L1 and L2 Phonetic Processing of Dutch L2 Learners of English:

An Eye-Tracking Study

by

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Abstract

There are multiple theoretical standpoints in Second Language Acquisition and the debate between them is far from settled. Some theories argue that the acquisition of L1 and L2 happen in very different ways, whilst others suggest the exact opposite. The current study attempts to shed light on this debate by making use of eye tracking. A previous study suggested that infants use selective attention to focus on the mouth to acquire the speech forms of their L1. This study explores the possibility of a similar process occurring in Dutch L2 learners of English. Our data suggests that there is a difference between L1 and L2 processing, yet no difference between processing of an L2 that is not being learned or an L2 that is being learned was found. Furthermore, the data suggests the possibility that the division of attention in an L2 that is being learned is affected by the age of the learner in question. Overall, the results seem to suggest the interpretation that there are separate mechanisms for L1 and L2 phonological processing. Whether this this effect would also be found for more proficient learners could not be established using our data.

1. Theoretical Framework

The field of Second Language Acquisition (henceforth SLA) is characterised as a field full of conflicting interpretations, views, and theories (Benati & VanPatten, 2010; VanPatten & Williams, 2015). Its issues range from the effect of setting, instruction, and age to the representation of language in the mind of the speaker (Doughty & Long, 2008, p.4). Contrary to much of the earlier research in SLA, the focus of current SLA research is mostly on the cognitive side of language acquisition; the current aim is to discover *how* a second language is attained, not *what* is attained (Doughty & Long, 2008). Much of the debate in the current literature revolves around whether L1 and L2 acquisition are different with regards to following the same rules, storing linguistic knowledge in a similar fashion, and using the same processes and mechanisms (Gass & Selinker, 2001; Benati & VanPatten, 2015).

An example is the current debate about storage versus computation in the mental lexicon. One of the chief methods used to investigate this topic is by measuring response times in morphological processing (Bowden *et al*, 2010). Multiple studies have found that there is an effect of word frequency on the response times of irregular past tense forms in L1 processing, while such an effect for regulars is absent (Beck, 1997; Ullman, 1999; Clahsen, Hadler, & Weyerts, 2004); This is suggested to be evidence for the storage of irregular forms and for the rule based derivation of regular forms. However, evidence for the effect of frequency on both regular and irregular forms has also been found (Sereno & Jongman, 1997; Baayen *et al*., 2002). These findings have been used to argue different perspectives on whether language uses multiple systems; the findings implying a difference in processing time suggest separate systems for storage and computation, whilst the studies finding similar response times suggest the opposite (Prado & Ullman, 2009; Bowden *et al*., 2010).

This issue then extends into L2 processing, where conflicting results have been found (Babcock *et al*, 2012). Some have argued that the mechanisms in L1 and L2 processing are largely the same, claiming that all L1 and L2 acquisition is facilitated by associative learning (Ellis, 2005; Perani & Abutalebi, 2005; DeKeyser, 2008). In short, associative learning is the process whereby form-meaning pairs known as *constructions* are stored in memory. A construction is strengthened when its use increases; The theories that support this are usually referred to as Usage Based theories (VanPatten & Williams, 2015). Though frequency is not the only variable affecting acquisition in this theory, it is supposed to be one of the best predictors (Robinson & Ellis, 2008). When it comes to the mental lexicon, there is some evidence supporting the claim that all storage and computation is by means of a single system (Feldman *et al*, 2010; Perani & Abutalebi, 2005).

Others have posited that L1 and L2 processing are separate to various degrees (DeKeyser, 2008). Bley-Vroman (1990), for example, suggests that the L2 learner’s inability to access Universal Grammar results in reliance on different processes, mechanisms, and neural substrates than would be used in L1 acquisition. However, the arguments for this when it comes to the mental lexicon have been largely theoretical and there has been little convincing evidence that supports this view (Bowden *et al*, 2010; Feldman *et al*., 2010).

There are also theories that combine certain aspects of the aforementioned sides, with an example being Ullman's Declarative/Procedural model (Ullman, 2004) or DP model for short. Ullman's model, and others like it, pose that L2 acquisition initially makes use of purely lexical processes to store linguistic information. This is unlike processing in L1, where only the information that cannot be processed by rule is stored as lexical information. In the DP model specifically, all linguistic information in L2 acquisition would be stored in Declarative Memory; this would only be the case for idiosyncratic information in L1 acquisition. However, the model poses that the reliance on Declarative memory decreases as the proficiency of an L2 speaker increases, thereby making the mechanisms more like in L1 acquisition (Ullman, 2004). However, learners beyond the age of puberty would slowly lose the ability to access procedural memory. The model therefore hypothesises that L2 acquisition after puberty relies on different processes and mechanisms entirely (2004). When it comes to the mental lexicon, there have been some findings that support this theory (Bowden *et al*., 2010; Neubauer & Clahsen, 2009, Lalleman *et al*., 1997). Other support has been drawn from various correlational and fMRI studies (see VanPatten & Williams, 2015), though the findings of the latter have not been conclusive.

