers and L1 Spanish-L2 English speakers while processing sentences containing subject-verb agreement violations. Participants heard sentences with a singular subject and either a plural/singular verb and a

plural/singular local noun (i.e. *The key to the cabinet/s literally was/*were on the table*.) and were asked to select one of four images on a screen that best represented the subject of the sentence they had just heard. In the offline interpretation results, both the L1 and L2 English speakers were more likely to select a plural subject when both the local noun and the verb were plural, with an even higher proportion of plural subject selections for the L1 Spanish-L2 English speakers compared to the L1 English speakers. The online eye-tracking results showed that participants in both groups fixated more frequently on the plural subject picture in sentences that had a plural local noun/plural verb, but the L1 Spanish-L2 English speakers fixated the plural subject more in the later time window of the sentence (i.e., post verb-onset), showing a delay in processing time among the L2 speakers compared to the L1 English speakers. While the offline and online measures show similar results between the groups, the online eye-tracking measures provide a better idea of how participants process sentences over-time, rather than the offline measure, which provides insight only into the participants' final interpretations. Overall, the results between the L1 and the L1 Spanish-L2 English speakers were very similar, with slightly stronger agreement attraction effects in the L1 Spanish-L2 English speakers. These results further add to Cunnings' (2017) proposition of memory retrieval-based differences in L1 and L2 speakers, as both groups showed evidence of building syntactic structures.

The Present Study

The current study looks at the cognate effect as applied to agreement attraction in the local noun phrase of a sentence. In the current study, L1 German-L2 English speakers heard sentences like *The blackboard for the schools really was too old to use.*, with variations in number of the local noun and the verb. The participants then selected the subject of the sentence from four pictures on a screen, using the same procedure as in Brehm et al. (2019). As previous research has shown, the singular subject of a sentence is more likely to be remembered as plural when there are other plural words in the sentence

(Brehm et. al., 2018, 2019; Patson & Husband, 2015). This study seeks to find if this holds true when the local noun is a cognate (e.g., *the blackboard for the schools* vs. *the blackboard for the office*). While cognates have been shown to facilitate more native-like processing in a sentence context for L2 speakers (Hopp, 2017) and L2 speakers are more susceptible than L1 speakers to interference in agreement attraction (Cunnings, 2017), it is unknown whether the cognate status of a nontarget local noun will affect the degree of interference among L2 speakers. Interference may decrease in sentences with a cognate local noun distractor, as the presence of a cognate would facilitate lexical retrieval, thereby allowing the participant to focus less on semantic meaning, as it is a word they more easily recognize, and focus more on the syntactic features of the sentence. On the other hand, it is possible that interference could increase, as the cognate local noun may further activate L1 morphosyntactic features for the participant, leading to a misinterpretation of the subject.

Chapter 2

Method

Participants

Thirty-six L1 German-L2 English speakers were tested at the Technical University of Braunschweig in Germany. Two participants were excluded due to early exposure to a language other than German, such that the final number of participants was 34 (31 female; three male). All participants received monetary compensation for their participation. All participants began learning German at age six or later in school, and all considered English their second language. Each participant also completed a 50-point multiple choice English proficiency task to assess their understanding of English grammar and vocabulary. This task came from the Michigan English Learning Institute College English Test, also

known as MELICET or GCVR. All participants scored at least 28 points, indicating that all participants were intermediate to advanced L2 learners of English. Complete biographical information can be found in Table 1.

	M (SD)	*Range*
Current age (years)	24.6 (5.8)	18-50
Age of first exposure to English (years)	8.8 (1.4)	6-12
Total time spent abroad (months)	6.9 (6.8)	0-24
English proficiency score (out of 50)	41.6 (6.0)	28-49
Self-ratings of English (out of 7)		
Listening	6.1 (0.8)	4-7
Speaking	5.4 (0.9)	3-7
Reading	6.1 (0.7)	4-7
Writing	5.3 (1.0)	3-7

Table 1: Participant Biographical Information

Materials

There were 48 stimuli total and for each stimuli item there were 6 variants, as in examples (1a) – (1f) below. They varied according to whether the local noun was a cognate or non-cognate between English and German. For example, in the examples below, conditions (1a) - (1c) contain a cognate as the local noun *(e.g. 'school' = Schule)*, and conditions (1d) - (1f) contain a non-cognate as the local noun *(e.g. 'office' = Büro)*. The sentences also varied by verb

number (Singular vs. Plural; *'was'* or *'were'*), and they also differed by local noun number (Singular vs. Plural; *'school'* or *'schools'*). T-tests revealed no significant difference between cognate and noncognate words with regard to the log frequency of the plural forms, based on data from the English Lexicon Project (Balota et. al., 2007) ($t(46) = 0.39$, $p = .695$). Similarly, t-tests revealed no significant difference in length between cognate and noncognate words ($t(47) = 0.64$, $p = .525$).

1a. The blackboard for the school really was too old to use. (Cog., Local SG, Verb SG)

1b. The blackboard for the schools really was too old to use. (Cog., Local PL, Verb SG)

1c. The blackboard for the schools really were too old to use. (Cog., Local PL, Verb PL)

1d. The blackboard for the office really was too old to use. (Non-Cog., Local SG, Verb SG)

1e. The blackboard for the offices really was too old to use. (Non-Cog., Local PL, Verb SG)

1f. The blackboard for the offices really were too old to use. (Non-Cog., Local PL, Verb PL)

For the actual experiment, each participant heard 108 sentences: Forty-eight stimuli sentences mixed with 60 filler sentences. Participants saw eight items for each of the six experimental conditions, but no more than one version of any given item. There were four general types of filler sentences that the participants heard, and all participants heard the same 60 fillers. Filler sentences were based on Brehm et al. (2019) and consisted of eight items containing color references (e.g. *The button that fell off the boy's jacket was blue*), 20 items containing double-object dative constructions (e.g. *The librarian served the coffee to the plumber*), eight items containing number-marked subject nouns (e.g. *Two lizards sat in the sand and enjoyed some sunshine*), and 24 items containing the prepositional phrase *without* (e.g. *Brad hiked several miles without his sweater on this afternoon*).

