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L1 AND L2 PHONETIC INTERACTION IN CLASSROOM L2 LEARNERS: A DEVELOPMENTAL PERSPECTIVE

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ABSTRACT

Around the world, millions of students are learning a foreign language in their school classrooms every day. In an increasingly globalized world, it is deemed important that children gain knowledge of a second language (L2) and can communicate effectively with native speakers. It is therefore necessary that we know more about the process of L2 learning in the classroom, including the learning of L2 phonology. This study targets the research question, "How does the L2 mental lexicon of L2 learners develop and interact with first language (L1) lexical knowledge?" This question is particularly relevant in child L2 learners who concurrently develop their L1 lexical knowledge, which may lead to unique patterns of interaction. This study specifically focuses on patterns of interaction between L1 and L2 phonetic systems during speech production in child classroom L2 learners, and analyzes VOTs in cognates and noncognates. Parallel research testing adult bilinguals observed contrasting patterns. In line with the exemplar-based speech production model, Amengual (2012) found phonetic co-activation in cognate production resulting in an average of VOTs in L1 (Spanish) and L2 (English) in adult proficient Spanish-English bilinguals. In contrast, Jacobs, Fricke, and Kroll (2015) found that intermediate and high proficiency English-Spanish bilinguals produced Spanish cognates with longer (and more English-like) VOTs, and proposed that bilinguals are unable to inhibit the L1 during L2 speech production.

To test patterns of interaction between L1 and L2 phonetic systems in child L2 learners, we used VOTs to examine the production of cognate and noncognate pictures and words in 41 Dutch child classroom learners of L2 English, all 6th graders who had received English language instruction since Kindergarten, for 2-3 hours per week. Critical points for VOT analysis are 1)

words beginning with /b/ and /d/ as these are voiced plosives in Dutch and show pre-voicing, while in English they present with a short lag, and 2) words beginning with /p/ and /t/ as they are voiceless plosives in Dutch and present with a short lag, while these are comparatively aspirated in English and show a longer positive VOT. Twenty-seven participants have been analyzed for VOT and these results show a clear influence of the L1 VOT on L2 production. However, a significant difference was found between voiceless cognates in English and Dutch, as well as noncognates, showing unique patterns of interaction. This pattern of findings most closely aligns with the results of Jacobs, Fricke, and Kroll (2015) which describes an inability to inhibit the L1 in L2 production. Although, the voiceless L2 production results trended toward being more L2-like, creating a unique pattern of phonetic interaction in child L2 English learners that differs from what has been found with adult L2 English learners.

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Chapter 1 Introduction

Around the world, millions of students are learning a foreign language in their school classrooms every day. In an increasingly globalized world, it is crucial that children gain knowledge of a second language (L2) and can communicate effectively with native speakers of that language. Because this is so important, we need to know more about the cognitive and linguistic processes involved in learning a second language in the classroom, and how newly learned structures in the L2 interact with knowledge of the native language (L1). The study reported in this thesis specifically focuses at the phonetic level, the sound structures of human speech. More specifically, the study targets the research question, "Do the L1 and L2 phonetic systems interact during speech production in classroom L2 learners, and if so, how?" This research is aimed at gaining a better idea of if and how a child learner's L1 and L2 interact during L2 learning in a classroom setting, specifically through the analysis of speech production. In this introduction, I will first discuss the significance of cognates in relation to the concept of phonetic interaction. I will also explain the relevance of Voice Onset Time in studying bilingual speech production, and more precisely how it gradually develops in both bilinguals and monolinguals. These factors will then be integrated to explain the research questions that guide the current study involving child Dutch classroom learners of English.

Phonetic Interaction in Cognate Production in Bilinguals and L2 Learners

Previous research has examined both word comprehension and production in studying cross-language activation. One of the most robust findings in lexical comprehension and production in adult L2 learners and bilinguals is that cognates (words that share their phonology, orthography, and semantics across languages, such as the English-Dutch translations 'dolphin-dolfijn' or 'piano-piano') are comprehended and produced faster and more accurately than noncognates (for a review, see Van Hell & Tanner, 2012). However, this cognate facilitation effect may be less robust in child classroom L2 learners, as observed by Brenders, Van Hell, and Dijkstra (2011). They found that cognates were recognized faster than noncognates when only cognate and noncognate words were presented in a visual word recognition task. However, this cognate facilitation effect turned into a cognate inhibition effect (i.e., slower responses to cognates than to noncognates) when homographs (words that share spelling but not meaning, e.g., 'angel' meaning 'sting' in Dutch) were added to the list of stimulus items; in adult bilinguals, the cognate effect was not influenced by this manipulation. This suggests that in child L2 learners, the links between L2 words' phonological, orthographic, and semantic codes are weaker and less well developed, and more sensitive to lexical ambiguity across languages, than in more proficient adult bilinguals. This may also imply that in child L2 learners, interactions between L1 and L2 phonological, orthographic, and semantic codes differ during speech production (cf. Poarch & Van Hell, 2012), but it is unknown how this unfolds in actual phonetic segmentation in articulation.

Studies testing phonetic interaction during production often measure and analyze Voice Onset Time (VOT) values. Voice Onset Time (VOT) is defined as the time between the plosive release and the onset of the vowel phonation (voicing), usually measured in milliseconds (ms).

For the purposes of studying the Dutch and English languages, Voice Onset Time can be organized into three categories, including “prevoicing”, “short lag”, and “aspiration”, as shown in Figure 1. “Prevoicing” involves voicing before the onset of the consonant and is presented as a VOT with a negative value; “short lag” is manifested as a short, positive VOT value; and “aspiration” is presented as a longer, positive VOT value. The three categories are visibly different when looking at the speech waveforms, as shown in Figure 2. Various studies in bilingualism and language learning have used Voice Onset Time (VOT) as a main point of analysis in studying speech production, and more specifically, cross-language production.

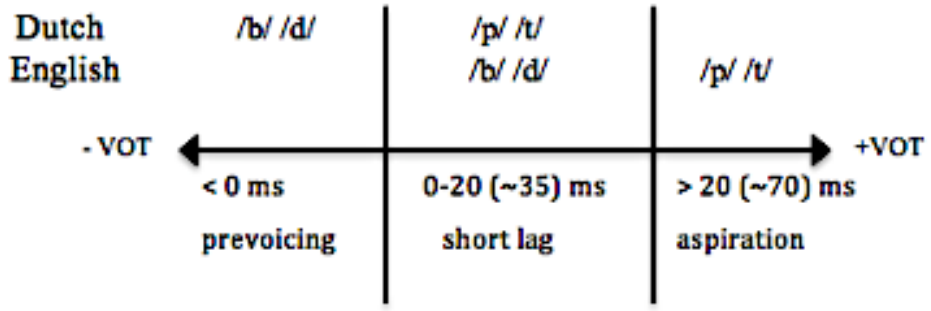


Figure 1 The VOT Continuum: phonological and phonetic categories. Adapted from "Heritage language exposure impacts voice onset time of Dutch-German simultaneous bilingual preschoolers” by Stoehr et al., 2018, *Bilingualism: Language and Cognition,* p. 601. Copyright 2017 by Cambridge University Press