This debate between the various theoretical sides does not simply pertain itself to the discussion of the mental lexicon and morphology. Other subjects include the acquisition of grammar and semantics, the importance of input, the effects of age and setting, the role of the first language, and bilingualism (Benati & VanPatten, 2010). While a full review of the positions of the various sides on all of these is beyond the scope of this study, it should be clear that there are multiple theoretical views within SLA that have different predictions regarding the availability of L1 processes and mechanisms in L2 acquisition. The aim of this study is to further explore the possibility of access to L1 processes and mechanisms in L2 acquisition.

Lewkowicz and Hansen-Tift (2012) posit that infants might employ specific mechanisms during the process of learning how to produce native speech. Specifically, they suggested the possibility that infants might employ selective attention during specific stages of speech development to gain access to highly salient audio-visual speech information (p. 1434). The access to this information would then help them learn their native language forms (p. 1434). To further investigate this, they showed monolingual L1 English infants between the ages of 4 to 12 months videos of an adult speaking to them in either English or Spanish. They found that 4-month old infants paid more attention to the eyes, while infants older up to an age of 8 months would gradually pay more attention to the mouth. They concluded that between 4 to 8 months of age the attention of the infants shifted from the eyes to the mouth regardless of whether the language that was spoken to them was the native or the non-native language. The attention of the infants older than 8 months gradually shifted back to the eyes for native English, meaning that 9 month old infants spent more time focussed on the eyes than 8 month olds and so forth. The infants' attention did not revert to the eyes for non-native Spanish as age increased.

The window in which the infants started and ended this shift in attention coincides with the period in which they learn to produce the sounds of their native language, which led Lewkowicz and Hansen-Tift (2012) to hypothesise that the change in looking behaviour in the native language of their participants is due to the increase in linguistic knowledge of the native language. They also argue that this increase of linguistic knowledge of the native language goes hand in hand with an effect of perceptual narrowing, which causes a decrease in sensitivity to the sounds of non-native speech. Due to this, the infants with the phonemic categories of their native language already in place would retain their focus on the mouth during non-native speech to disambiguate the speech signal (p.1435).

Given that infants shift their attention to the mouth of the speaker when learning the sound system of their L1 one might presume, depending on their theoretical standpoint, that adolescent L2 learners employ similar tactics and mechanisms as the infants in Lewkowicz and Hansen-Tift (2012). Should it therefore be the case that the acquisition of phonemes in an L2 is done in a similar fashion to the acquisition of phonemes in the L1, as some of the aforementioned theories hypothesise, one might expect that adolescent L2 learners pay more attention to the mouth than to the eyes when in the process of learning the sounds of the L2. Furthermore, it might be expected that their attention shifts back when the learners become more proficient. Based on the aforementioned theoretical debate, it might also be expected that there is a difference between the processing of a native language and the processing of any foreign language regardless of whether that language is being learned.

This study sought to determine whether there is a difference between L1 and L2 processing by investigating the division of attention of Dutch adolescent L2 learners of English when listening to either Dutch or English. Besides this, it attempted to determine whether there is a difference between the processing of an L2 that is being learned and an L2 that is completely new. Furthermore, it sought to establish whether the processing of an L2 that is being learned is affected by proficiency.

2. Research question and hypotheses

Research question: Do Dutch L2 learners of English pay more attention to the mouth when listening to English than they do when listening to Dutch?

Given that infants might use cues given by the mouth of a speaker in the acquisition of L1 speech forms, it might be that L2 learners have a similar mechanism. Regretfully, research into L2 processes and mechanisms active in the acquisition of phonetics has been next to non-existent, making it difficult to give a prediction of what is to be expected based on prior research. However, the various theoretical standpoints in L2 acquisition have different theories regarding the availability of all L1 processes and mechanisms in L2 acquisition. Various nativist researchers and theories have different predictions regarding the availability of L1 processes and mechanisms in L2 acquisition (Williams & VanPatten, 2015). It would therefore be difficult to give an exact prediction from this theoretical view. In contrast, the other two aforementioned theories both predict that the processes and mechanisms of L1 acquisition should be available to adolescent L2 learners. Due to this, it might be reasonable to assume that Dutch L2 learners of English will pay more attention to the mouth of an English speaker when listening to English in an attempt to learn the phonetic forms of English.

Sub-question: Is there a difference in the attention paid to the mouth between English and Hungarian?

If it is to be assumed that Dutch L2 learners of English pay more attention to the mouth when listening to English than they do when listening to Dutch, then there are multiple possibilities. The first is that more attention is paid to the mouth when listening to English than when listening to Hungarian. This might then be caused by the activation of a mechanism similar to Lewkowicz and Hansen-Tift (2012), causing the focus of attention to shift to the mouth of the language the Dutch L2 learners of English are learning, which might not yet have been activated for Hungarian due to lack of exposure. The second option is that there is more attention towards the mouth when listening to Hungarian than there is when listening to English. This would then suggest a shift in the reliance on the cognitive mechanisms of the L2 to the cognitive mechanisms of the L1. Such a finding might be evidence for the DP model, as it poses that L2 processes and mechanisms start out being different, yet change to processes and mechanisms similar to those of an L1. However, another possibility is that the division of attention in both foreign languages is relatively the same. This finding could mean multiple things, the most theoretically impactful of which would be that it suggests two separate systems for L1 and L2 processing regardless of whether the L2 is being learned. However, two of the aforementioned theories predict an effect of exposure on processes and mechanisms, thereby making the stance that there will likely be a difference between the attention to the mouth when listening to English and to Hungarian the most likely.