Procedure & Apparatus

Participants sat in front of a computer monitor with an SMI RED eye tracker located beneath the monitor, which measured participants' eye gazes at 60 Hz. Before each trial began, participants were calibrated to the eye tracker. They were asked to fix their gaze on a blue elephant located in the center of the screen and to continue to fix their gaze on the elephant as it moved across the screen. Target visual acuity was below one degree, and calibration was repeated multiple times if necessary to achieve target acuity. Participants with eye glasses were also asked to remove their glasses. After the calibration, they were asked to complete a set of five practice trials before the actual experiment began.

For each trial, a screen appeared with four images. These images were displayed on the computer screen as participants listened to the target sentence. For the 48 experimental items, the images on the screen were of the following: a singular version of the subject, a plural version of the subject, a singular version of the local noun, and a plural version of the local noun, as shown in Figure 1. After listening to each sentence, the participant was prompted to select the image that they thought represented the subject of the sentence they had just heard.

The sentences were split into four blocks of 27 sentences each with an option in between each set for participants to take a short break. At the end of the four blocks, the participants were then asked by the experimenter if a) they found any of the sentences peculiar (to assess if they were catching on to the experiment's purpose) or b) if they used any strategies to pick the subject of the sentence. The participant then filled out the 50-point multiple-choice MELECIT test (see *participants* section for reference). The last portion of the experiment consisted of a lexical decision task (Hopp, 2014) that contained 40 real words and 40 pseudowords in which the participant was prompted to decide if each item was a real word or was not a real word in

English. The top-left image in Figure 1 above represents the non-literal subject of the sentence. The top-right image represents the singular local noun, and the bottom-right represents the plural local noun. The bottom-left image represents the literal subject of the sentence.

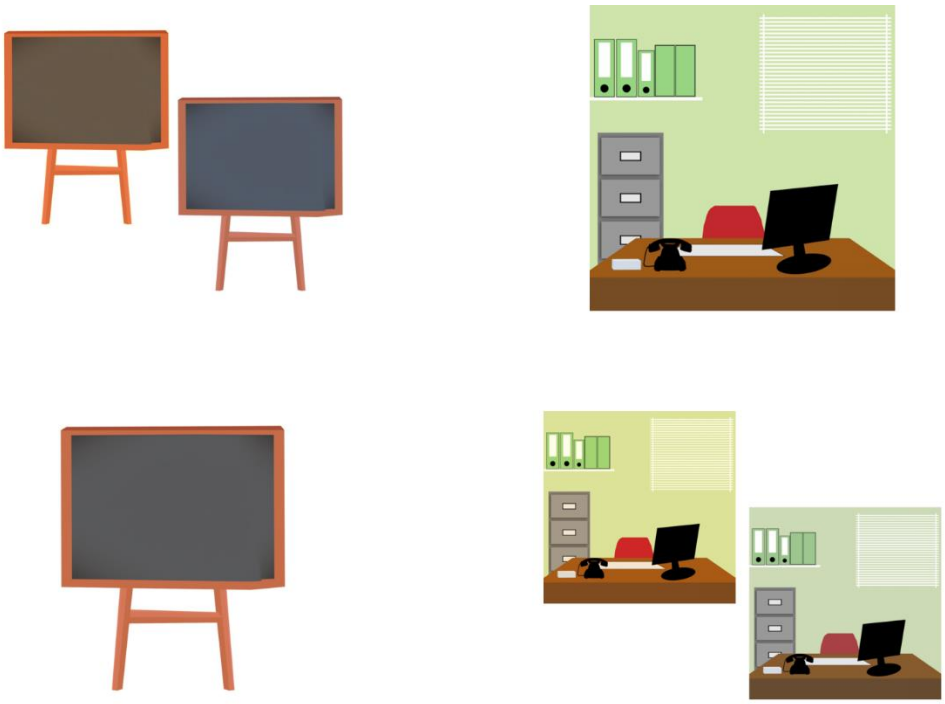

Figure 1: Example images for items 1d-1f

Chapter 3

Results

Subject Selection

The subject selection data were analyzed using mixed-effect logistic regression models in R version 3.2.5 (R Development Core Team, 2016). Participants' subject selection (non-literal plural vs. literal singular) was used as the dependent variable. Cognate status (cognate vs. noncognate) was entered as a fixed effect using sum coding (-.5, .5). Number marking was coded using Helmert contrasts with the first comparison being between number marking on the verb (plural vs. singular) and the second comparison being between local noun number (singular vs. plural). All models used the maximal random effect structure supported by the experimental design (Barr, Levy, Scheepers, & Tily, 2013), including random intercepts for items and participants and decorrelated by-item random slopes for cognate status.