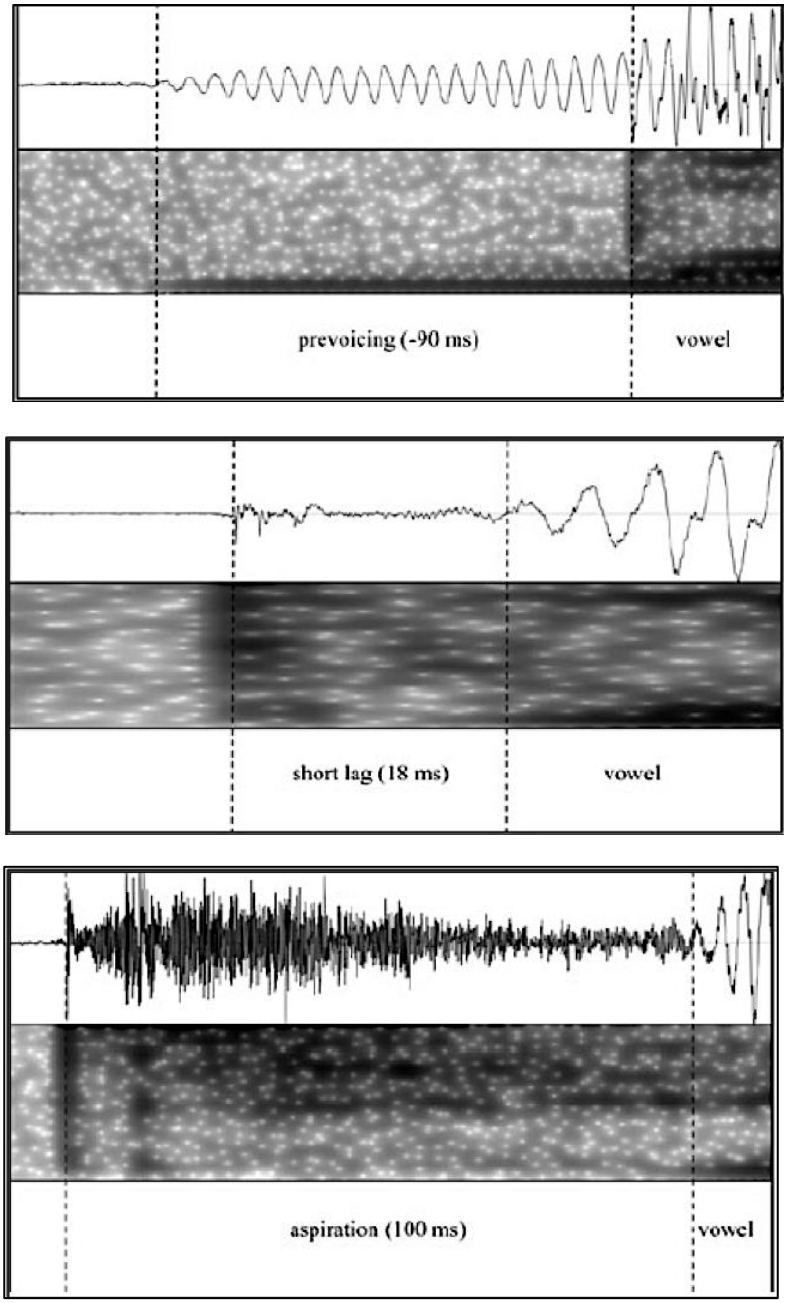


Figure 2 Examples of VOT measured in Praat (Stoehr et al., 2015)

An influential theory that has been proposed to describe phonetic interaction in speech production is the exemplar-based speech model (Amengual, 2012; Bybee, 2001; Pierrehumbert, 2001). According to the exemplar-based speech model, VOTs are dependent upon the mental categorization of phonetic information. The exemplar-based speech model assumes that phonological representations are stored along with other lexical information into distinct categories. When involving similar phonological information across languages, some of these categories may overlap. For example, this overlap would be true in the earlier example of the Dutch-English cognates 'dolfijn-dolphin'. Therefore, when applied to bilingual speech production, the exemplar-based speech model predicts that cognate VOTs in each of the bilingual's languages will emerge as an average of exemplar VOTs in the L1 and L2. Specifically, this means that when producing cognates, bilinguals are drawing on an association between phonologically similar word representations, resulting in bilingual (averaged) VOT values. Noncognates (e.g., Dutch-English translation pair 'fles-bottle') would not have this association, or overlap, and therefore have separate phonological representations for words in the L1 and the L2, resulting in separate exemplar VOT values. To test the prediction of the exemplar-based speech model, Amengual (2012) examined VOTs of highly proficient Spanish-English bilinguals by asking them to read aloud Spanish sentences that contained a cognate, noncognate, or filler word. Sentences followed the format of "*Yo puedo decir* TARGETWORD" (I can say TARGETWORD). Critical stimuli were cognate and noncognate words beginning with /t/ and followed by a midvowel of /e/ or /o/. The phoneme /t/ was chosen because it is produced with an aspiration in English and shows a longer, more positive VOT that is distinctly

different than in Spanish. Filler words did not contain this manipulation. Amengual (2012) found that, consistent with the exemplar-based speech model's predictions, noncognates remained more L1-like when producing them in the L1 and more L2-like when producing them in the L2. However, there was a phonetic co-activation in cognate production resulting in an average of VOTs in L1 (Spanish) and L2 (English), meaning that VOT values of cognates were presented as an average of the typical values for each language; the /t/ in Spanish cognates sounded more English-like.

However, a different outcome was obtained by Jacobs, Fricke, and Kroll (2015) who found that the VOT of cognates was not an average of the L1 and L2, but favorable to the more proficient language (L1). Jacobs and colleagues used VOT to study the planning and articulation of cognates and noncognates in college-aged English L2 classroom learners of Spanish compared to advanced L2 speakers of Spanish. They used a speeded word-naming task consisting of 50 Spanish cognates and 50 Spanish noncognate control words. They found an overall cognate effect for both advanced speakers and classroom L2 learners in planning, but found that in production, classroom learners produced cognates with shorter durations and a more English-like VOT in the L2 (Spanish) as compared to advanced speakers. Jacobs et al. (2015) explained this result by proposing that L2 classroom learners may be unable to inhibit the L1 during speech production. More specifically, their greater knowledge and proficiency of the L1 English relative to the L2 Spanish makes it more likely that L2 learners will be unable to control the co-activation of languages resulting in more L1-like production when producing Spanish cognates, which are linguistically more similar in both languages than noncognates.

Recently, Abdollahi and Van Hell (in prep) studied co-activation during production in highly proficient (L1) Dutch – (L2) English bilinguals, who were either highly proficient

classroom learners, or had recently been immersed in an L2 English environment. Participants completed a word-naming and a picture-naming task of cognates and noncognates in the L1 Dutch and L2 English. Bilinguals who had recently been immersed in an L2 English environment produced significantly more L2-like VOTs to both cognates and noncognates in the L2, while classroom learners did not produce significantly different VOT values for cognates or noncognates in the L2 compared to the L1 (they showed a trend towards L2-like VOT in the L2, but it was not significant). These results contrast with findings discussed above, as the immersed learners did not show an average of L1 and L2 VOTs when producing cognates in L2 (Amengual, 2012), but VOTs that were significantly more L2-like. Furthermore, the classroom learners did not show a significantly L1-like VOT in the L2 production of cognates and noncognates, as in Jacobs et al. (2015), but rather trended towards averaged VOTs. Together these studies provide evidence, albeit inconclusive, for cross-language interaction at the phonological level in bilinguals. The exact nature of the interaction seems to be influenced by level of L2-proficiency and L2-immersion experiences. However, all studies tested adult L2 learners or bilinguals, who were all university students and had reached a high proficiency level in their native language. What remains unexplored is how L1 and L2 phonetic systems interact in child classroom L2 learners who are not only learning an L2, but are also still developing their L1 (e.g., Nippold, 2007).