Sub-question: Is there an effect of proficiency on the division of attention between the eyes and the mouth when listening to English?

The various theories predict different outcomes, yet the finding that proficiency has an effect on the representation of the L2 in the brain across multiple subdomains (Perani *et al.*, 1998; see Ullman, 2004 for a review) suggests that an effect of proficiency might very well be plausible. We therefore consider the existence of an effect of proficiency on the division of attention between eyes and mouth in English to be more likely, as evidence to the contrary does not pertain to the processing of phonology.

3. Method

3.1 Participants

Our group of participants consisted of 80 Dutch secondary school children between the ages of 12 and 18 (M = 14.49, SD = 1.591). These ages are equivalent to the first to the fifth grade in the Dutch secondary school system. 40 male and 40 female students were quasi-randomly selected from the various grades. This was done to ensure that participants of varying levels of proficiency were taking part; the underlying assumption is that the students in higher grades would be more proficient. Participants were enrolled in lower general secondary education (MAVO), senior general secondary education (HAVO), or pre university education (VWO)[1]. Students with Autistic Spectrum Disorder or with a form of Dyslexia were not excluded from the study, yet were tagged as such to ensure that their results can be processed even if those results are deviant. The participants were recruited from a secondary school in Wageningen at which one of the researchers is employed. Participation in the study was optional. No grade or bonus points were awarded on the basis of participation, though the students were told that the study might give them an idea of their proficiency in English as well as being fun to do. Further details about the study were not disclosed.

3.2 Materials

The study contained three tests in total: two tests to measure English proficiency and one eye-tracking test. The proficiency tests were deemed necessary because some participants may already have been more proficient than others for various reasons. All of the proficiency tests were performed in a separate room from the eye-tracking test. This was done because doing the tests in two separate rooms was more convenient. It allowed the researchers to test more participants than would have been possible if both setups were in one room. Furthermore, having two setups with respective rooms might have prevented any effects that could have occurred from having multiple test setups in the same room.

3.2.1 LexTALE

[1] Translation taken from the Dutch Ministry of Education website, for a more in depth explanation see http://www.government.nl/topics/secondary-education.

The first of the proficiency tests is LexTALE (Lemhöfer & Broersma, 2012), a visual lexical decision task which can be used to measure the familiarity of the subject with the lexis and, in extension, the phonotactics of the language in question. The test features 60 stimuli, 40 of which are real words and 20 are non-words. The participant is presented with each word sequentially and is given the choice whether or not this is a real word in the language after having seen the word. Participants are allowed to answer that a word is part of the language even if they cannot define its meaning. After all the items have been assessed, a score out of 100 is given by calculating the average of the percentage of correct answers for nonwords and the correct answers for the real words. LexTALE has been found to be a good indication of general language proficiency, with substantial correlations between it and more extensive proficiency tests such as the Quick Placement Test (QTP) and the TOEIC test (Lemhöfer & Broersma, 2012). Even higher correlations have been found with tests that measure translation performance, in particular so for the group of Dutch participants in the study (2012).

However, the LexTALE test might only measure one specific part of linguistic knowledge, namely lexical knowledge. This knowledge may be part of what might be deemed as knowledge of a language, yet it is likely too general a test to make accurate predictions regarding the receptive language abilities of the participant in question. Some participants might indeed score much higher than their peers due to having read more in English without having had more overall input, causing them to score higher despite not being more proficient. Similarly, a participant that has Dyslexia or has had most of their input through speech might not score as highly as some of their equally proficient peers would. It was therefore deemed necessary to implement another measure, namely a phoneme discrimination task, to give a better representation of the type of proficiency that we are interested in. This task would aim to measure the extent to which the participant is able to tell

English phonemes apart, and is therefore assumed to measure the knowledge of the phonology of a language of the participant in the language in question, in this case English.

3.2.2 Phoneme Discrimination Task

The second test featured a total of 60 stimuli. A specific set of phonemes was used to construct nonsense words. This set consisted of phonemes that are native to the participants (e.g. /p/, /b/, amongst others) as well as some non-native phonemes from the British English phonetic system (e.g. /θ/, æ). Some phonemes are difficult to place in either of these categories, with examples being /ʧ/ and /ʤ/. Other phonemes were left out due to time constraints or due to relative improminence. An example of this is the glottal stop /ʔ/. Despite occurring in both languages, it is not deemed to be salient enough because it occurs mostly as an allophone in English and in very strict circumstances in Dutch (Collins & Mees, 1984).