	Estimate	Std. Error	z-value	Pr (> |z|)
(Intercept)	2.09	0.21	9.81	<.001
Cognate Status	0	0.17	0.03	.980
Verb Number	2.50	0.21	12.05	<.001***
Local Noun Number	-0.48	0.22	-2.24	.025*
Cognate Status: Verb Number	-0.08	0.39	-0.22	.827

Cognate Status : Local Noun Number	0.19	0.43	0.45	.650

Table 2: Summary of the Mixed Logit Model for Singular versus Plural Interpretations (* refers to scores where $p < 0.05$; * refers to scores where $p < 0.001$)**

Results show that there was no significant effect for cognate status. There was a significant effect for number marking because participants were more likely to pick the non-literal subject (i.e., *blackboards*) in the presence of a plural verb versus a singular verb. Further, even within conditions containing a singular verb, participants were more likely to pick the non-literal subject in the presence of a plural local noun versus a singular local noun. Finally, there was no significant interaction between cognate status and number marking because the overall pattern of results was similar for both cognate and non-cognate conditions.

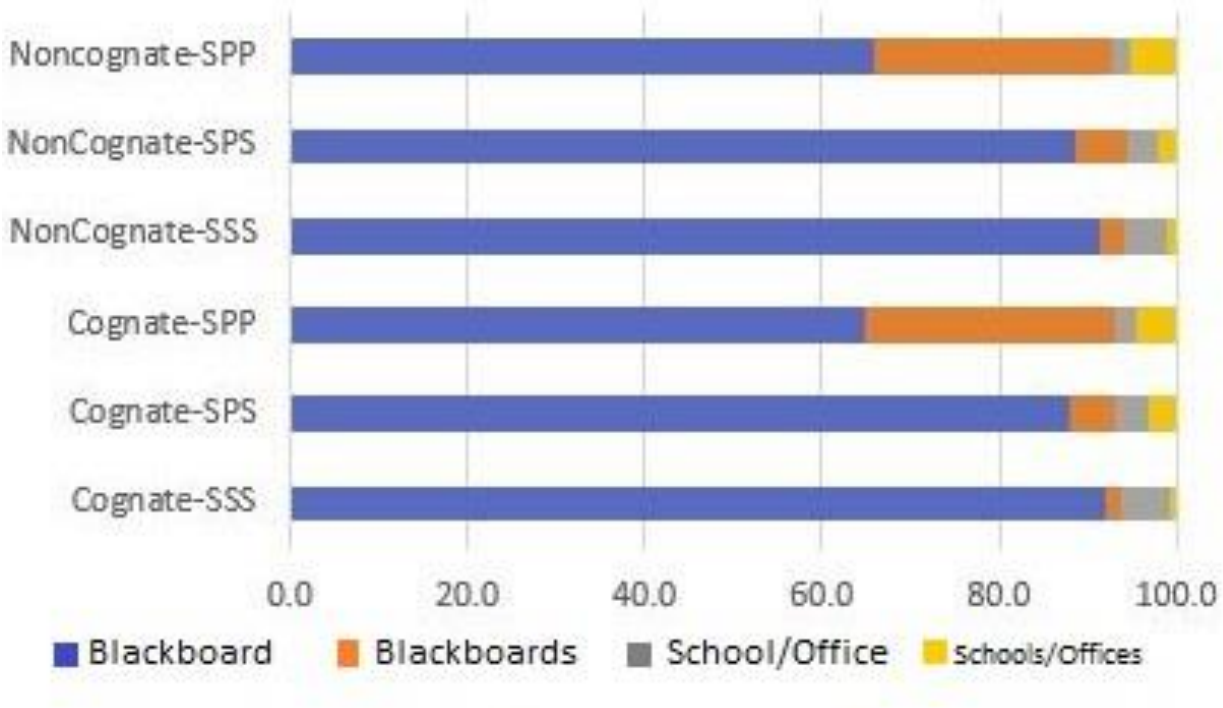

Figure 2: Subject selection results for each of the six sentence conditions

These effects align with the actual subject selection results, as shown in Table 2. Participants overwhelmingly chose the literal subject (i.e., *key*), which is seen in the above figure as represented by the

blue bars. The two conditions with a higher proportion of nonliteral subject interpretations (i.e., *keys*) are both conditions that contain a plural verb. Participants also had a slightly higher frequency of choosing the nonliteral subject noun in both cognate and noncognate conditions for the conditions with a plural local noun. This pattern was similar across both the cognate and noncognate conditions.

Eye-Fixations

For all instances where the participants selected the singular subject, we graphed the average proportion of fixations over time. Each graph has four lines, each representing one of the four image options that were presented to the participants. The x-axis represents time as the participant is listening to the sentence, and the y-axis represents the proportion of fixations to a particular image. Reading from left to right on the graph, the colored line that is the highest represents the image that the participants fixate most at that particular time in the sentence.