VOT Development in Monolinguals and Bilinguals

As described by Stoehr, Benders, Van Hell, and Fikkert (2018), the development of adult-like VOT values is a gradual process beginning very early on in the babbles of young

children. Regardless of whether the child's native language makes a distinction between voicing in terms of prevoicing and short lag (as in Dutch) or short lag and aspiration (as in English), children begin producing short lag plosives as babies and begin to produce adult-like prevoicing beginning typically in their early school years. Research has found that Dutch children prevoice only about 30% of all "voiced" plosives at one or two-years old, but begin prevoicing about 60% of these plosives around the end of their third year of life (Stoehr et al., 2018). Monolingual children acquiring an aspiration language (such as English) can distinguish between "voiceless" and "voiced" plosives as early as age two, although the length of their aspiration may still be less adult-like. Overall, it is known that VOT development begins very early on for children, yet VOT values may not reach typical adult-like values until the school years or beyond.

Bilingual children face an additional challenge: they need to resolve any ambiguity between plosive categories, depending on the two languages being learned. For example, children learning a prevoicing language (such as Dutch) and an aspiration language (such as English) have to make sense of the overlap in the short lag VOT range which corresponds to "voiceless" plosives in Dutch and "voiced" plosives in English. Most of the studies done in this line of research take place in an immersive environment of the second language and not in a balanced environment or in a classroom setting. The acquisition process of adult-like VOTs may be different based upon factors such as environment, input from multiple speakers, and language of schooling (Stoehr et al., 2018). The developmental trajectory of English VOTs in Dutch children learning L2 English in an elementary classroom setting, the topic of the present thesis, may be rather unique. First, children may not yet have acquired adult-like Dutch VOT at the time of testing. Second, unlike bilingual children exposed to two languages from birth (such as the simultaneous bilingual children tested by Stoehr et al., 2017, to be discussed below), the Dutch

child L2 classroom learners did not begin learning to produce English-like VOTs until the beginning of elementary school, approximately 7 years prior to testing. These factors potentially result in unique patterns of L1 and L2 phonetic interaction in child L2 classroom learners, as shown through the L1 and the L2 VOTs.

The Current Study

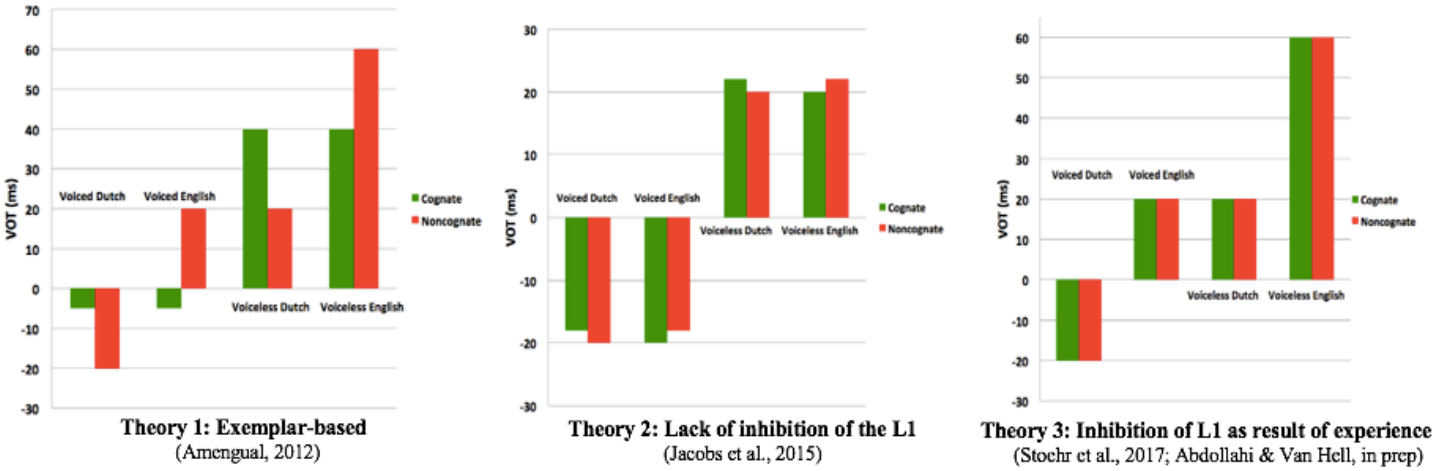
Although past research has focused mainly on adult bilinguals, a more recent study by Stoehr, Benders, Van Hell, and Fikkert (2017) reported a VOT analysis of child bilinguals. Stoehr et al. (2017) studied the role of cross-linguistic influence on phonological acquisition in Dutch-German simultaneous bilingual preschoolers who were exposed to Dutch and German in their homes, since birth. They found that bilingual preschoolers produced VOT differently from their monolingual peers in the L2 (German), but not in the L1 (Dutch). However, they also found an effect for language exposure in that the children with more exposure to German produced more German-like VOT, yet this did not influence their Dutch VOT. Although this study assessed simultaneous bilinguals who were raised with two languages from birth, it provides first evidence that subtle differences in relative exposure to two languages and immersive experience impact dual language development, specifically with respect to phonological acquisition in a second language. What remains unknown, however, is how successive bilingual children, i.e., children who learn their L2 at a later point in life, acquire L2 phonology and how the L2 and L1 phonological systems interact. This is the research question of the study reported in my honors thesis. More specifically, following the methods of Abdollahi and Van Hell (in prep) used in adult Dutch-English bilinguals, the current study used VOT to examine the production of

cognates and noncognates in Dutch beginning L2 learners of English in order to examine the unique patterns of phonetic interaction between the L1 and the L2. Importantly, child successive bilinguals differ from child simultaneous bilinguals because they learned their L2 at a later age, at a time when their L1 phonological, lexical, and syntactic systems were already developed to a certain extent. However, the child successive bilinguals tested in the present study learned their L2 since Kindergarten, at an earlier age than the adult successive bilinguals tested in previous studies. Moreover, the child successive bilinguals in the present study are tested at age 11-12, so at a time when they are still developing their L1 skills (in addition to acquiring an L2).