The nonsense words that were created from this set were made into minimal pairs. The sounds could differ in voicing, place of articulation, or manner of articulation. The differences occurred in initial, medial, or final position, yet not in more than one of these. This was done to ensure that the items could statistically be checked for validity, as some differences may be more difficult to spot than others for non-native speakers.

The main focus of this test were the phoneme pairs that featured at least one English phoneme. Some phoneme pairs that occur in Dutch were also used, though largely as a control measure. It is assumed that some of these pairs would be more difficult than others. The pairs that occur in Dutch (for example /p/ and /b/) would be less difficult than the pairs with one native and one non-native phoneme (/f/ and /θ/). The pairs with two non-native sounds, e.g. /θ/ and /ð/, are assumed to be the most difficult. Pairs of two non-native sounds are therefore only given in a context of sounds that are native to the speaker. An example would be the case of /bIθ/ and /bIð/. In this case, the focus, the dental fricative in final position, does not occur in Dutch. The other phonemes in this item, /b/ and /I/, are native to Dutch to then ensure that the item tests whether the participants can discriminate between the variants of the non-native phoneme.

To then record these stimuli, a male native speaker of English with an RP-like accent (middle-middle class Estuary English) was recruited from the English department of Utrecht University. The speaker has a moderate knowledge of phonology, though admits not having used it in recent years. The stimuli were recorded in a phonetics lab at the Utrecht Institute of Linguistics using a Sennheiser me64 microphone and Audacity recording software. The sound files taken from these recordings were then strung together in Audacity. Using this program, sound files were created which have a word followed by either its minimal pair or itself. The latter of these is used as a control to avoid a response bias. The stimuli were presented to the participants in a fixed order in which the pairs were randomised in such a way that there would be no adjacent target-control pairs.

3.2.3 Main Test: Eye-Tracking

Our eye-tracking test sought to establish whether an increase in attention on the mouth was found when the participants were listening to an L2 they are learning. Furthermore, it attempted to discover whether there was an effect of proficiency or an effect of unknown L2 vs L2 being acquired. If our hypothesis is correct, an increase in eyes over mouth ratio should be seen as the proficiency in the non-native language increases. A setup with three languages was needed to attest this. The first would be the native language of the participant to provide a baseline for the other conditions. The second would then be the language in which the proficiency varies due to the participants being in different stages of acquisition; for our study, this is English. The third language in this setup is used to determine whether a difference in attention between the other two conditions cannot be explained by English being a foreign language rather than a language that is being learnt. Hungarian was chosen for this purpose for two reasons: First, it is one of the most distant languages from Dutch. Languages such as German might not immediately register as foreign due to being rather similar to Dutch. Second, one of the researchers happened to be acquainted with a Dutch-Hungarian bilingual. Consequently, this setup relies on the assumption that none of our participants would be familiar with Hungarian. It was possible that there would be some participants that know Hungarian. Despite this, participants were asked whether they had any experience with Hungarian to ensure that none of our participants had any knowledge of Hungarian. With the exception of 2 participants that knew some very basic Hungarian words, none of the participants had any knowledge of Hungarian.

A number of videos were recorded to serve as stimuli for this experiment. The videos featured a speaker telling one story from a selection of stories that were written specifically for this study. Each of the stories were monologues with a length of around 400 words. The monologues were centred around teenage life and school, as well as being written from a first person view, to ensure that the stories were relatable to the participants. Two of the stories were in Dutch, one was in English, and one was in Hungarian. The stories in Dutch and English were made by the researchers, yet the translation of the last story into Hungarian was done by a native speaker of Hungarian since neither of the researchers know it well enough to do so. As mentioned before, a setup with three languages would be required to give an accurate representation of the attention the participants pay to the face of a speaker of the language they are learning. Because no native Dutch, English, and Hungarian trilingual could be found, a setup with two speakers was used. Two speakers from the researchers' personal network were recruited for this, one speaker with Dutch and English as native languages and one speaker with Dutch and Hungarian as native languages. The speakers are both females in their early twenties and were not compensated except for travelling costs. The stories were then read by the respective speakers in their respective native languages. Recordings were then made using a Panasonic SDR-H80 video recorder in which the speakers tell the stories in an anecdotal fashion. The videos were made in a 1920 by 1080 resolution to make the image as clear as possible. The audio was recorded into Audacity using a Sennheiser ME-64 through a pre-amplifier and was later synced with the video recording of that segment in order to make a video with high quality audio and video.