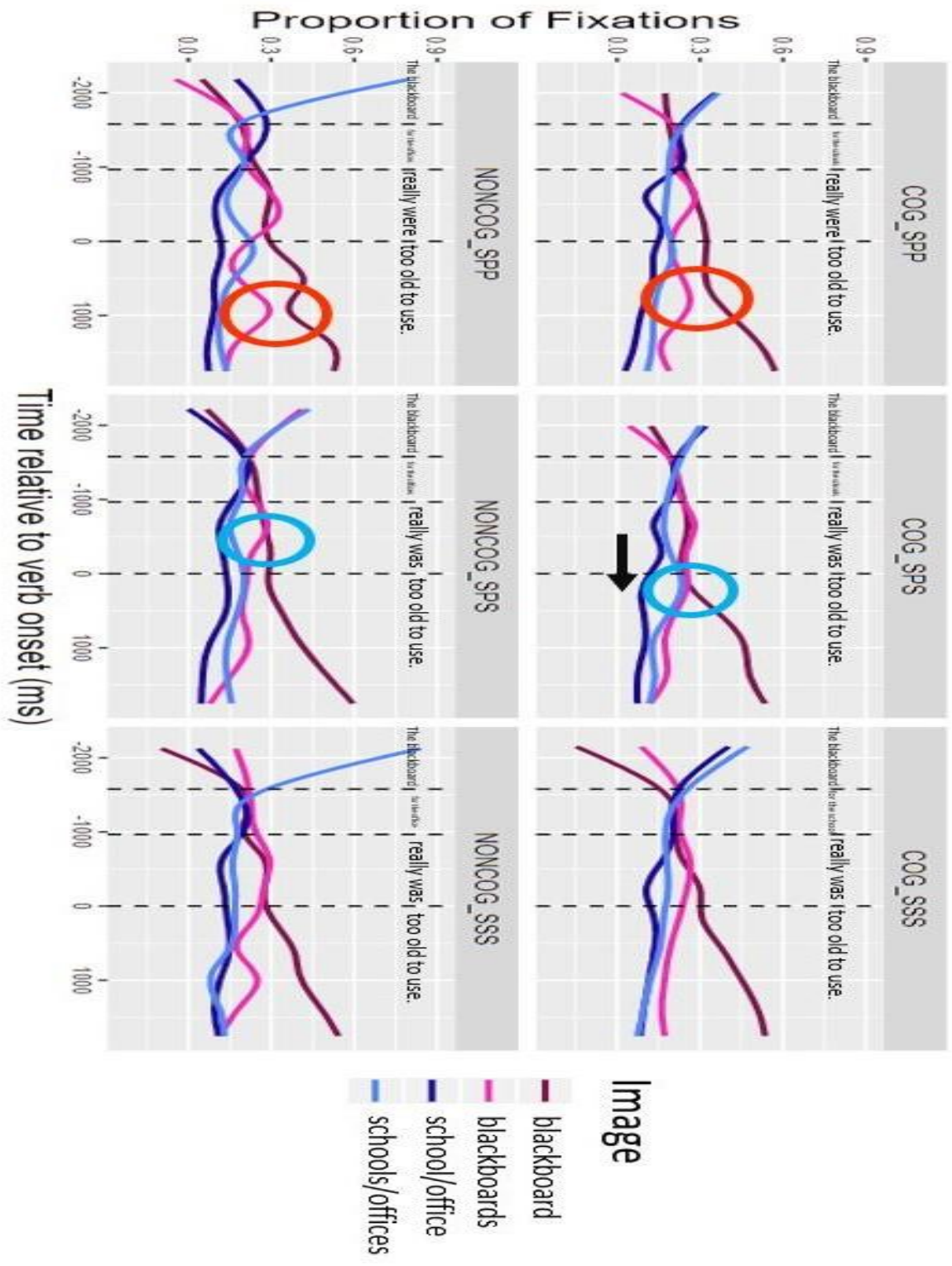

Figure 3: Proportion of fixations to each image within each of the six experimental conditions over time as the participant is hearing the sentence

The three graphs on the top of Figure 3 represent the cognate sentence conditions, and the three graphs on the bottom represent the noncognate sentence conditions. The two graphs on the right, top and bottom, show the results for sentences containing a singular local noun and a singular verb (i.e., COG-SSS and NONCOG-SSS). In both the cognate and the noncognate sentences, the participants switched to focus on the image of the singular subject (i.e., blackboard) at approximately the same time in the sentence, namely upon hearing the verb *was*. There was no significant difference in the time point at which participants started focusing primarily on the singular subject between the cognate and the noncognate sentences. The two central graphs, top and bottom, represent the sentences that contained a plural local noun and a singular verb (i.e., COG-SPS and NONCOG-SPS). Looking at the time that it took for participants to predominantly fixate on the image of the singular subject, it took the participants slightly longer to focus on the singular subject in the sentences containing a cognate local noun. In the noncognate sentences, the participants focused on the singular subject prior to hearing *was*. In cognate sentences, the participants focused on the singular subject at the word following the verb in the sentences (e.g., *too*). On the left, the two graphs, top and bottom, represent sentences containing a plural local noun and a plural verb (i.e., COG-SPP and NONCOG-SPP). In both variants, participants fixated primarily on the image of the singular subject at about the same time in the sentence, namely upon hearing the word *was*. After hearing a plural verb, however, there was a slight increase in the proportion of fixations to the plural subject, but eventually, the participants fixated on the singular subject. This pattern was similar for both cognate and noncognate sentences.

Chapter 4

Discussion

Summary

This study looked at the effect of cognate status on linguistic interference by investigating the offline interpretation and online processing patterns of L2 speakers, when listening to sentences containing subject verb agreement violations. The L2 participants were more likely to choose the plural version of the subject when presented with more plural cues in the sentence. Specifically, participants selected the plural subject slightly more often in sentences with a plural local noun compared to a sentence with a singular local noun. Likewise, a sentence with a plural local noun and a plural verb triggered more plural subject interpretations than any other condition. This pattern of findings was similar for both cognate and noncognate conditions, suggesting that cognate status had no effect on final sentence interpretation. These subject selection results parallel those seen in L1 participants with similarly structured sentences (Brehm et. al., 2018; Patson & Husband, 2015).

Turning to the eye-tracking results, we looked at the online results of participants' fixations for the trials in which participants selected the singular subject. The conditions with multiple plural cues (i.e., conditions with a plural local noun and a plural verb; conditions with a plural local noun only) led to a higher proportion of fixations to the image of the plural subject. More specifically, in conditions with a plural local noun and a plural verb, participants fixated primarily on the image of the singular subject around verb onset but, after hearing a plural verb, switched to fixate briefly on the image of the plural subject before switching back to fixate on the image of the singular subject. The pattern of findings in conditions with a plural local noun but a singular verb differed between cognate and noncognate

sentences. In conditions with a plural local noun and a singular verb, participants briefly looked at the image of the plural subject in both cognate and noncognate conditions after hearing a plural local noun, but it took longer for participants to go back to focusing solely on the image of the singular subject in cognate compared to noncognate conditions.