The hypotheses guiding this study are based on three distinct theories of phonetic interaction; these theories are based on speech production in adult bilinguals and are adapted to child L2 learners (for an overview of the predicted patterns of these three theories, see Figure 3). According to the modified exemplar model (as proposed by Amengual, 2012) VOTs are dependent upon the mental categorization of phonetic information and VOT values should be related to the overlap in mental representation. To reiterate, they found that advanced Spanish (L1) - English (L2) bilinguals produced noncognates that were more Spanish-like in Spanish and more English-like in English, whereas cognates were produced with an average of the two exemplar VOT values (of Spanish and English) based on the association in mental storage. Therefore, the exemplar-based theory of speech production would predict that children will also produce cognates with averaged-VOT values based on the overlap in mental categorization. With respect to noncognates, the exemplar-based theory states that noncognates do not have a mental overlap, and are therefore predicted to retain L1-like values in the L1 and L2-like values in the L2. In contrast, Jacobs et al. (2015), after testing English (L1) classroom learners of Spanish (L2), argued that classroom L2 learners are not able to inhibit their L1 knowledge during

planning and articulation of the L2. If L1 inhibition also applies to child L2 learners, I predict that the Dutch child L2 learners of English would produce cognates with a more Dutch-like VOT because of their inability to control the Dutch activation during production. For the same reason, I predict that noncognates would be produced with an L1-like VOT as well. A third possible pattern emerges from the studies by Abdollahi and Van Hell (in prep) who found that for Dutch (L1) classroom learners of English (L2), VOT values of cognate production only trended toward being L2-like, although immersed learners demonstrated a clear L2-like production of cognates. This finding related to immersed learners was also observed in bilingual Dutch-German preschoolers (Stoehr et al., 2018). This is best explained by assuming that L1 inhibition depends on experience and exposure with the L2 in such a way that greater experience and/or exposure to the L2 would create more ability in the L2 and therefore less reliance on the L1. If L2 phonological acquisition of child successive L2 learners is based on similar mechanisms, I predict that VOT values for cognates and noncognates produced in the L1 would remain L1-like and VOT values in the L2 (English) would trend toward L2-like or become significantly L2-like based on the amount of classroom exposure. Figure 3 below shows the predicted graphs according to these three different hypotheses.

Figure 3 Predicted outcome patterns for each of the three theories (for more details, see Introduction).



Chapter 2 Methods

Participants

Dutch children living in the Netherlands were recruited from three different elementary schools throughout the Netherlands in the cities of Enschede, Voorschoten, and Warnsveld. All children were enrolled at "Early Bird" schools, which begin teaching English in the first year of schooling, at Kindergarten. All children were tested in their final year of elementary school (sixth grade) and had been actively learning English in the classroom for approximately 7 years. A group of 41 children were tested, although the data of 14 children were excluded from the analysis due to knowledge of a third language (*n*= 5), having lived outside of the Netherlands for more than 2 months (*n*= 4), having a language disorder (*n*= 3), or difficulty completing the tasks as designed (*n*= 2). The remaining 27 participants (17 boys, 10 girls; average age 11-12 years old) were native Dutch speakers and did not report speaking any language other than Dutch in their homes, having lived outside of the Netherlands for more than 2 months, or having learned or studied a language other than Dutch or English. All participants had normal or corrected-to-normal vision and had no neurological impairment or language disorders.

Materials

The word-naming and picture-naming materials were adapted from Abdollahi and Van Hell (in prep). These two critical production tasks were chosen as an effective way to gather

clear voice recordings of critical stimuli for VOT analysis. Although materials were previously used with a college-aged participant group, my honors thesis advisor, a native Dutch speaker, deemed the materials developmentally appropriate for the child participant group as well. Word lists consisted of 160 words each and included 40 cognates, 40 noncognates, and 80 filler words. Each of the words began with the phonemes of /p/, /b/, /t/, and /d/. The selection of these specific plosives was based on the systematic variation in VOT between the English and Dutch languages, which made for a distinct comparison between the two. While /b/ and /d/ present with a negative prevoicing in Dutch, they are produced with a short lag and show a small, positive VOT in English. Similarly, /p/ and /t/ are produced with a short lag and a small, positive VOT in Dutch, while these two phonemes are aspirated in English and show a longer positive VOT. The filler items included cognates and noncognates that did not begin with /p/, /b/, /d/, and /t/,

Materials included a Dutch word list and an English word list for a total of 320 items. In consultation with a Dutch phonologist, words were matched on relevant lexical factors in Dutch and English, including phoneme identity and count, syllable count, and stress placement. For the picture-naming task, stimuli were pictures representing cognates, noncognates or filler words. Participants completed either the Dutch picture naming task and the Dutch word-naming task followed by the two tasks in English, or they completed the English tasks first followed by the Dutch tasks. The pictures were the same as the word lists in each of the two languages.

		Cognate	Noncognate
/p/	Dutch	pinguin (penguin)	perzik (peach)
	English	piano (piano)	pencil (potlood)
/b/	Dutch	baby (baby)	borstel (brush)
	English	bed (bed)	bottle (fles)
/t/	Dutch	tent (tent)	tandarts (dentist)
	English	toilet (toilet)	turtle (schildpad)
/d/	Dutch	dolfijn (dolphin)	doolhof (maze)
	English	doctor (dokter)	dog (hond)

Table 1. Examples of cognate and noncognate critical stimuli from both Dutch and English word lists

Procedure

The children were tested in one session that was approximately 45 minutes long. The testing took place in a quiet room at their school. After receiving a completed consent form from the parent, the researcher provided informed child assent with a Dutch witness present. Children then completed a language history survey written in English inquiring about their knowledge of other languages and past experiences studying a foreign language. The Language History Survey, consisting of 9 questions, asked participants about their language background. The survey included questions such as, “Do you speak a language other than Dutch in your home?” and “Have you lived anywhere other than the Netherlands for more than 2 months?” Participants

also answered a question related to having taken any foreign language classes outside of school in the past or having studied a foreign language other than English. This information was necessary in order to exclude the data of participants whose extensive knowledge or exposure to a language other than Dutch or English could influence their speech production, and thus contaminate the findings.

In the next stage, children completed the LexTALE task, the picture-naming task, and the word naming task in one language (Dutch or English), and then completed these tasks in the other language. Half the children started in Dutch followed by English, and the other half started in English followed by Dutch. In both the Dutch and English version of the LexTALE task (Lemhöfer & Broersma, 2012), children read the instructions provided on the screen while also having them explained verbally by the researcher. Children were given the opportunity to ask any questions before continuing with the task. The LexTALE task is a vocabulary test in which participants were asked to decide if the letter string displayed on the screen is a word or not in the given language (Lemhöfer & Broersma, 2012). None of the items from the LexTALE task were also items in the experimental tasks. The scores were used to gain a better sense of the overall Dutch and English proficiencies of the children and to compare their scores between languages.

After completing the LexTALE test, the children moved on to the picture-naming task, which took approximately 5-10 minutes. This section always began with a practice task, consisting of 8 pictures, to get participants accustomed to the task and speaking clearly into the microphone. This task consisted of 160 pictures for each version of the task and participants were reminded whether they were completing the task fully in English or in Dutch, as the stimuli were obviously more ambiguous. In the picture-naming task, an asterisk appeared in the middle

of the computer screen for 750 milliseconds, followed by a blank screen for 500 ms, followed by the picture stimulus. Participants were instructed to name the picture as quickly and accurately as possible. Their voice response prompted the next trial. If the child did not give a response, the picture remained on the screen for 5000 milliseconds followed by another blank screen for 600 ms before starting the next trial. This task was recorded for VOT analysis. An example of this task is shown in Figure 4.