3.3 Procedure

Testing took place over the course of nine days between the 9th and the 20th of May. Both of the rooms at the secondary school where we recruited our participants were prepped for the tests on the first day of testing. A laptop that was used for conducting the first two tests was placed in the first room. A pair of headphones was also placed there for use in the phoneme discrimination task. The eye-tracker was placed inside the other room, which was dimly lit to prevent the lighting affecting the tracking. Four differing sequences of the recordings were made in the eye-tracker’s software to ensure that any effect of the video’s order of appearance could be detected. All the tests were then checked to ensure the tests could be successfully administered. The participants were brought in one by one. They were first lead into the room where the proficiency tests would be conducted. The admission of the two proficiency tests was automated due to possible issues of validity that could be caused by administering the tests manually. The participant was told to sit behind the laptop and follow the instructions of the program on screen. The program presented a startup screen in which the participant was prompted to enter their age, year, level of education, and gender. The researcher could also enter any commentary that might affect the results, such as Dyslexia. Next, the researcher had to enter the participant number that has been assigned beforehand to ensure the anonymity of the student in question; only valid participant numbers could be entered. After this, the program gave an introduction to the LexTALE by showing the participant a translated version of the explanation given in the LexTALE manual. After the participant had fully read and understood the explanation, the program started administering the LexTALE and saved the participant's score in a variable for later use. The program then prompted the explanation for the Phoneme Discrimination task and conducted it. The participant was asked to wear a pair of headphones during this task to minimise possible interruptions and confounds. The participant's responses on the Phoneme Discrimination task were saved for statistical validation at a later date. This is contrary to the case of the LexTALE, where the items did not need to be kept for validation because the LexTALE is standardised.

The participant was subsequently lead to the next room and was told sit in the chair opposite to the eye tracker. The researcher then briefly explained the eye tracking, the task, and calibrated the eye-tracker. The participants were told to pay attention to the stories in such a way that they would be able to summarise the story of each video in two sentences. They were also told that two videos would be in Dutch, one would be in English, and one would be in Hungarian. This was done to avoid the participant interrupting the test due to hearing a language they are not familiar with. They were then shown one of the sequences of videos on the eye-tracker. Each fixation on any point in the AOIs was registered and tagged. Each entry contained the time at which the fixation started, the duration, and the AOI in which the fixation started. This way, the total time and amount of fixations within these AOIs could be calculated.

4. Results

4.1 LexTALE

The data of two of the participants was deemed unusable due to an error in the program. The error was subsequently resolved to avoid further loss of data. The data of the remaining 78 participants has been visualised in Figure 1.1.

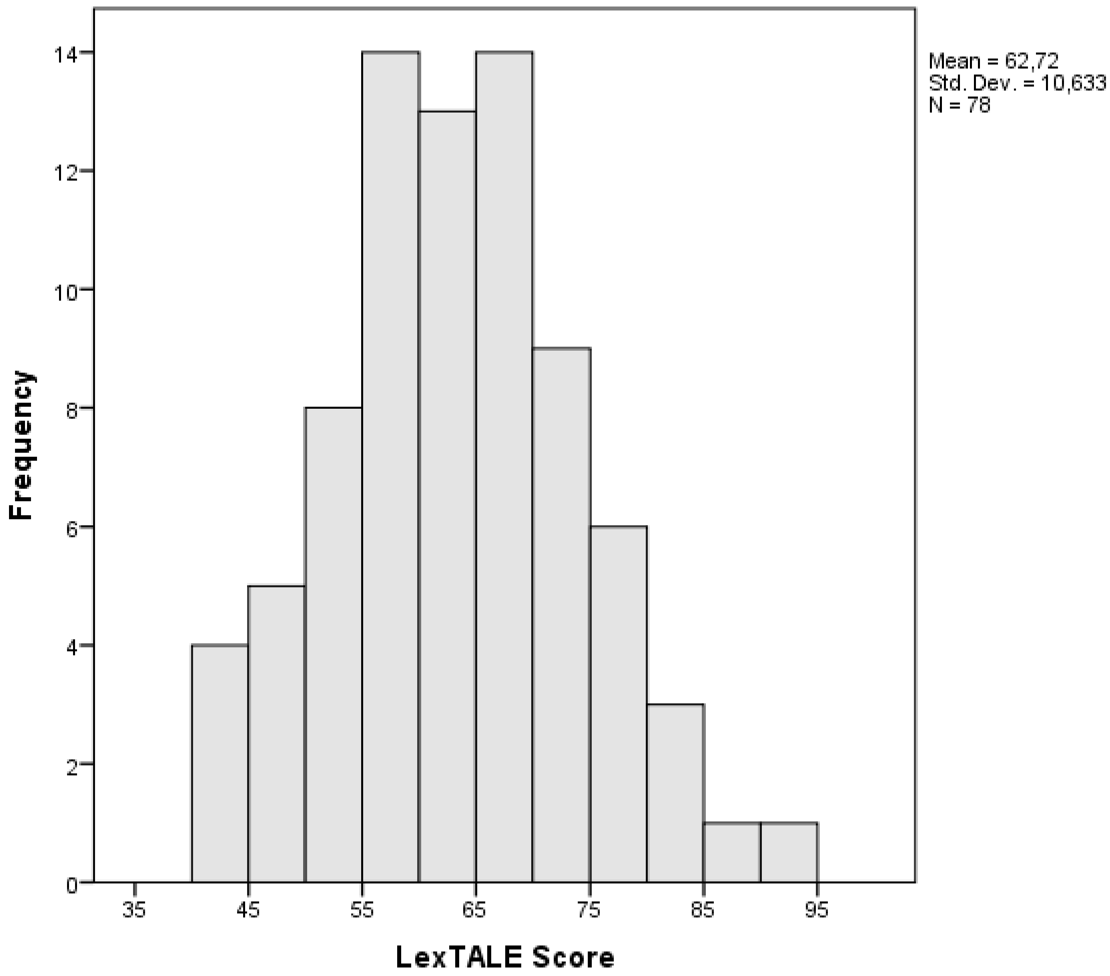

Figure 1. LexTALE scores and their frequencies. Mean, Standard Deviation, and sample size are provided.