Interference during L2 processing

Cunnings (2017) proposed that L2 speakers may be more susceptible to interference from conflicting linguistic cues due to differences in memory in L2 speakers compared to L1 speakers. Language processing requires knowledge of syntactic structure and semantics, and L2 speakers possess this knowledge for two languages, both of which are active at the same time. This increase in language knowledge contributes to a greater memory load for L2 speakers as compared to L1 speakers. More specifically, there could be potential inference from L1 structures when processing linguistic structures in the L2. The subject selection results, however, show similar interference effects in L2 speakers to those of the L1 speakers (Brehm et al., 2018; Patson & Husband, 2015), in that both groups were more likely to select a plural subject when they heard multiple plural cues (i.e., a plural local noun and a plural verb; a plural local noun only).

The subject selection results only allow us to observe one snapshot in time, namely participants' final interpretation of the sentence. In contrast, the online eye-tracking data allows us to observe how the participants processed the sentence as they listened to it, rather than measuring just their final interpretation. These results only reflect the data for sentences in which the participants chose the image of the singular subject as the sentence subject. For the online eye-tracking data, participants showed a similar pattern of results to the subject selection data, as the sentences with more plural cues led to more fixations to the image of the plural subject. In sentences with no plural cues, participants quickly fixated

on the image of the singular subject. In sentences with a plural local noun and a singular verb, participants fixated on the image of the singular subject with a slight delay compared to the sentences with no plural cues. In sentences with a plural local noun and a plural verb, participants had an increased delay compared to the other conditions in terms of when they began to fixate primarily on the image of the singular subject. These results show signs of interference even in situations where the participant chose the singular subject, suggesting that eyetracking results can show different evidence of interference than subject selection results. These results also show similar patterns of interference in eyetracking results seen in L1 speakers, in which they were presented sentences with subject-verb agreement violations similar to the sentences used in the present study (Brehm et al., 2019).

The results from both the subject selection and the eyetracking fixations suggest that the mechanisms that drive interference are not dependent on differences in processing between L1 and L2 speakers, but rather reflect more universal mechanisms that all language speakers use when processing linguistic input. These data show that interference from plural cues can be seen both in final sentence interpretation, as well as real-time processing. It also suggests that interference can occur in processing, even when it does not arise in overall interpretation. The L2 speakers showed evidence of grammatical processing. More fixations to plural images when listening to sentences containing more plural cues shows that the L2 speakers heard plural markers and processed them as such. Though the participants processed them as plural, the subject in the target sentences was never plural in any sentence condition, suggesting several possibilities regarding the way in which the participants processed the target sentences. First, the participants may have had a poor representation of the subject after initially listening to it, which would allow for the subsequent plural cues on the local noun and the verb to affect their interpretation of the subject number. Alternatively, the participants could have misremembered the subject as plural, as a result of encountering a verb marked for a plural subject, leading the participant to retrieve the subject incorrectly. Both of these possibilities show that we are still processing the subject of the sentence when

encountering the verb. This is true for both L1 and L2 speakers, as L1 speakers have exhibited similar grammatical interference effects in other studies (Brehm et. al., 2018, 2019; Patson & Husband, 2015;).

There is currently not any L1 data for both sentence interpretation results and online fixation results for the specific conditions in the present study. While the interpretation data reveal similar levels of interference for conditions that are similar in structure to those used in previous research with L1 speakers (Patson & Husband, 2015; Brehm et. al., 2018), it is still unknown whether the magnitude of interference is different between L1 and L2 speakers, as postulated by Cunnings (2017). To compare the data from the present study with L1 speakers, it would be necessary to run the same study with L1 speakers and compare L1 speakers' results with the present data from L2 speakers, in order to better understand differences and similarities in the magnitude of interference during online processing among L1 and L2 speakers.

The impact of cognates on L2 processing

In Hopp's (2017) research on cognate versus noncognate verb effects on reading times among L2 speakers, he hypothesized that cognate status may contribute to the degree of L1 interference during L2 processing. His research suggested that cognate facilitation at the lexical level may increase effects of L1 syntactic interference, as it may increase activation of L1 syntactic structures in L2 speakers. In the present study, there is no significant difference in the interpretation data between the cognate and noncognate conditions suggesting that cognate status may not affect the level of interference in final interpretation at the lexical level.

In the online eye-tracking data, however, there was a difference between cognate and noncognate conditions in sentences that contained a plural local noun only (the local noun also being the word that was either a cognate or a noncognate). In the cognate conditions, the participants fixated on the image of

the plural subject after hearing the plural local noun. In the noncognate conditions, the participants fixated on the singular subject in this same time window. The delay in singular subject fixation in cognate conditions suggests that cognate status may increase levels of syntactic interference at the lexical level. Going back to Hopp's (2017) hypothesis, the cognate status of the local noun in the conditions with a plural local noun only may have increased activation of L1 morphosyntactic structures in L2 speakers. The interpretation data for this condition did not show signs of increased syntactic interference, however. Together, these offline interpretation and online eye-tracking results suggest that L1 morphosyntactic structures may be partially or temporarily activated, but that this activation does not persist. This also suggests, then, that an L2 speaker may experience interference in sentence processing, but be able to overcome this interference to correctly interpret a sentence.