Next, participants completed the word-naming task in the same language as the picture-naming task and using the same word list. This task consisted of 160 words in each language and also took approximately 5-10 minutes to complete in each language. In the word-naming task, an asterisk appeared in the middle of the screen for 750 milliseconds, followed by a blank screen for 500 ms, followed by a word. Children were instructed to read the word aloud as quickly and accurately as possible. Their voice response prompted the next trial to begin. If the child did not give a response, the word remained on the screen for 1000 milliseconds followed by another blank screen for 600 ms, before beginning the next trial. The word-naming task was preceded by a practice session consisting of 8 items. This task was also recorded using a voice recorder for later VOT analysis. An example of this task is shown in Figure 5.

After completing all three tasks in one language, they moved on to complete the LexTALE, picture-naming, and word-naming tasks in the other language. Upon completion, children were verbally debriefed, given the opportunity to ask any questions they had, and were given their participation gift of a plastic cup and pencil with the Penn State University logo.

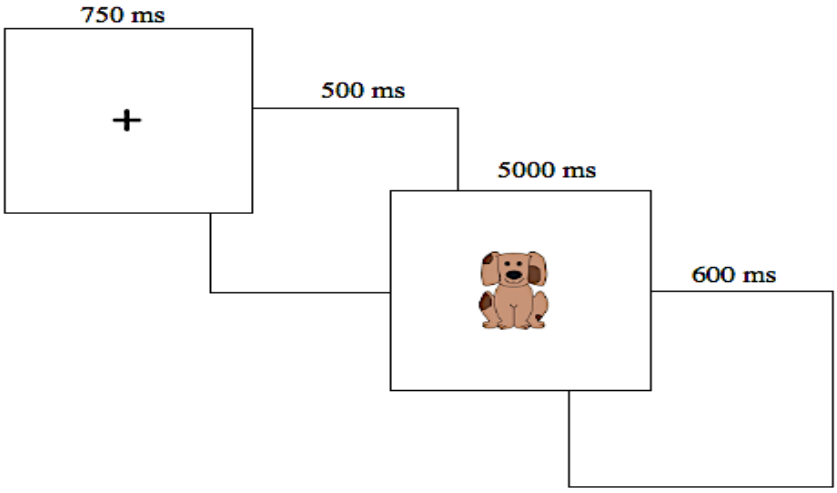


Figure 4 Example of a picture-naming task trial

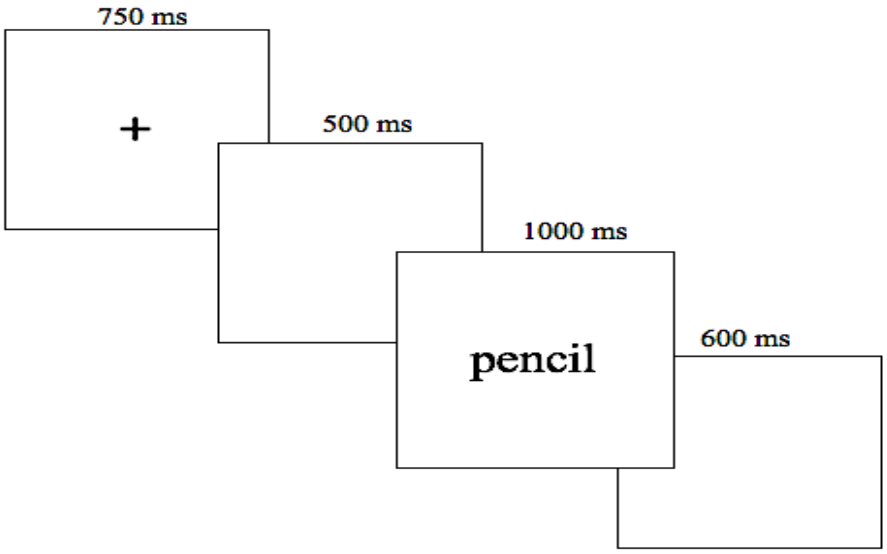


Figure 5 Example of a word-naming task trial

Teacher Questionnaire

A questionnaire was created with the intention of distributing it electronically to the English teachers from each of the three schools participating in this study. The purpose of this questionnaire was to gain more insight into the language history and English proficiency of the teachers themselves, as well as their teaching attitudes and methods used in the classroom. The sections of the questionnaire included: Teacher Background, English Language Background, English Self-Evaluation, Teaching Attitudes, and English Teaching Methods & Classroom. Some examples of the types of questions asked include "What variety of English do you speak?", "Do you incorporate explicit phonetic activities into English lessons?" and "How many hours of English instruction per week does each group receive?". Since there were many unique variables that contributed to the second language instruction in all three classrooms, this was a tool used to better understand the type of language experience and exposure that the children were receiving.

Recordings and VOT Analysis

Voice recordings from the word-naming tasks were coded for Voice Onset Time using Praat (Boersma & Weenink, 2017). The critical phonemes for this study were /p/, /b/, /t/, and /d/. The selection of these specific plosives was based on the systematic variation in VOT between the English and Dutch languages. As described previously, while /b/ and /d/ present with a negative prevoicing in Dutch, they are produced with a short lag and show a small, positive VOT in English. Similarly, /p/ and /t/ are produced with a short lag and a small, positive VOT in Dutch, while these two phonemes are aspirated in English and show a longer positive VOT.

The first author of the paper coded all files for the VOT analyses using Praat (Boersma & Weenink, 2017). The waveforms and spectrograms were analyzed while viewed at 0-5000 Hz. In measuring VOT, the burst onset was defined as the onset of energy release. If there was more than one release burst, VOT was measured from the first visible burst. The onset of voicing was defined as the first periodic component of the waveform and was measured at the preceding zero-crossing (Stoehr et al., 2018).

Chapter 3 Results

Proficiency Scores

The LexTALE task, which was completed by all participants in both English and Dutch, automatically generates an accuracy score based on a percentage out of 100% after completing the task. Scores ranged among students, although as expected, Dutch scores were higher than English scores. The average Dutch LexTALE score was 68.79%; *SD*=10.87. In contrast, the average English LexTALE score was 47.93%; *SD*=10.28.

Based on varied responses in the picture-naming tasks, this task was also coded as an overall marker of proficiency, by scoring the accuracy of naming the target words for both English and Dutch picture-naming tasks. The average Dutch picture-naming score was 84.52%; *SD*=6.27. The average English picture-naming score was 51%; *SD*=12.53.

To conclude, accuracy scores of the LexTALE and picture naming tasks show a converging pattern reflecting higher proficiency in Dutch than in English, although Dutch accuracy scores are still not (close to) perfect and show variability across children.

Word Naming VOT

After the VOTs were coded in Praat, a series of t-tests were conducted comparing the voiced durations between English and Dutch, as well as the voiceless durations between the two languages. Cognate VOT durations were also compared to noncognates within and between languages.

The three comparisons which showed significant differences were related to the voiceless production of cognates and noncognates in Dutch and English. There was a significant difference in the voiceless cognate production between Dutch and English ($t(26)= 3.325$, $p < .003$. There was also a significant difference in the voiceless noncognate production between Dutch and English ($t(26)= 3.554$, $p < .001$). Finally, there was a significant difference between the overall categories of Dutch and English voiceless production ($t(26)= 3.638$ $p < .001$). No other categorical comparisons showed significant differences.