As can be read from the above figure, the lowest score was 40 out of 100 whilst the highest score was 90 out of 100. The mean of these scores is 62.7 with a standard deviation of 106.3. The participant that scored 90 percent is omitted from the data hereafter due to being raised with English and having native-like proficiency. An effect of Dyslexia on LexTALE scores was found, t(76) = 1.897, p = .031, but could not be verified due to the characteristics of the participants in the sample. Other factors such as gender, ADHD, and Autism Spectrum Disorder were shown to not significantly affect LexTALE scores (p values above 0.05).

4.2 Phoneme Discrimination Task

The data of 80 total participants was gathered for this test. The items on the test were found to be highly reliable (α = .879). There were no outliers as Cronbach's Alpha did not change more than .01 with the removal of any item. The data was divided into a score on the controls and a score on the English targets. The data of one participant is omitted due to scoring below chance level on both the English targets and the controls. The mean of the scores on the English targets was 88.09 and the standard deviation was 14.79. The highest achieved score was 100 out of 100 whilst the lowest was 30 out of 100.

4.3 Eye Tracking

The data of 8 of the 80 participants was deemed unusable due to lack of data. The participant with native-like proficiency was excluded from this dataset as well. This brought us to a total of 71 participants of which 33 were male and 38 were female. There was no effect of sequence, gender, or Dyslexia on the division of attention between the AOIs (p values above 0.05). Interestingly, there was a significant correlation between participant age and the division of attention in English (r(69) = .24, p = .049), the language they are learning. No such correlation was found for the other languages (all p values above 0.2). The sample size of the participants with Autism Spectrum Disorder was too small to make meaningful conclusions regarding any differences in their division of attention. Furthermore, no significant correlations were found between the division of attention and the scores on the LexTALE and the Phoneme Discrimination Task.

A Repeated Measures Anova on the data of remaining 71 participants revealed there to be a significant effect of both speaker ($F(1,70) = 102.26$, $p < .001$, partial $\eta 2 = .59$) and native versus non-native language ($F(1,70) = 5.34$, $p = .024$, partial $\eta 2 = .07$). This means that the participants spent more time looking at the mouth of the Dutch-Hungarian bilingual, as well as spending more time looking at the mouth when listening to foreign languages. An interaction effect between speaker and language was not found. A visualisation of this can be found in Figure 1.3.