Conclusion

There is some evidence in this research to suggest that cognate status may increase the overall interference in L2 speakers at the syntactic level (e.g., Hopp, 2017). This increase in syntactic interference may be a signal of increased activation of L1 morphosyntactic structures catalyzed by cognate status. The absence of signs of interference from cognate status in overall sentence interpretation, however, suggests that the increased levels of interference during online processing did not necessarily affect overall sentence interpretation. This research parallels other research investigating the role of interference in L2 speakers, but provides novel insight into how cognate status does—and does not—influence L2 processing. Future research continuing in this vein could help to further identify the similarities and differences in how semantic and syntactic interference has an impact on language processing among both L1 and L2 speakers.

Appendix A

Critical Items

1a. The stamp on the postcards likely were from the post office. (Cog., Local PL, Verb PL)

1b. The stamp on the postcard likely was from the post office. (Cog, Local SG, Verb SG)

1c. The stamp on the postcards likely was from the post office. (Cog, Local PL, Verb SG)

1d. The stamp on the envelopes likely were from the post office. (Noncog, Local PL, Verb PL)

1e. The stamp on the envelopes likely was from the post office. (Noncog, Local PL, Verb SG)

1f. The stamp on the envelope likely was from the post office. (Noncog, Local SG, Verb SG)

2a. The cake for the babies definitely were chocolate.

2b. The cake for the baby definitely was chocolate.

2c. The cake for the babies definitely was chocolate.

2d. The cake for the children definitely were chocolate.

2e. The cake for the children definitely was chocolate.

2f. The cake for the child definitely was chocolate.

3a. The bowl for the bananas mostly were blue and red.

3b. The bowl for the banana mostly was blue and red.

3c. The bowl for the bananas mostly was blue and red.

3d. The bowl for the potatoes mostly were blue and red.

3e. The bowl for the potatoes mostly was blue and red.

3f. The bowl for the potato mostly was blue and red.

4a. The tent for the campers unfortunately were put up over there.

4b. The tent for the camper unfortunately was put up over there.

4c. The tent for the campers unfortunately was put up over there.

4d. The tent for the counselors unfortunately were put up over there.

4e. The tent for the counselors unfortunately was put up over there.

4f. The tent for the counselor unfortunately was put up over there.

5a. The knife in the restaurants definitely were really sharp.

5b. The knife in the restaurant definitely were really sharp.

5c. The knife in the restaurants definitely was really sharp.

5d. The knife in the kitchens definitely were really sharp.

5e. The knife in the kitchens definitely was really sharp.

5f. The knife in the kitchen definitely was really sharp.

6a. The lady with the earrings happily were living in a mansion.

6b. The lady with the earring happily was living in a mansion.

6c. The lady with the earrings happily was living in a mansion.

6d. The lady with the necklaces happily were living in a mansion.

6e. The lady with the necklaces happily was living in a mansion.

6f. The lady with the necklace happily was living in a mansion.

7a. The pillow on the beds really were old.

7b. The pillow on the bed really was old.

7c. The pillow on the beds really was old.

7d. The pillow on the chairs really were old.

7e. The pillow on the chairs really was old.

7f. The pillow on the chair really was old.

8a. The present for the cooks actually were from the customer.

8b. The present for the cook actually was from the customer.

8c. The present for the cooks actually was from the customer.

8d. The present for the waiters actually were from the customer.

8e. The present for the waiters actually was from the customer.

8f. The present for the waiter actually was from the customer.

9a. The customer with the muffins totally were wearing boots.

9b. The customer with the muffin totally was wearing boots.

9c. The customer with the muffins totally was wearing boots.

9d. The customer with the candies totally were wearing boots.

9e. The customer with the candies totally was wearing boots.

9f. The customer with the candy totally was wearing boots.

10a. The businessman with the papers already were late.

10b. The businessman with the paper already was late.

10c. The businessman with the papers already was late.

10d. The businessman with the files already were late.

10e. The businessman with the files already was late.

10f. The businessman with the file already was late.

11a. The label on the bottles totally were recognizable.

11b. The label on the bottle totally was recognizable.

11c. The label on the bottles totally was recognizable.

11d. The label on the jars totally were recognizable.

11e. The label on the jars totally was recognizable.

11f. The label on the jar totally was recognizable.

12a. The backyard with the lights literally were out of a movie.

12b. The backyard with the light literally was out of a movie.

12c. The backyard with the lights literally was out of a movie.

12d. The backyard with the trees literally were out of a movie.

12e. The backyard with the trees literally was out of a movie.

12f. The backyard with the tree literally was out of a movie.

13a. The king of the islands unfortunately were too old.

13b. The king of the island unfortunately was too old.

13c. The king of the islands unfortunately was too old.

13d. The king of the countries unfortunately were too old.

13e. The king of the countries unfortunately was too old.

13f. The king of the country unfortunately was too old.

14a. The sign by the guitars totally were showing the right price.

14b. The sign by the guitar totally was showing the right price.

14c. The sign by the guitars totally was showing the right price.

14d. The sign by the drums totally were showing the right price.

14e. The sign by the drums totally was showing the right price.

14f. The sign by the drum totally was showing the right price.

15a. The farmer with the tomatoes already were sold out.

15b. The farmer with the tomato already was sold out.

15c. The farmer with the tomatoes already was sold out.

15d. The farmer with the onions already were sold out.

15e. The farmer with the onions already was sold out.

15f. The farmer with the onion already was sold out.

16a. The cage for the tigers literally were wide open.

16b. The cage for the tiger literally was wide open.

16c. The cage for the tigers literally was wide open.

16d. The cage for the lions literally were wide open.

16e. The cage for the lions literally was wide open.

16f. The cage for the lion literally was wide open.

17a. The drawing of the planets seriously were hanging on the fridge.

17b. The drawing of the planet seriously was hanging on the fridge.