The average VOT for voiced Dutch cognates was -16.43 ms (*SD* = 47.05), whereas the average voiced Dutch noncognate was -17.80 ms (*SD* = 49.20). The average voiced English cognate was produced with a VOT of -16.62 ms (*SD* = 53.22), and the English voiced noncognate average value was -15.24 ms (*SD* = 50.20). The voiceless Dutch cognates showed an average VOT of 27.51 ms (*SD* = 19.76), while for noncognates the average was 25.72 ms (*SD* = 17.78). For voiceless English cognates the average VOT value was 35.91 ms (*SD* = 27.65), while for noncognates this average was 34.71 ms (*SD* = 24.52). These averages are shown in Figure 6.

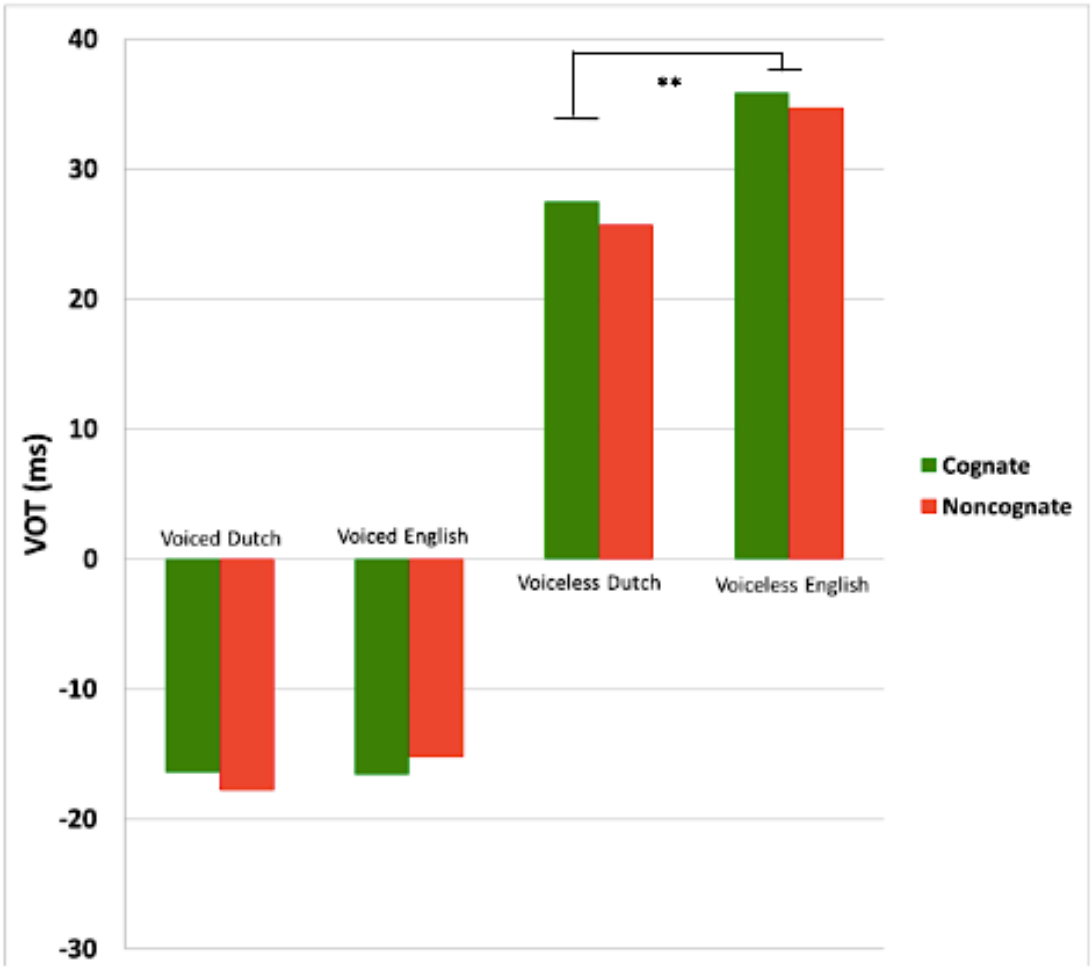


Figure 6 Graph showing average VOT in milliseconds

Correlations

A correlation analysis was also conducted in order to examine any associations between VOT measurements and proficiency scores. These values are displayed in Table 2 below.

Table 2 ***Correlations***

Variables	1	2	3	4	5	6	7	8
Dutch Cognate VOT (N=701)	-							
Dutch Noncognate VOT (N=690)	-.02	-						
English Cognate VOT (N=696)	.03	.13**	-					
English Noncognate VOT (N=625)	.12**	-.07	.05	-				
Dutch Picture Naming	-.08*	-.15**	-.06	-.12**	-			
Dutch LexTALE	.07	.05	.12**	.004	.12**	-		
English Picture Naming	-.09*	-.12**	-.1**	-.13**	.21**	.15**	-	
English LexTALE	.05	.05	.05	-.04	.02	.37*	.38**	-

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Chapter 4 General Discussion

The purpose of this study was to examine phonetic interaction between L1 and L2 through the production of cognates and noncognates in Dutch child classroom learners of English. In the following section, I will summarize the findings of this study and discuss them in relation to the previous research and to the theoretical perspectives guiding this study. I will also make note of some limitations of this study and discuss further directions that can be taken in this specific line of research.

The children's proficiency scores were, as expected, much higher in Dutch than in English. However, it is important to note that the Dutch scores were not at ceiling, reflecting the fact that these children are concurrently developing two languages simultaneously. While (L1) Dutch is the more proficient language, these children are still building their knowledge of this language, in addition to learning (L2) English, although their exposure to L1 Dutch is more extensive than their exposure to L2 English. The process of developing two languages at the same time (albeit with different levels of exposure) may help to explain the unique patterns of phonetic interaction in the VOT values, as will be elaborated upon below.

Regarding the main research question of "Do the L1 and L2 phonetic systems interact during speech production in classroom L2 learners?", we found strong evidence for the interaction of phonetic systems in the Dutch classroom learners. Since the VOT values were not both completely L1-like (Dutch) in L1 production of cognates and noncognates and completely L2-like (English) in L2 production of cognates and non cognates (see Figure 1 for comparative

VOT values), it shows that there is some interaction that is happening at the phonetic level during production. Voiced cognates and noncognates in both Dutch and English were being produced with prevoicing, and therefore negative values, which correspond to Dutch-like VOTs. This shows that even when children are producing words in English, the Dutch phonetic system is still active. Similarly, the significant difference between voiceless English and Dutch VOT values, with a trend toward English-like in the L2, shows that both languages are at work. This interaction occurs because the voiceless English VOT values for cognates and noncognates are still within possible Dutch range, although they are significantly higher than the voiceless Dutch production, which exemplifies that the Dutch language is still playing a role in production.