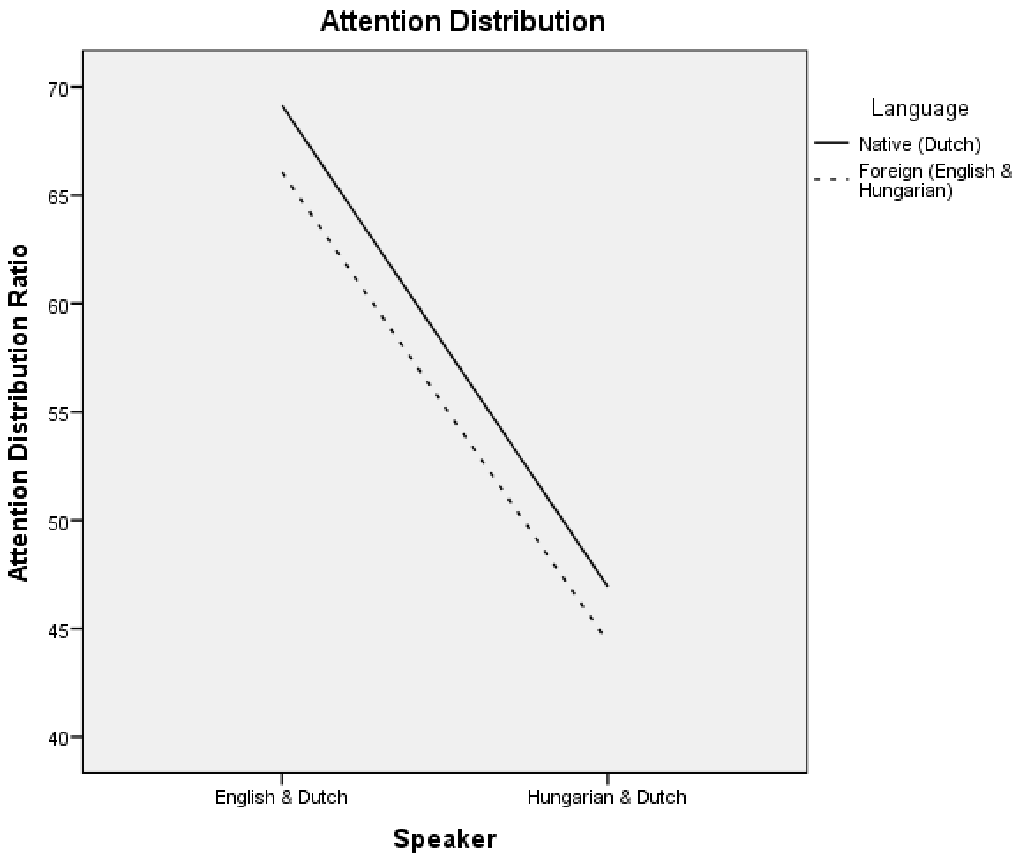

Figure 1.3. Distribution of attention between eyes and mouth for native and foreign language. The ratio is given on a scale from 0 to 100 where 0 is attention to only the mouth and 100 is attention to only the eyes.

A Repeated Measures ANCOVA showed that the effect of language on division of attention was no longer significant when the scores on the Phoneme Discrimination Task were taken as a covariate ($F(1,68) = 0.88$, $p = .35$, partial $\eta 2 = .013$). The effect of speaker did not disappear with this covariate ($F(1,68) = 14.65$, $p < .001$, partial $\eta 2 = .18$).

Both the effect of language ($F(1,67) = 0.372$, $p = .544$, partial $\eta 2 = .006$) and speaker ($F(1,67) = 3.096$, $p = .083$, partial $\eta 2 = .044$) disappeared when the scores on the LexTALE test were taken as a covariate.

5. Discussion

The present study tried to explore whether L2 learners would focus more on the mouth of someone speaking a language they are learning than they do when that person is speaking their native language. It also attempted to compare the division of attention in a language that is being learned to the division of attention in a language that is completely unbeknownst to the learner. Furthermore, it also tried to establish whether this division of attention was in any way affected by the proficiency of the learner in question.

Experiments show that Dutch L2 learners of English spend more time looking at the eyes of a speaker that is speaking their native language. The division of attention seems to be strongly affected by the speaker that the learners are seeing. The attention shifts slightly towards the mouth when said speaker is speaking a foreign language. There seems to be no effect of whether this foreign language is completely new or a language that is being learned. Furthermore, the division of attention in English seems to not be affected by the English proficiency of the participant in question regardless of which measure of proficiency is used.

Some of the findings in this study are not new. The finding that most of the attention is centred around the core features of the face: the eyes, nose, and mouth has been attested previously (Pelphrey et al, 2002). The finding that most of the attention is captured by the eyes has previously been replicated by a large number of studies, given its occurrence in social cognition, recognition of emotion, and affirmation of intent (for a detailed account see Itier, Villate & Ryan, 2008). The finding that the attention is usually centred on the most salient facial features for various reasons has also been replicated (Calvo & Nummenmaa, 2008).

Some findings, however, are new. First of all, the findings of this study suggest there to be a connection between the age of the participant and the division of attention for the language they are learning. Specifically, younger participants looked more at the mouth when listening to English than older participants. No such effect was found for the native language or the other foreign language. This may be a maturational effect due to development of the brain during puberty that affects psychological state and cognitive functioning (Blakemore, Burnet & Dahl, 2010; Blakemore 2008). However, this is unlikely because there is no significant correlation between age and the division of attention in the other languages (none of the significance levels are below 0.2). Another explanation lies in the negative effect of age on suppression; the ability to focus on highly relevant information (Rogers, 2000). It might be that the learners are aware that the mouth provides a large amount of linguistic information. This information would then be helpful to them in a language of which they have at least partial knowledge, but not in a language that is fully acquired or completely unknown. This might then mean that the change from mouth to eyes with age in the learner language is due to an aging effect causing a decrease in the ability to focus on the relevant material. However, this interpretation cannot be validated and might be pre-emptively disproven by the fact that cognitive aging effects begin after adolescence (Birdsong, 2006). Conclusions regarding this finding should therefore be taken cautiously. First, a correlation does not indicate that the effect on the division of attention is caused by age. Second, there might be other factors which this study has not accounted for. Further research is needed to established whether there is an effect of age on L2 attention and processing.