17c. The drawing of the planets seriously was hanging on the fridge.

17d. The drawing of the clouds seriously were hanging on the fridge.

17e. The drawing of the clouds seriously was hanging on the fridge.

17f. The drawing of the cloud seriously was hanging on the fridge.

18a. The road to the houses really were near the river.

18b. The road to the house really was near the river.

18c. The road to the houses really was near the river.

18d. The road to the mountains really were near the river.

18e. The road to the mountains really was near the river.

18f. The road to the mountain really was near the river.

19a. The bag for the markers luckily were in the backpack.

19b. The bag for the marker luckily was in the backback.

19c. The bag for the markers luckily was in the backback.

19d. The bag for the pens luckily were in the backpack.

19e. The bag for the pens luckily was in the backpack.

19f. The bag for the pen luckily was in the backpack.

20a. The sidewalk with the stones literally were a safety hazard.

20b. The sidewalk with the stone literally was a safety hazard.

20c. The sidewalk with the stones literally was a safety hazard.

20d. The sidewalk with the pebbles literally were a safety hazard.

20e. The sidewalk with the pebbles literally was a safety hazard.

20f. The sidewalk with the pebble literally was a safety hazard.

21a. The contestant with the medals honestly were crying.

21b. The contestant with the medal honestly was crying.

21c. The contestant with the medals honestly was crying.

21d. The contestant with the ribbons honestly were crying.

21e. The contestant with the ribbons honestly was crying.

21f. The contestant with the ribbon honestly was crying.

22a. The stage for the dancers probably were set up outside.

22b. The stage for the dancer probably was set up outside.

22c. The stage for the dancers probably was set up outside.

22d. The stage for the actors probably were set up outside.

22e. The stage for the actors probably was set up outside.

22f. The stage for the actor probably was set up outside.

23a. The story about the vampires definitely were for adults only.

23b. The story about the vampire definitely was for adults only.

23c. The story about the vampires definitely was for adults only.

23d. The story about the witches definitely were for adults only.

23e. The story about the witches definitely was for adults only.

23f. The story about the witch definitely was for adults only.

24a. The orchard with the apples totally were for sale.

24b. The orchard with the apple totally was for sale.

24c. The orchard with the apples totally was for sale.

24d. The orchard with the peaches totally were for sale.

24e. The orchard with the peaches totally was for sale.

24f. The orchard with the peach totally was for sale.

25a. The box for the tshirts probably were upstairs.

25b. The box for the tshirt probably was upstairs.

25c. The box for the tshirts probably was upstairs.

25d. The box for the pencils probably were upstairs.

25e. The box for the pencils probably was upstairs.

25f. The box for the pencil probably was upstairs.

26a. The frame for the photos unexpectedly were in the bathroom.

26b. The frame for the photo unexpectedly was in the bathroom.

26c. The frame for the photos unexpectedly was in the bathroom.

26d. The frame for the paintings unexpectedly were in the bathroom.

26e. The frame for the paintings unexpectedly was in the bathroom.

26f. The frame for the painting unexpectedly was in the bathroom.

27a. The pond near the gardens actually were very small.

27b. The pond near the garden actually was very small.

27c. The pond near the gardens actually was very small.

27d. The pond near the benches actually were very small.

27e. The pond near the benches actually was very small.

27f. The pond near the bench actually was very small.

28a. The blackboard for the schools really were too old to use.

28b. The blackboard for the school really was too old to use.

28c. The blackboard for the schools really was too old to use.

28d. The blackboard for the offices really were too old to use.

28e. The blackboard for the offices really was too old to use.

28f. The blackboard for the office really was too old to use.

29a. The lightbulb for the lamps suddenly were not working.

29b. The lightbulb for the lamp suddenly was not working.

29c. The lightbulb for the lamps suddenly was not working.

29d. The lightbulb for the refrigerators suddenly were not working.

29e. The lightbulb for the refrigerators suddenly was not working.

29f. The lightbulb for the refrigerator suddenly was not working.

30a. The enclosure for the horses actually were behind the barn.

30b. The enclosure for the horse actually was behind the barn.

30c. The enclosure for the horses actually was behind the barn.

30d. The enclosure for the chickens actually were behind the barn.

30e. The enclosure for the chickens actually was behind the barn.

30f. The enclosure for the chicken actually was behind the barn.

31a. The meal for the guests unfortunately were not ready.

31b. The meal for the guest unfortunately was not ready.

31c. The meal for the guests unfortunately was not ready.

31d. The meal for the boys unfortunately were not ready.

31e. The meal for the boys unfortunately was not ready.

31f. The meal for the boy unfortunately was not ready.

32a. The wall with the posters finally were painted white.

32b. The wall with the poster finally was painted white.

32c. The wall with the posters finally was painted white.

32d. The wall with the windows finally were painted white.

32e. The wall with the windows finally was painted white.

32f. The wall with the window finally was painted white.

33a. The basket for the oranges probably were outside.

33b. The basket for the orange probably was outside.

33c. The basket for the oranges probably was outside.

33d. The basket for the cookies probably were outside.

33e. The basket for the cookies probably was outside.

33f. The basket for the cookie probably was outside.

34a. The roof with the antennas frequently were checked for damage.

34b. The roof with the antenna frequently was checked for damage.

34c. The roof with the antennas frequently was checked for damage.

34d. The roof with the chimneys frequently were checked for damage.

34e. The roof with the chimneys frequently was checked for damage.

34f. The roof with the chimney frequently was checked for damage.

35a. The bucket for the frogs probably were in the backyard.

35b. The bucket for the frog probably was in the backyard.

35c. The bucket for the frogs probably was in the backyard.

35d. The bucket for the tadpoles probably were in the backyard.