This can also be more clearly explained through the tangible VOT values. The average VOT values for the voiced Dutch cognates was -16.43 ms and -17.80 ms for noncognates, which remains in the expected range of Dutch-like values, which are below zero. The voiced English VOT average for cognates was -16.62 ms and -15.24 ms for noncognates, which are still consistent with the expected negative Dutch values and demonstrates the interaction of the two phonetic systems. The Dutch voiceless VOT values of 27.51 ms for cognates and 25.72 ms for noncognates again show typical Dutch voiceless values (ranging from 0 to 35 ms). The English voiceless VOT values of 35.91 ms for cognates and 34.71 ms for noncognates still remain within Dutch-like values as well (0 to 35 ms). Typical voiceless English VOT values range from 35 ms to 70 ms. However, because of the significantly higher voiceless English VOT values (35. 91 ms & 34.71 ms) relative to the Dutch voiceless values (27.51 ms & 25.72 ms), there is evidence that some kind of interaction is occurring between phonetic systems. If phonetic systems did not show an interaction, we should have expected to see L1-like production in the L1 and L2-like productions in the L2, most clearly probably for noncognates, which do not have phonetic

similarities between languages. Therefore, another interesting finding of this study is that there were no significant differences between cognates and noncognates in any category, demonstrating this phonetic interaction even in words (i.e., noncognates) that are distinct to each language. Finally, the correlational analysis did not show any strong relationships between the proficiency scores and the VOT measurements.

To reiterate, we found clear evidence for the influence of the L1 (Dutch) on the production of the L2 (English), demonstrating an interaction of phonetic systems. In referencing the predicted outcomes of three theoretical perspectives, depicted in the three graphs shown in Figure 3, this finding is most closely tied to the results of Jacobs and colleagues (2015), who also found that classroom L2 learners produced cognates and noncognates with more L1-like VOT values. They explained this pattern by proposing that L2 learners (who were not immersed in the L2) lack inhibition of the L1 in L2 production. Referring to both the English and Dutch production in this study, since the VOTs are being produced with typical Dutch-like values overall, there is strong evidence to support the notion that L2 classroom learners are unable to suppress the first language in the production of the second language. However, the present study also yielded a significant difference between the voiceless production in both Dutch and English, with the L2 English trending towards typical native English speaker VOT values. Even though the child L2 learners' voiceless English VOT values are still not quite comparable to those of adult native speakers of English, as previously mentioned, children are gradually developing VOT in both English and Dutch and the significant difference between the Dutch and English values confirms the concurrent development of both languages and the unique phonetic patterns that result from the different stages of development between the two languages. This finding is similar to that of Abdollahi & Van Hell (in prep) which showed an L2-like trend in VOT values

for production of cognates in the L2 by adult Dutch-English bilinguals, although the significant difference between English and Dutch VOT values in voiceless production of the current study is especially interesting. Referencing the graphs in Figure 3, we predicted that based on Stoehr et al.'s notion of L1 inhibition as a result of exposure, that there would be a clear and significant VOT difference in the production of Dutch and English voiceless plosives. Indeed, the child classroom L2 English learners are producing both English cognates and noncognates with longer aspiration, which demonstrates that they are able to make a distinction between the voiceless plosives in English and Dutch, since the Dutch values are significantly lower. In contrast, voiced plosives in L2 English remained more Dutch-like overall. In all, the present findings are partly in line with the lack of L1 inhibition account (theory 2) and the notion that L1 inhibition varies with amount of L2 exposure (theory 3).

The child classroom L2 learners are showing interesting, and unique, patterns of phonetic interaction between L1 and L2, and these patterns do not directly align with the findings of previous research. Specifically, these data demonstrate a unique pattern in the production of English aspirated plosives, suggesting that these phonemes are easier to learn and produce for Dutch children learning English. Since this study shows a trend toward English-like production and the longest positive VOT for L2 English words beginning with phonemes /p/ and /t/, it can be inferred that these are easier for Dutch children to learn. By placing an emphasis on the production of these specific phonemes in English-learning classrooms, teachers may be able to instill more native-like English production in the children. A further pedagogical implication of these findings is that teachers may want to explicitly focus on the importance of inhibiting L1 phonemes during L2 production. For example, English production should not show any negative prevoicing (see also Figure 1), yet children are still producing words beginning with /b/ and /d/

with prevoicing in English. Therefore, it is recommended that English teachers of Dutch students make a purposeful distinction between the way these phonemes are produced in Dutch and English in efforts to create more native-like English speech.

There are also a few limitations to this study that are important to discuss. First, the participant group was recruited from three different schools, so there may be pre-existing differences among the type of input that the children were receiving in the classroom and the amount of exposure that they received. While all three schools were following the same "Early Bird" curriculum and providing English instruction through all years of primary school, we are not able to assume that all children received identical instruction, related to potential variability in, for example, the teachers' knowledge of the English language or the number of hours per week exposed to English at school. Between schools, the students' experience and exposure in the classroom may vary and therefore lead to differences in production. An additional analysis should compare VOT patterns between the three schools to justify this claim. Additionally, this study did not test an age-matched monolingual English group in order to gain comparative English VOT values, which may make it harder to explain the results in relation to the production patterns of other English primary school children.

Finally, future directions for this study may take many forms. While a teacher questionnaire was created for this study in order to gain more insight into the teacher's language history and typical English lessons in the classroom, the data has not yet been examined. However, more direct observation could be even more useful and a future study could involve a classroom observation and coding scheme to get a true sense of the classroom environment and English language instruction.

The second author of this paper also collected VOT data of college-aged, and more proficient, Dutch learners of English at Radboud University in the Netherlands (Abdollahi & Van Hell, in prep). Future analysis could examine the average VOT values of those college students in comparison to the elementary school students tested in this study. This may provide interesting insights into the role of L2 proficiency and L2 exposure on L2 English speech production.

Additionally, since there was such variability among the accuracy of responses to the picture-naming task, a further study could again try to effectively compare the word-naming to the picture-naming tasks to examine whether there is a difference between VOT values when stimuli are more language-ambiguous (in the form of pictures) rather than when the language is explicitly given, such as in the word-naming task. Related to this, it would be interesting to combine the current word-naming tasks in order to create one task that involves both English and Dutch words. This future study could be adapted from the word-naming task in the current study to create a word naming task that randomly displays either a Dutch or English word on the screen, prompting the participant to read it aloud as quickly and accurately as possible. This would create a more mentally demanding task, but potentially other unique patterns of phonetic interaction. Future projects should examine the results of cross-lexical production in children of other languages, as well, to see how these patterns may compare.

Conclusion

Overall, the goal of this research was to examine the patterns of phonetic interaction between L1 and L2 in child classroom L2 learners by measuring the Voice Onset Time of the

production of cognates and noncognates in L1 and L2. Even though some studies have addressed this question in adult L2 learners, the question remained largely unexplored in child L2 learners who learn their L2 in a classroom setting. The results of the current study show a clear influence of the L1 (Dutch) on children's L2 (English) production. However, a significant difference emerged between voiceless cognates in English and Dutch, as well as noncognates, showing unique patterns of phonetic interaction. This research also has practical implications for the way in which L2 English is taught to children in the Netherlands and suggests that making children aware of phonetic differences between Dutch and English (e.g., knowing when to inhibit L1 phonemes during L2 production) may help children to achieve native-like L2 production.