Another new finding is that our data suggests that learners pay similar amounts of attention to the mouth of someone speaking a foreign language regardless of whether this language is in the process of being acquired. The finding that more attention is paid to the mouth in a completely foreign language is not very surprising, as it has previously been suggested that the mouth plays a vital role in L2 speech segmentation (Cunillera, Camara, Laine & Rodriguez-Fornelis, 2012; Lusk & Mitchel, 2016; Mitchell & Weiss, 2014). One study, Perani *et al* (1996) examined the brain activity of adults listening to stories in their native and second language, as well as an unknown language. All the adults in question had acquired their second language after the age of 7. They found that the brain areas active in phonological processing were active for the second and the unknown language, but not for the L1. From this, they concluded that some brain areas are shaped by early exposure to maternal language. The second and unknown language would then have to be processed by different areas in the brain than the native language. This finding, paired with our data, suggests that the processes and mechanisms involved in the acquisition of phonology in an L2 are not the same as those in L1 acquisition. However, there are some objections to this conclusion. The first of these is that Perani et al (1996) used low proficiency L2 bilinguals in their study. It might be that the proficiency of the participants in question had an effect on the representation of the L2 in the brain. Later results suggested this to be the case. Perani *et al.* (1998) looked at the brain activity of highly proficient L1 Italian L2 English bilinguals using the same task as in Perani *et al.* (1996). They found that the highly proficient bilinguals processed the stories in their L2 in a similar fashion to their L1. It might therefore be that low proficiency learners use different parts of the brain and, in extension, other processes and mechanisms than high proficiency learners, a finding which would be in line with Ullman's

DP model. However, it is still uncertain whether the initial acquisition of L2 speech forms makes use of L1 processes and mechanisms or not, as to the best of the author's knowledge little to no research has been done on processes and mechanisms in the initial stages of acquisition. It could therefore be that younger learners that have just started the process of acquiring L2 speech forms exhibit a very different process than what has been shown here.

Future research will be necessary to determine whether an effect of proficiency on division of attention can be found. The results of our proficiency tests suggest that the learners in our study were already too proficient for such an effect to occur. Research on the attention of younger speakers who are at early stages of acquisition might yield different results. The findings of this study suggest that learners pay more attention to the mouth when spoken to in a foreign language than they do for the native language. Furthermore, the data suggests that there is an effect of age on the processing of an L2 that is being learned. However, these findings needs to be validated due to the small amount of research on the topic. Furthermore, it is still unknown what the division of attention would be for bilinguals or learners that are native-like. More research is needed to give a more definitive answer to these questions.

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Appendix A

A broad phonetic transcription of all the minimal pairs has been provided below. The orthographic representation is given after each pair. Unvoiced-voiced pairs that are difficult to represent orthographically like Thimu, Thimv have been marked with an asterisk.

1. /fɒd/ and /θɒd/	Fod, Thod
2. /jæf/ and /jæθ/	Yaf, Yath
3. /pep/ and /peb/	Peb, Peb
4. /puːŋ/ and /buːŋ/	Puung, Buung
5. /tʊʧ/ and /dʊʧ/	Tootch, Dootch
6. /rət/ and /rəd/	Rut, Rud
7. /ʧIb/ and /ʤIb/	Chib, Djib
8. /sɑʧ/ and /sɑʤ/	Sach, Sadj
9. /kɔɪv/ and /gɔɪv/	Koive, Goive
10. /ʃɪk/ and /ʃɪg/	Shik, Shig
11. /θIm/ and /ðIm/	Thimu, Thimv *
12. /bIθ/ and /bIð/	Bithu, Bithv *
13. /dep/ and /dæp/	Dep, Dap
14. /tɒn/ and /tɑn/	Ton, Tan
15. /wʌb/ and /wɜːb/	Wub, Wub (difference is difficult to present orthographically)
16. /dʊp/ and /dɔːp/	Dohp, Doop
17. /ʃɒv/ and /ʃʊv/	Shov, Shoov
18. /tɪək/and /teək/	Tiuhk, Teuhk
19. /baʊd/ and /bəʊd/	Baood, Beood
20. /faɪk/ and /faɪg/	Faik, Faig

The order in which the sound files appeared to the participants in the phoneme discrimination task has been provided below.

1 Shik Control,
2 Rut Control,
3 Dootch Control,
4 Koive Goive,
5 Tiuhk Control,
6 Bithu Control,
7 Shov Shoov,
8 Doop Control,
9 Tootch Control,
10 Puung Control,
11 Rud Control,
12 Sach Control,
13 Teuhk Control,
14 Thimu Control,
15 Dap Control,
16 Pep Control,
17 Baood Control,
18 Wuhb Control,
19 Tan Control,
20 Pep Peb,

21 Dep Control,
22 Tiuhk Teuhk,
23 Chib Jib,
24 Wub Wuhb,
25 Beood Control,
26 Wub Control,
27 Goive Control,
28 Thimv Control,
29 Bithu Bithv,
30 Dohp Control,
31 Rut Rud,
32 Bithv Control,
33 Sadj Control,
34 Shov Control,
35 Yaf Yath,
36 Peb Control,
37 Jib Control,
38 Fod Control,
39 Shig Control,
40 Sach Sadj,
41 Thod Control,
42 Doop Dohp,
43 Fayk Control,
44 Dep Dap,
45 Yath Control,
46 Thimu Thimv,
47 Ton Tan,
48 Fod Thod,
49 Yaf Control,
50 Shoov Control,
51 Koive Control,
52 Fayk Faig,
53 Puung Buung,
54 Shik Shig,
55 Baood Beood,
56 Faig Control,
57 Ton Control,
58 Tooch Dooch,
59 Buung Control,
60 Chib Control