35e. The bucket for the tadpoles probably was in the backyard.

35f. The bucket for the tadpole probably was in the backyard.

36a. The building near the museums definitely were taller.

36b. The building near the museum definitely was taller.

36c. The building near the museums definitely was taller.

36d. The building near the churches definitely were taller.

36e. The building near the churches definitely was taller.

36f. The building near the church definitely was taller.

37a. The neighbor with the cats likely were going to the barbecue.

37b. The neighbor with the cat likely was going to the barbecue.

37c. The neighbor with the cats likely was going to the barbecue.

37d. The neighbor with the dogs likely were going to the barbecue.

37e. The neighbor with the dogs likely was going to the barbecue.

37f. The neighbor with the dog likely was going to the barbecue.

38a. The key to the doors actually were in the purse.

38b. The key to the door actually was in the purse.

38c. The key to the doors actually was in the purse.

38d. The key to the gates actually were in the purse.

38e. The key to the gates actually was in the purse.

38f. The key to the gate actually was in the purse.

39a. The plate for the cheeses clearly were not washed yet.

39b. The plate for the cheese clearly was not washed yet.

39c. The plate for the cheeses clearly was not washed yet.

39d. The plate for the sausages clearly were not washed yet.

39e. The plate for the sausages clearly was not washed yet.

39f. The plate for the sausage clearly was not washed yet.

40a. The bun for the hamburgers luckily were still in the refridgerator.

40b. The bun for the hamburger luckily was still in the refridgerator.

40c. The bun for the hamburgers luckily was still in the refridgerator.

40d. The bun for the hotdogs luckily were still in the refridgerator.

40e. The bun for the hotdogs luckily was still in the refridgerator.

40f. The bun for the hotdog luckily was still in the refridgerator.

41a. The skirt with the hearts unfortunately were missing.

41b. The skirt with the heart unfortunately was missing.

41c. The skirt with the hearts unfortunately was missing.

41d. The skirt with the stars unfortunately were missing.

41e. The skirt with the stars unfortunately was missing.

41f. The skirt with the star unfortunately was missing.

42a. The zipper on the jackets unexpectedly were approved by the designer.

42b. The zipper on the jacket unexpectedly was approved by the designer.

42c. The zipper on the jackets unexpectedly was approved by the designer.

42d. The zipper on the coats unexpectedly were approved by the designer.

42e. The zipper on the coats unexpectedly was approved by the designer.

42f. The zipper on the coat unexpectedly was approved by the designer.

43a. The pot for the plants really were yellow.

43b. The pot for the plant really was yellow.

43c. The pot for the plants really was yellow.

43d. The pot for the flowers really were yellow.

43e. The pot for the flowers really was yellow.

43f. The pot for the flower really was yellow.

44a. The room for the students absolutely were too small.

44b. The room for the student absolutely was too small.

44c. The room for the students absolutely was too small.

44d. The room for the teahers absolutely were too small.

44e. The room for the teachers absolutely was too small.

44f. The room for the teacher absolutely was too small.

45a. The shelf for the books literally were about to fall down.

45b. The shelf for the book literally was about to fall down.

45c. The shelf for the books literally was about to fall down.

45d. The shelf for the games literally were about to fall down.

45e. The shelf for the games literally was about to fall down.

45f. The shelf for the game literally was about to fall down.

46a. The nurse with the thermometers carefully were walking down the hallway.

46b. The nurse with the thermometer carefully was walking down the hallway.

46c. The nurse with the thermometers carefully was walking down the hallway.

46d. The nurse with the bandages carefully were walking down the hallway.

46e. The nurse with the bandages carefully was walking down the hallway.

46f. The nurse with the bandage carefully was walking down the hallway.

47a. The car of the athletes unexpectedly were stopped by a cop.

47b. The car of the athlete unexpectedly was stopped by a cop.

47c. The car of the athletes unexpectedly was stopped by a cop.

47d. The car of the lawyers unexpectedly were stopped by a cop.

47e. The car of the lawyers unexpectedly was stopped by a cop.

47f. The car of the lawyer unexpectedly was stopped by a cop.

48a. The mug with the roses absolutely were in the cabinet.

48b. The mug with the rose absolutely was in the cabinet.

48c. The mug with the roses absolutely was in the cabinet.

48d. The mug with the birds absolutely were in the cabinet.

48e. The mug with the birds absolutely was in the cabinet.

48f. The mug with the bird absolutely was in the cabinet.

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ACADEMIC VITA

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Education

Pennsylvania State University, State College, PA, 2014-Present
Schreyer Honors College
Bachelor of Science in Agricultural Sciences
Bachelor of Arts in Philosophy, Math and Science Option
Minors in Horticulture, International Agriculture, and German
Graduation May 2019

Experience

Learning Group Leader, Shaver's Creek/Pennsylvania State University, 2018-19

- Crafted multiple weeks of lessons for 9-12 year olds focused on ecosystems, the water cycle, and flora and fauna native to Pennsylvania
- Collaborated with and evaluated a teaching team of 4 other college students, who I assisted in creating and executing their own lessons
- Led my teaching team and group of 10 students through the wilderness, teaching and adhering to Leave-No-Trace principles when selecting trails and stopping points

MacKinnon's Café/Starbucks, Pennsylvania State University, State College, PA, 2015-Present

- Managed a team of 60+ students, assisting in training them on how to prepare the 150+ drinks and food items on our menu
- Adapted to fill different roles throughout shifts including preparing food, brewing drinks, performing customer service, and maintaining order and cleanliness throughout the cafe

Special Skills

- Wilderness First Aid Certified
- Speak German
- Certified Tea Specialist