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ACADEMIC VITA
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EDUCATION

The Pennsylvania State University | Schreyer Honors College — **University Park, PA**
Bachelor of Arts in Psychology — *Graduation: May 2019*
Bachelor of Arts in Italian
Human Development and Family Studies Minor

Honors Thesis in Psychology (Advisor: Dr. Janet G. Van Hell):
L1 and L2 Phonetic Interaction in Classroom L2 Learners: A Developmental Perspective

HONORS AND AWARDS

- **Dean's List (every semester)**
- **Partnerships for International Research and Education (PIRE) Fellowship**
- **Phi Eta Sigma National Honor Society at Penn State**
- **Psi Chi - The International Honor Society in Psychology**
- **Gamma Kappa Alpha Italian Honor Society at Penn State**
- **Josephine Rhea Awards for Excellence in Italian Studies for 2016-2017**
- **Irving L. Foster Memorial Award from The Department of Spanish, Italian, and Portuguese for 2018**
- **Certificate of Excellence Award from The Department of Spanish, Italian, and Portuguese for 2019**
- **Paterno Fellows Program**
  Honors Program including advanced academic coursework, thesis, study abroad and/or internship, ethics study, and leadership/service commitment

RESEARCH EXPERIENCE

Bilingualism and Language Development Lab — **University Park, PA**
Research Assistant for Janet van Hell, PhD — *September 2017 — Present*
- Involved in various psycholinguistic studies examining bilingualism and language development
- Gained extensive experience coding Voice Onset Time phonology data using Praat software
- Gained experience assisting in multiple EEG experiments
- Attended weekly lab meetings which involved discussion of relevant research articles and new research projects

Cognition Affect and Temperament Lab — **University Park, PA**
Research Assistant for Koraly Perez-Edgar, PhD — *February 2016 — Present*
- Coded behavioral data for the BRAINS project examining social interactions and attention among children
- Assisted in various eye-tracking studies testing infants and their parents

ABROAD EXPERIENCE

Partnerships for International Research and Education (NSF PIRE program) — **Nijmegen, The Netherlands**
Undergraduate Fellow — *May 2018 -July 2018*
- Applied for and received a National Science Foundation funded grant through the Center for Language Science at Penn State
- Conducted independent research which involved collecting phonology data in three Dutch elementary schools

Human Development and Family Studies (HDFS) in Italy **Florence, Italy**
International Student *May 2017 -June 2017*

- Participated in a seven-week study abroad program about child development, education systems, and family in Italy; course work included field experience in an Italian preschool

CONFERENCE PRESENTATIONS

Linguistics and Cognitive Science Student Conference **Newark, DE**
Poster Presenter *April 2019*

- Yuro, J., Abdollahi, F., Unsworth, S., Van Hell, J. (2019) *L1 and L2 Phonetic Interaction in Classroom L2 Learners: A Developmental Perspective* [Poster]

Psi Chi Undergraduate Research Conference **University Park, PA**
Poster Presenter *April 2019*

- Yuro, J., Abdollahi, F., Unsworth, S., Van Hell, J. (2019) *L1 and L2 Phonetic Interaction in Classroom L2 Learners: A Developmental Perspective* [Poster]

Young Scholars Speaker Series 2019 **University Park, PA**
Poster Presenter *February 2019*

- Yuro, J., Abdollahi, F., Unsworth, S., Van Hell, J. (2019) *L1 and L2 Phonetic Interaction in Classroom L2 Learners: A Developmental Perspective* [Poster]

Center for Language Science Weekly Meeting **University Park, PA**
Presenter *December 2018*

- Gave an oral presentation to the CLS faculty, staff, and students during a weekly meeting related to the independent research project that I conducted in the Netherlands and my overall experience

PSUxLing5 Meeting **University Park, PA**
Poster Presenter *October 2018*

- Yuro, J., Abdollahi, F., Unsworth, S., Van Hell, J. (2018) *A Developmental Approach on Cross-Language Production in School-Aged L2 Learners* [Poster]

Multidisciplinary Approaches to Child and Adult Language Acquisition **University Park, PA**
Poster Presenter *October 2018*

- Yuro, J., Abdollahi, F., Unsworth, S., Van Hell, J. (2018) *L1 and L2 Phonetic Interaction in School-Aged L2 Learners* [Poster]

Young Scholars Speaker Series 2018 **University Park, PA**
Poster Presenter *April 2018*

- Yuro, J., Abdollahi, F., Van Hell, J. (2018) *A Developmental Approach on Cross-Language Production in School-Aged L2 Learners.* [Poster]

LEADERSHIP EXPERIENCE

Penn State Dance Marathon (THON) **University Park, PA**
Organization THON Chair *May 2016-Present*

- Provided emotional support to Four Diamonds Families affected by pediatric cancer at Penn State Children's Hospital in Hershey, PA
- Motivated a group of 24 members to raise a cumulative total of approximately $30,000 over two years for pediatric cancer research through various fundraising efforts
- Supervised other chair positions in carrying out their designated roles effectively

Penn State Dance Alliance **University Park, PA**
Team member and Vice President *August 2015-Present*
- Managed all social media accounts (website, Facebook, Instagram) for outreach and promotional use
- Kept attendance and other organizational means for a dance organization
- Choreographed multiple large group dances for campus performances

Friendship Group Program **University Park, PA**
Coach *September 2017-April 2018*
- Facilitated social skills group therapy sessions for children with behavioral problems and developmental delays, including children with ADHD, autism, and anxiety
- Received weekly feedback from a doctoral student in clinical psychology at Penn State

Delta Phi Epsilon Sorority **University Park, PA**
Founder *October 2016-Present*
- One of the founding members of the Delta Pi chapter at Penn State University
- Involved in many meetings and elections to create the bylaws and foundation of the chapter
- Raised money and awareness through the organization of and participation in events for the Cystic Fibrosis Foundation (CFF) and Anorexia Nervosa and Associated Eating Disorders (ANAD)

WORK EXPERIENCE

Bilingualism and Language Development Lab **University Park, PA**
Paid Research Assistant *January 2019-Present*
- Worked closely with a graduate student to assistant in EEG testing and analysis related to a project on novel word learning in college students

Center for Arts and Crafts at Penn State **University Park, PA**
Dance Instructor *August 2018-Present*
- Taught "Contemporary and Jazz Movement" and "Exploring Dance Styles" classes to students and faculty
- Created the idea and the curriculum for the classes, as well as weekly choreography

VOLUNTEER EXPERIENCE

Cedar Heights Church **University Park, PA**
Kids Program Volunteer *January 2019-Present*
- Responsible for leading and teaching a group of 1-2 year old children during Sunday services

Hort Woods Child Care Center at Penn State **University Park, PA**
Volunteer *January 2017- April 2017*
- Assisted head teachers and recorded observations in an Infant/Toddler and a Pre-K classroom for a semester
- Coursework for an HDFS class required creating and teaching an age-appropriate and relevant lesson to the children in each group

Jersey Shore University Medical Center **Neptune, NJ**
Child Life Program Volunteer *June 2016 – August 2016*
- Worked under a certified Child Life Specialist to provide developmentally appropriate games and activities to hospitalized children

INTERESTS AND ACCOMPLISHMENTS

- Proficient in the Italian Language: reading, writing, speaking, and comprehension